Review Article

Critical Care Surge Capacity in Saudi Arabia in Response to COVID-19 Pandemic

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Abstract

Preparedness for coronavirus disease 2019 (COVID-19) started early in the Kingdom of Saudi Arabia before the World Health Organization declared COVID-19 as a pandemic. In this article, we narratively describe critical care surge planning in Saudi Arabia from an organizational perspective. In Saudi Arabia, the surge capacity response focused on seven domains, critical care surge capacity codes, communications, staff, space structure, supply, and strategies.

Keywords: *Coronavirus disease 2019, critical care, disaster, emergency operation, pandemic, review article, surge planning*

Introduction

Preparedness for coronavirus disease 2019 (COVID-19) started in the Kingdom of Saudi Arabia early in the course of the pandemic, even before the World Health Organization declared COVID-19 as a worldwide emergency on March 11, 2020.[1] In fact, Saudi Arabia took strict precautionary measures to prevent the spread of COVID-19 to the country and mitigate its impact.[2] Preparedness started by estimating the epidemiological projections of COVID-19 cases utilizing data from other countries and mathematical simulation modeling. In addition, preparedness involved different layers of the health-care system, including health-care providers, administrators, supply chain for personal protective equipment and critical care equipment, policymakers, and alternative space and staff planners.

The response started by activating National and Regional Emergency Operation Centers (NEOC and REOC). The response to COVID-19 pandemic across critical care units in different health sectors was built on previous preparedness work over the years. For example, the National Approach to Standardize and Improve Mechanical Ventilation project has involved more than 60 intensive care units (ICUs) in 24 cities across the country.[3,4]

Critical Care Surge Capacity

Surge capacity is defined as the ability to rapidly expand and accommodate as many patients as possible in response to a disaster.[5] The surge in the COVID-19 pandemic is a complex multi-system event that increases the demand for critical care resources.[6] In such crisis, decision-making should move from being individual-centered to population-centered.[7] It is essential to have an effective framework to better understand and manage the COVID-19 critical care surge. In Saudi Arabia, the surge capacity response focused on seven domains, critical care surge capacity codes, communications, staff, space structure, supply, and strategies. All elements are necessary to permit hospitals to effectively respond to disasters [Figure 1].

Codes and communication

Saudi Arabia is divided into 22 health regions and clusters; each region has its REOC, which oversees all acute care admissions and discharges daily and report to the NEOC. The national critical care task force runs national critical care utilization and management. This task force is led by the Ministry of Health (MOH) adult critical care services leader and includes regional critical care leaders. The NEOC, led by the MOH deputy minister, meets daily to discuss ICU surge capacity and challenges in all regions, and take actions according to the surge capacity level. In addition, the NEOC

How to cite this article: Al Aseri ZA, Alaama T, Alhazzani W, Al-Suwaidan F, Arabi YM. Critical care surge capacity in Saudi Arabia in response to COVID-19 pandemic. Saudi Crit Care J 2020;4:14-7.

Submitted : 14-Sep-2020
Revised : 29-Sep-2020
Accepted : 29-Oct-2020
Published : 07-Dec-2020

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Access this article online

Website: www.sccj-sa.org

DOI: 10.4103/sccj.sccj_51_20

Quick Response Code:

is responsible for mobilizing extra resources, opening new beds, extending services to private organizations, deploying new beds and field hospitals, and assigning mobile taskforce teams to provide support and guidance in high-demand regions. The national critical care taskforce creates and publishes local critical care protocols and guidelines, receives daily reports from ICU in each region, and provides medical and logistical support as needed. Health region directorate through NEOC activates the surge plan according to the proportion of critical care COVID-19 cases in relation to non-COVID cases. This is divided into four levels Level 1 (Green) <15%; Level 2 (Yellow) 15%–30%; Level 3 (Orange) 31%–40%; and Level 4 (Red) >40%. The level of response is based on the projected number of critically ill patients and the availability of essential resources (i.e. staff and ventilators). Response and actions start locally, and local resources are utilized to manage demand. NEOC is planned to support levels 3 and 4.

Finally, a critical care referral hotline that is covered by experienced intensivists is available to discuss support less experienced clinicians and advise them on the need for referral to tertiary care centers. All these components are linked together and have high interrelatedness.

Staff

Globally, there is a huge gap between critical care demand and available qualified staff.[8] The COVID-19 pandemic made this gap even larger. To minimize this gap in the Kingdom of Saudi Arabia, the critical care task force and human resources at MOH, proactively, calculated the manpower needs for intensivists, critical care nurses, respiratory therapists, physiotherapists, clinical pharmacists, and dietitians at an early stage of the pandemic. Planning was based on the results of local epidemiological predictive modeling, estimating a worst-case scenario of 10,500 patients requiring ICU care simultaneously at a given time. Therefore, several human recourses measures were undertaken [Table 1]. The Saudi Commission for health specialties and MOH training worked together to provide focused online training for noncritical care physicians and nurses (COVID 19 Critical Care Crash Course [5Cs] and the Nurses Critical Care Crash Courses [Triple C]) to prepare them for the critical care environment.

The noncritical care physicians and nurses who completed mandatory training were given temporary privileges for direct and indirect patient care in the ICU under an intensivist and critical care nurse's supervision. Predictive models used the assumption that caring for 42 ICU patients would require one supervising intensivist, 6 noncritical care physicians, 6 respiratory therapists, 6 physiotherapists, 2 dietitians, and 2 clinical pharmacists [Figure 2].

Supply

In the early stages of the pandemic, a national critical care equipment committee was established to make decisions about the type and quantities of required equipment throughout the crisis.

Planning was made based on the worst-case scenario of having 10,500 critically ill COVID-19 cases at once, and

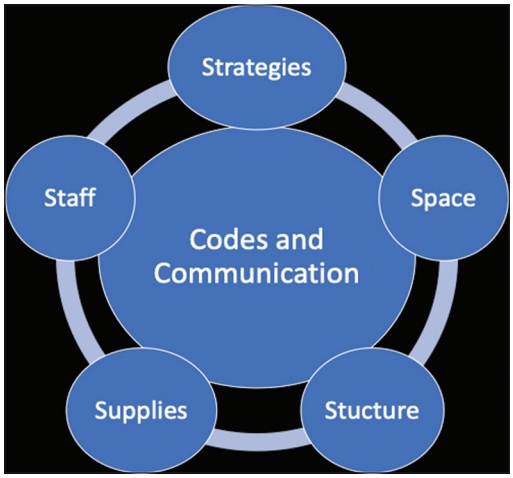

Figure 1: A framework for coronavirus disease 2019 intensive care unit surge capacity components

Table 1: Human recourses utilization measures in COVID-19 Pandemic. ICU: Intensive care units, PICU: Pediatric intensive care unit

General
Inter-sector mutual agreement for reallocation of critical care human resources
Facilitate temporary privileging
Each sector manages manpower based on own situation
Physicians
Utilize anesthesia and pulmonary consultants as ICU consultants
Upscale medicine, anesthesia and surgery physicians to function as ICU physicians under certified intensivist
Privileging ICU board certified graduates as consultant.
Utilize ICU fellows and final year ICU residents as acting consultants
Upon approval of program director, use residents of ED/ICU/Anesthesia to cover ICU, and considered as rotation
Nursing
Formal rapid orientation and training program for non critcal care nurses to work in ICU
Utilize PICU, anesthesia, endoscopy, bronchoscopy, burn unit and coronary care nursing staff

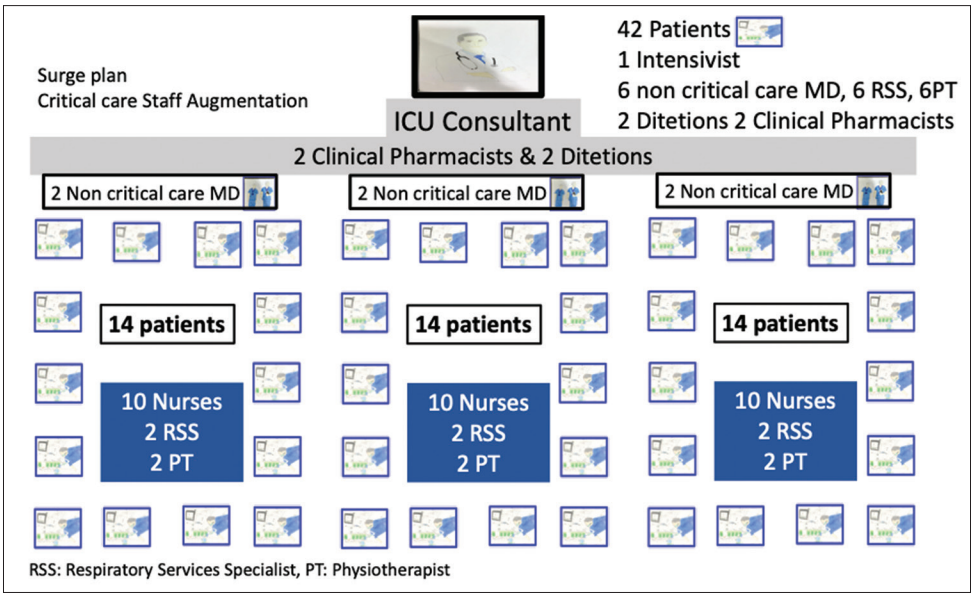

Figure 2: A proposed model for surge plan to augment critical care staff capacity

Hardware:	Consumables:	Basic ICU medication:
• Ventilators • High flow nasal cannula • Oxygen therapy resources • Monitors • Infusion pumps • Crash carts • CRRT • ECMO	• Airway • Linens • Personal protective equipment • Central lines • Arterial lines • Inline suction • NIV Interface	• Sedation • Recommend sedation • Alternative sedation • Analgesic • Vasopressor agents • Recommend Inotropic agents • Alternative Inotropic agents **Tele ICU & Remote monitoring**

CRRT: continuous renal replacement therapies; ECMO: extracorporeal membrane oxygenation.

Figure 3: Critical care supplies that should be considered during coronavirus disease 2019 surge capacity planning

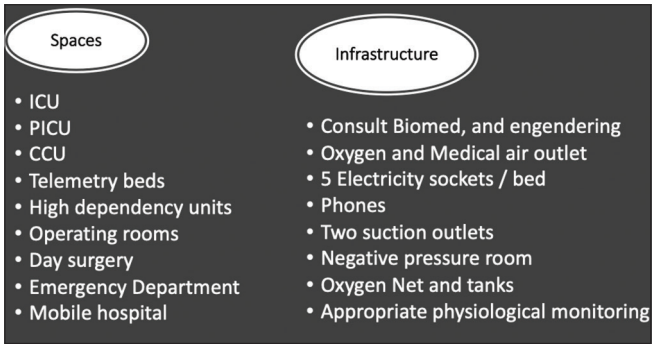

Figure 4: Potential spaces and needed infra-structures for coronavirus disease 2019 surge capacity planning

critical care hardware, consumables, and medications were purchased accordingly [Figure 3]. All ICUs were requested to provide information on their current stock of equipment, including consumables and disposables, assess potential requirements with increasing ICU load on a regular basis. All ventilators and their readiness were identified and reported to the Saudi Health Council. Hospitals were requested to work on keeping equipment functional and to timely repair out-of-service devices.

Strategies

In May 2020, the Saudi critical care society published its first evidence-based practice guidelines on managing critically ill COVID-19 patients,[9] which have been widely adopted since its release. Response to critical care COVID-19 surge requires cooperation between local and national health-care authorities.[10] To ensure integration and cooperation, the national critical care committee developed several critical care guidelines and protocols.

The strategies and guidelines covered emergency plan communication, ICU triage, admission, and discharge criteria, need for intubation, level of care, use alternative modes of oxygenation, ICU Triage, ethics in surge capacity plan, ventilation management, transfer policy, and extra-corporeal membrane oxygenation services and chain of supply.

Space and structure

Critically ill patients during a pandemic may overwhelm existing ICU bed capacity.[11]

The rapid increase in cases and the high need for hospital care put a significant burden on ICU services. For better utilization of the ICU beds, we developed and published ICU admission and discharge guidelines.[12] ICU admission checklist form [Table 2] should be filled for every ICU admission. Other clinical areas with the infrastructure suitable for critically ill patients should be identified [Figure 4]. The hospital administration should work with critical care and allied health leadership to expand the services in these areas when needed.

Conclusion

COVID-19 pandemic has been a major challenge to the health-care system both globally and in Saudi Arabia. It

Table 2: Checklist of ICU Admission Criteria

City:	**Hospital:**	**Date:**		
Source of admission	□→ED	□→In hospital	□→Referral	Admitting Consultant
Patient Name:	Date of birth:		Code Status	
MRN:	□→Male	□→Female	□→ Full Code	
Diagnosis:	Expected length of ICU Stay		□→ DNR	

Check the appropriate indication/s for ICU admission:

□→Need Invasive Mechanical Ventilation.

□→Requiring more than 2 hours on Non-Invasive Ventilation.

□→Patient requiring more than 2 hours on High Flow Nasal Cannula.

□→Oxygen saturation <90% on >50% oxygen.

□→Labored Breathing i.e.Tachypnea.

□→Patient with hemodynamic instability despite initial conservative fluid resuscitation.

□→Patient require vasopressor support.

□→Patient with a decreased level of consciousness.

□→ABG with pH < 7.3 or PCO2 > 50 mmHg. or above patient's baseline.

□→Lactate>2 mmol/L.

□→Patient with more than one acute organ failure.

□→Requires continuous renal preplacement therapy and cannot tolerate hemodialysis.

□→Patent with new ECG findings, including ischemia, arrhythmias, heart block.

□→Other, Please Specify:----------

Admitting Physician: **Signature:** **Date:**

requires applying the concepts of disaster response, including reliable preparedness and mitigation. The critical care surge capacity for the COVID-19 pandemic in Saudi Arabia has been an example of an elaborate response that addressed different domains, including communication, activation codes, staff, supply, strategies, space, and structure.

Acknowledgment

The authors would like to thank the college of art and design student Raneem Al Aseri for her help in designing the figures.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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