



Logistic Challenges and Constraints in Intensive Care During a Pandemic

Sigal Sviri, Michael Beil, Yoram G. Weiss, Arie Ben-Yehuda, and P. Vernon van Heerden

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🏠 Learning Objectives

- To discuss the major challenges hospitals and ICUs are faced with during prolonged periods of increased morbidity and demand.
- To discuss the importance of flexibility in resource allocation during increasing and decreasing demand.
- To understand the importance of prioritization at a national, regional, and institutional level.
- To discuss options for increasing availability of personnel and equipment
- To understand the importance of staff safety, protection, and reducing burnout
- To increase pre and post ICU capabilities
- To improve triage decisions in the elderly population
- To plan for future events based on past experience

36.1 Introduction

We define a “disaster” in the medical sphere as any situation in which the number of casualties or cases exceeds the available resources to deal with them [1]. Twenty victims of a bomb blast on a bus may represent a sudden emergency, while many cases presenting with respiratory failure due to viral pneumonitis caused by COVID-19 may represent a more gradual emergency [2, 3]. Health system planners are very familiar with planning for acute surges in cases as may occur after a natural occurrence (earthquake or flooding) or a terrorist attack, and although such an occurrence may temporarily overwhelm the healthcare system, it is soon over (in a matter of weeks or days) [1, 4]. What we are less used to dealing with, and which we have now unfortunately been schooled in, is planning for and dealing with a situation where medical resources are inundated and indeed overwhelmed for a prolonged period of time (weeks and months) [5]. This chapter will address some aspects of the logistic challenges in the practice of intensive care medicine under pandemic conditions and how they have been dealt with.

■ Table 36.1 summarizes the major challenges and suggested solutions.

■ **Table 36.1** Summary of major challenges and suggested solutions

	Challenges	Suggested solutions
Flexibility	Sudden and quick/exponential increases in patient load Fluctuating load according to surges and lockdown measures Changing requirements for equipment and personnel Availability of PPE Extended period of uncertainty	Flexibility in admitting changing number of patients in a short period of time Expanding and decreasing number of dedicated beds and human resources depending on surges Quick planning by management and regular multidisciplinary meetings, updates, and overseeing implementation Integrating new knowledge about disease mechanisms and evidence (e.g., requirement for invasive interventions, updating treatment protocols)
National prioritization	Protecting the healthcare system	Lockdown measures Vaccination programs

■ **Table 36.1** (continued)

	Challenges	Suggested solutions
Regional prioritization	Providing adequate care for Covid-19 and non-Covid-19 patients Adjusting load	Dedicated Covid-19 wards or hospitals Transferring patients to less overloaded centers
Institutional prioritization	Dedicated area for Covid-19 patients Providing adequate care for Covid-19 and non-Covid-19 patients	Expanding intensive care facilities , beds, equipment, and personnel Deciding which services to maintain and which to reduce
Equipment	Purchasing and producing a large number of equipment in a short period of time Competing with other centers/countries Costs	Quick decision-making Dedicated funds (government support, national funds, diversion of hospital funds, donations) Planning future needs
Personnel and burnout	Shortage in critical care nurses and doctors Maintaining standard of care Mixed teams having to work together Long working hours Difficult working conditions High patient load High mortality	Planning additional training programs and continuous updates and refresher courses (e.g., ESICM online training programs) Mixing ICU nurses with non-ICU nurses Recruiting and training non-ICU physicians and nurses Reducing nurse/patient ratio Support groups Psychological support Changing teams regularly Childcare arrangements Positive feedback and acknowledgment Overtime and bonuses
Staff safety	High risk for staff and their families Absences due to exposure and fatigue/burnout	Providing constant and adequate PPE Regular staff PCR testing Priority in vaccinations
Pre- and post-ICU care	Large patient load in the community Reducing hospitalizations After loading acute care beds	Increased home care capabilities Increased post Covid-19 respiratory and physical rehabilitation programs
Elderly patients	Improving triage to intensive care of elderly patients with uncertain reserve and prognosis	Incorporating multi-morbidity and frailty in triage decisions Considering a time-limited trial in the ICU Admission to high dependency units
Limited resources	Increased demand during ICU shortage	Development and implementation of institutional and national triage guidelines based on a broad consensus and within established legal and moral frameworks

(continued)

■ **Table 36.1** (continued)

	Challenges	Suggested solutions
Future	Learning from the Covid-19 experience Planning for the next pandemic	Defining successes and failures Implementing conclusions Stressing the importance of intensive care, increasing ICU beds Increasing pool of trained medical and nursing staff Regular training programs and refresher courses Public relations work—Limits of what intensive care can achieve

36.2 Flexibility

It is true of any emergency that no amount of planning will foresee all eventualities, as described by the old adage that in times of war the best laid plans do not survive the first bullet fired. One of the first lessons for the healthcare system is to **heed warnings** and to be flexible in the response to the perceived load of cases expected [6, 7]. The warning period may be short (a few hours) in the event of a bomb blast before the cases start arriving at the hospital. It may also be longer, as we have seen during the COVID-19 pandemic, when we were able to see what was happening in the rest of the world and plan accordingly in the areas where we provide services. The healthcare system also needs to accommodate for increasing and decreasing morbidity, as surges come and go and thus be able to expand and reduce resources as required [8, 9].

In the case of the COVID-19 pandemic, we all had weeks to prepare for what was to come. What was uncertain was the scale of what we would have to deal with, especially during the first wave of the pandemic in Spring 2020. This brings us to the second important point—the healthcare system has to be **flexible** to be able to cope with the situation [10, 11]. We may have planned to deal with thousands of ventilated patients and only received hundreds, or vice versa. However, we had to deal with what we got. The uncertainty caused by the unknown morbidity of the disease resulted in, for instance, a run on mechanical ventilators around the world where suppliers were not able to meet the demand and factories were repurposed for the manufacture of these devices in several countries [12–15].

36.3 Prioritization

To provide and plan for the cases during the pandemic, there had to be a system of prioritization. This occurred at all levels. At the national level there had to be a decision to limit the spread of the disease with a system of lockdowns and curfews versus keeping businesses open and the economy vibrant [16]. Strict lockdown measures had severe economic consequences in most countries, especially in countries where citizens work as day laborers and depend on their daily income to feed their families [17]. In some countries this process was politicized, with demonstrations against

lockdown measures [18]. Nations also had to deal with issues such as border closures, who to let into the country, and how to deal with new arrivals, such as place and duration of quarantine. Countries that were successful in reducing patient numbers placed their resources in strict lockdowns, limiting entry to the country and extensive “test and trace” procedures to identify cases and their contacts. All of these measures required resources or had an economic cost but resulted in less burden on the healthcare system and less lives lost, these all being economic upsides of this approach [19]. Other countries took a different approach and favored keeping the economy going at the expense of a greater burden on the healthcare system and subsequent greater loss of life.

Another, perhaps less welcome, aspect of national prioritization seen during the pandemic was increased nationalism in the management of resources, such as wealthier nation states paying a premium for medical equipment, such as mechanical ventilators, personal protection equipment (PPE), and vaccines, at the expense of those countries not able to pay high prices. The converse of this was the willingness to transfer critically ill patients from one country (with less available resources) to neighboring countries with more, as was seen with the transfer of cases between France, the Netherlands, and Germany, for instance, at the height of the pandemic.

There have also been excellent examples of resource prioritization on the **international** level, such as the rapid development of vaccines against COVID-19, where huge economic resources were diverted for this purpose, for the benefit of humanity in general.

Regional prioritization concerns planning on the city or state/provincial level, where decisions were made to concentrate resources for the care of COVID-19 patients, that is, not every hospital had to be able to receive patients requiring strict barrier isolation and intensive care services [20]. Some hospitals could be set up as COVID-19 hospitals, with the required equipment and staff to receive high numbers of these cases, while its other services could be moved to nearby hospitals [21]. This approach made the logistics of providing oxygen, medications, and PPE to fewer locations easier but placed a burden on patient transport systems in order to get patients to regional COVID-19 centers from further away. In some instances, new COVID-19 hospitals were set up *de novo*, such as the example of a 1000 bed hospital being set up in Wuhan, China, in a matter of weeks to deal with COVID-19 cases. The advantage of this approach, besides concentrating resources, is the ability to continue providing regular services at “unaffected” hospitals, this being of benefit to the populace (e.g., not cancelling elective surgery or cancer treatment) and providing ongoing income for the institutions, depending on the funding model.

The focus of this chapter is the local or **institutional prioritization** of resources to deal with the COVID-19 pandemic. There was involvement of hospital management, divisional reorganization and departmental (intensive care) reorganization, and expansion within each institution dealing with COVID-19 patients [22].

Hospital management had two main priorities, deciding on which services to retain during the pandemic and then providing the resources to expand the intensive care services in the hospital. Intensive care services benefited from the recognition they received by hospital management and the general population at large, as being essential to the care of critically ill COVID-19 patients, who require a high degree of monitoring and vigilance, all forms of supplemental oxygen therapy, including mechanical ventilation and extracorporeal membrane oxygenation (ECMO) and

additional organ support [23]. Providing the infrastructure, space, beds, and equipment to provide these services was expensive and paid for out of existing funds, diversion of funds from other services, or new budgets provided by funding bodies such as state or national funding bodies [24]. There were many instances of misuse and misappropriation of these funds around the world in health systems usually chronically underfunded and then suddenly having access to “excess” funds. Management also had to oversee many aspects of the clinical management of COVID-19 patients, for example, setting up a committee to specifically review changing information from around the world and advise on current and acceptable therapeutic approaches.

In terms of providing the equipment, such as monitors and mechanical ventilators for newly established intensive care services, besides finding the means to purchase the equipment, hospitals also had trouble finding suppliers able to provide the equipment due to the increased worldwide demand [25]. Purchases also had to be made, not only with the immediate needs in mind but also with some thought to “the day after,” that is, how the equipment would be utilized in the future after the pandemic had passed, and so purchase equipment responsibly and not in a panic. It has to be recognized that in many instances ICUs had to be set up *de novo* or existing ICUs had to be rapidly expanded. This required equipment and manpower.

A common realization at the institutional level, based on personal experience and a survey of European intensive care units (personal communication) was that, once the equipment needs had been satisfied, the major resource missing was trained intensive care nurses. Although nurses used to dealing with acute medical cases (such as recovery room and operating room nurses) were drafted in to help with COVID-19 cases, they were not initially able to provide the same level of service to the critically ill patients as their intensive care-trained colleagues. It took time for their integration into the intensive care therapeutic teams and for them to become familiar with equipment and procedures [26]. This deficit was much more pronounced when non-acute nurses (e.g., from dermatology) were drafted into intensive care units. It was difficult to provide intensive care services at the same level as pre-pandemic times for two more reasons related to nursing staff. Often the number of patients cared for by each nurse at any one was increased (less time per patient, staff exhaustion), and intensive care nurses may have been taken from their regular units to care for COVID-19 patients. This reduced the level of care to non-COVID-19 patients, resulting in so-called “collateral” damage to these patients.

Most hospitals coped with the nursing shortage, in addition to drafting in nurses from other areas and reducing the nurse to patient ratio in the intensive care units (ICUs), by also instituting urgent training schemes (courses and on-the-job training) for non-intensive care nurses, as well as rehiring nurses who had left or retired from the profession. There was also an increased use of support staff to reduce the workload on nurses, such as student nurses and aides [27]. A major realization was the fact that developing teamwork between new intensive care team members takes time before there is smooth functioning of the team, that is, all the elements of the team may be in place, but it takes time until the team works well together. The lesson from this is that nursing staff need to be continuously trained and refreshed in their knowledge of critical care, even in non-pandemic times, so that there is a known reservoir of trained nursing staff that can be called upon in times of emergency/disaster. Between refresher courses, they can be deployed to their usual places of work.

The shortage of intensive care medical personnel was also brought into sharp relief by the pandemic, resulting in longer shifts, more patients per doctor, use of nonspecialist doctors, and more use of support staff, such as medical students. In many institutions resident medical staff from all other specialties were required to work in the intensive care units.

Hospitals had to provide additional support services to medical and nursing staff to cope with the stressful working conditions and high morbidity and mortality among the COVID-19 critically ill patients, such as counseling services for burnout and post-traumatic stress [28–30]. Staff had to cope with a much higher death rate among patients (e.g., 50% of ventilated COVID-19 patients died, many more than regular intensive care patients), often while being exposed to an increased risk of being infected with the virus as well as witnessing their family, friends, and colleagues also getting sick [31].

There was a definite evolution of the use of resources at the institutional level during the pandemic [32], ranging from uncertainty about how many cases would be received and what resources would be needed to deal with them to eventually recognizing that resources supporting frontline staff had to be provided, such as counseling services and other psychological support.

Special areas had to be set up either in existing ICUs or newly established ICUs to be able to care for COVID-19 patients while working with full barrier precautions. Working in full PPE gear for any length of time is challenging for anyone. It also requires additional attention to everyday infection control procedures for non-intensive care trained staff as well as for intensive care doctors and nurses dealing with invasive procedures such as central line insertion and maintenance and tracheal intubation or tracheostomy [26]. It also demanded additional special resources, such as communication equipment to allow communication between the “inside” and “outside” environments of closed COVID-19 intensive care units.

Additional ancillary staff had to be enrolled to deal with the large numbers of critically ill patients and their distressed relatives, such as clergy, social workers, and psychologists [31, 33]. These additional human resources all came at an economic cost and sometimes to the detriment of their regular services. Additional support services such as laboratory personnel, clerical staff, medical engineering staff to deal with medical equipment, respiratory technicians, and others were all unexpected human resources that had to be found and enrolled in the service of patients affected by the pandemic.

All of the human resources mentioned above were subject to sudden and significant absences that had to be managed and covered, either due to illness or due to the need to isolate because of exposure at work or outside of the work environment. This required extreme flexibility in managing the human resources, as well as expending more resources in the regular polymerase chain reaction COVID-19 (PCR) testing of the staff [34, 35].

Several more issues arose from the management of human resources, which were unexpected and difficult to plan for:

- Expecting medical staff from different specialty backgrounds to work together in the care of COVID-19 patients and the time it took to build effective medical teams

- Childcare arrangements, especially for nursing staff who had to work while children were at home due to closure of schools or kindergartens
- The need to recognize the additional hard work of staff, for example, by paying occasional bonuses, such as occurred in several European countries.

The practical day-to-day management of patients in the COVID-19 ICUs was and is a challenge, requiring more time, patience, and resources, for example, obtaining specialist consultations (more time for outside specialists to attend to consultations), or performing bedside investigations such as echocardiography (needing a separate machine or delaying the investigation until the end of the day when the machine could be cleaned and decontaminated).

36.4 Pre- and Post-ICU Care of COVID-19 Patients

The healthcare system as a whole also had to find resources to deal with three other special groups of patients affected by the pandemic:

- Patients who became **sick at home** and who either could not or would not come to the hospital for treatment. Many such patients were cared for by home carers and visited by doctors and nurses at home. They also required resources such as oxygen therapy (supplied via cylinder or oxygen concentrator), medications, and radiology and laboratory tests [36]. It was estimated that at the height of the third wave of the pandemic in Israel, there were more than 1000 such patients being cared for at home.
- Patients who have recovered from acute COVID-19 and required prolonged mechanical ventilation and rehabilitation, either in hospital or dedicated institutions [37, 38].
- The relatively large number of patients who remained extremely hypoxemic despite best-practice mechanical ventilation and were treated with ECMO [39]. This is an extremely resource-intensive activity.

None of these groups of patients were anticipated when planning for the pandemic.

Critically ill patients also clearly require support before admission to the ICU and after discharge from the ICU. This treatment falls to the regular wards in the hospital, be they medical or surgical wards, placing an additional burden on them also.

36.5 When Resources Are Limited

This chapter is not focused on the issue of patient triage (see chapter on “ICU decision-making under constraints”); however, the subject warrants a mention in the context of resources. When there is no possibility of increasing resources to meet demand, then in extreme cases the demand has to be reduced to meet the current resources. This is done by instituting a system of triage, where the patients most likely to benefit from intensive care are selected above those with a more limited prognosis [9, 40, 41]. In this light many national institutions or peak bodies in the specialty of intensive care drew up triage guidelines for use during the pandemic [42, 43]. There

was some debate in the popular press not to base these guidelines on factors such as age or disability. We await political and legal review of these guidelines.

The Elderly Patient with Uncertain Prognosis

Even in non-pandemic times, the decision whether to admit elderly patients to intensive care is challenging; however, evidence has shown that there may be an increased benefit from intensive care in this population in comparison to younger cohorts [44]. It has also been shown that chronological age in itself is not the most precise predictor to determine benefit from intensive care [45]. Increased age is associated with multi-morbidity which is associated with increased mortality [46]. Frailty is another important parameter for assessing vulnerability and functional reserves during critical illness and is also associated with increased mortality [47–49].

During pandemic times, when resources are limited and younger patients are competing for the last bed, the issues of age, multi-morbidity, and frailty become even more important for triage decisions [50, 51].

A possible solution for such dilemmas may be a time-limited trial, where patients' response to critical care is reassessed at certain time points and the level of further support is then determined accordingly [52].

In periods of severe resource constraints, however, time-limited trials in ICU might not be feasible anymore, and treatment in other units, such as high-dependence units, should be considered.

36.6 “The Day After”

In many jurisdictions, the pandemic is now abating, in some countries due to continued lockdown measures and in some countries due to extensive vaccination. Vaccines are another valuable resource that needs to be managed, for example, prioritizing which sector of the population to vaccinate first, sourcing sufficient vaccines, transportation, and rolling out the vaccination process in each country [53, 54].

Human nature being what it is, it will be tempting to put the pandemic down to a bad experience, which is or soon will be behind us and look to the future. Clearly, this is not the lesson to be learned. We should take the lessons in management and resource allocation of high acuity services as outlined above and plan for the next pandemic, which is inevitable [55].

Take-Home Message

Logistic challenges in the practice of intensive care medicine under pandemic conditions include flexibility of the healthcare system, hospitals, and intensive care units to increasing and decreasing demand, protecting the national and regional healthcare systems, making sure care is provided for both COVID-19 and non-COVID-19

patients and allocating enough equipment and personnel to meet demand. Triage decisions in elderly patients need to include multi-morbidity and frailty. Training and protecting the staff is crucial, and increased burnout must be dealt with. Planning for the future based on past experience is crucial.

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