VIEWPOINT

Critical Care Utilization for the COVID-19 Outbreak in Lombardy, Italy

Early Experience and Forecast During an Emergency Response

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Supplemental content

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On February 20, 2020, a patient in his 30s admitted to the intensive care unit (ICU) in Codogno Hospital (Lodi, Lombardy, Italy) tested positive for a new coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus that causes coronavirus disease 2019 (COVID-19). He had a history of atypical pneumonia that was not responding to treatment, but he was not considered at risk for COVID-19 infection.[1] The positive result was immediately reported to the Lombardy health care system and governmental offices. During the next 24 hours, the number of reported positive cases increased to 36. This situation was considered a serious development for several reasons: the patient ("patient 1") was healthy and young; in less than 24 hours, 36 additional cases were identified, without links to patient 1 or previously identified positive cases already in the country; it was not possible to identify with certainty the source of transmission to patient 1 at the time; and, because patient 1 was in the ICU and there were already 36 cases by day 2, chances were that a cluster of unknown magnitude was present and additional spread was likely.

On February 21, an emergency task force was formed by the Government of Lombardy and local health authorities to lead the response to the outbreak. This Viewpoint provides a summary of the response of the COVID-19 Lombardy ICU network and a forecast of estimated ICU demand over the coming weeks (projected to March 20, 2020).

Setting the Priorities and the Initial Response

In Lombardy, the precrisis total ICU capacity was approximately 720 beds (2.9% of total hospital beds at a total of 74 hospitals); these ICUs usually have 85% to 90% occupancy during the winter months.

The mission of the COVID-19 Lombardy ICU Network was to coordinate the critical care response to the outbreak. Two top priorities were identified: increasing surge ICU capacity and implementing measures for containment.

Increasing ICU Surge Capacity

The recognition that this outbreak likely occurred via community spread suggested that a large number of COVID-19–positive patients were already present in the region. This prediction proved correct in the following days. Based on the assumption that secondary transmission was already occurring, and even with containment measures that health authorities were establishing, it was assumed that many new cases of COVID-19 would occur, possibly in the hundreds or thousands of individuals. Thus, assuming a 5% ICU admission rate,[2] it would not have been feasible to allocate all critically ill patients to a single COVID-19 ICU. The decision was to cohort patients in 15 first-responder hub hospitals, chosen because they either had expertise in infectious disease or were part of the Venous-Venous ECMO Respiratory Failure Network (RESPIRA).[3]

The identified hospitals were requested to do the following.

1. Create cohort ICUs for COVID-19 patients (areas separated from the rest of the ICU beds to minimize risk of in-hospital transmission).
2. Organize a triage area where patients could receive mechanical ventilation if necessary in every hospital to support critically ill patients with suspected COVID-19 infection, pending the final result of diagnostic tests.
3. Establish local protocols for triage of patients with respiratory symptoms, to test them rapidly, and, depending on the diagnosis, to allocate them to the appropriate cohort.
4. Ensure that adequate personal protective equipment (PPE) for health personnel is available, with the organization of adequate supply and distribution along with adequate training of all personnel at risk of contagion.
5. Report every positive or suspected critically ill COVID-19 patient to the regional coordinating center.

In addition, to quickly make available ICU beds and available personnel, nonurgent procedures were canceled and another 200 ICU beds were made available and staffed in the following 10 days. In total, over the first 18 days, the network created 482 ICU beds ready for patients.

Containment Measures

Local health authorities established strong containment measures in the initial cluster by quarantine of several towns in an attempt to slow virus transmission. In the second week, other clusters emerged. During this time, the ICU network advised the government to put in place every measure, such as reinforcing public health measures of quarantine and self-isolation, to contain the virus.

ICU Admissions Over the First 2 Weeks

There was an immediate sharp increase in ICU admissions from day 1 to day 14. The increase was steady and consistent. Publicly available data indicate that ICU admissions (n = 556) represented 16% of all patients (n = 3420) who tested positive for COVID-19. As of March 7, the current total number of patients with COVID-19 occupying an ICU bed (n = 359) represents 16% of currently hospitalized patients with COVID-19 (n = 2217).

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All patients who appeared to have severe illness were admitted for hypoxic respiratory failure to the COVID-19 dedicated ICUs.

Surge ICU Capacity

Within 48 hours, ICU cohorts were formed in 15 hub hospitals totaling 130 COVID-19 ICU beds. By March 7, the total number of dedicated cohorted COVID-19 ICU beds was 482 (about 60% of the total preoutbreak ICU bed capacity), distributed among 55 hospitals. As of March 8, critically ill patients (initially COVID-19–negative patients) have been transferred to receptive ICUs outside the region via a national coordinating emergency office.

Forecasting ICU Demand Over the Next 2 Weeks

During the first 3 days of the outbreak, starting from February 22, the ICU admissions were 11, 15, and 20 in the COVID-19 Lombardy ICU Network. ICU admissions have increased continuously and exponentially over the first 2 weeks. Based on data to March 7, when 556 COVID-19–positive ICU patients had been admitted to hospitals over the previous 15 days, linear and exponential models were created to estimate further ICU demand (eFigure in the Supplement).

The linear model forecasts that approximately 869 ICU admissions could occur by March 20, 2020, whereas the exponential model growth projects that approximately 14 542 ICU admissions could occur by then. Even though these projections are hypothetical and involve various assumptions, any substantial increase in the number of critically ill patients would rapidly exceed total ICU capacity, without even considering other critical admissions, such as for trauma, stroke, and other emergencies.

In practice, the health care system cannot sustain an uncontrolled outbreak, and stronger containment measures are now the only realistic option to avoid the total collapse of the ICU system. For this reason, over the last 2 weeks, clinicians have continuously advised authorities to augment the containment measures.

To our knowledge, this is the first report of the consequences of the COVID-19 outbreak on critical care capacity outside China. Despite prompt response of the local and regional ICU network, health authorities, and the government to try to contain the initial cluster, the surge in patients requiring ICU admission has been overwhelming. The proportion of ICU admissions represents 12% of the total positive cases, and 16% of all hospitalized patients. This rate is higher than what was reported from China, where only 5% of patients who tested positive for COVID-19 required ICU admission.[2,4] There could be different explanations. It is possible that criteria for ICU admission were different between the countries, but this seems unlikely. Another explanation is that the Italian population is different from the Chinese population, with predisposing factors such as race, age, and comorbidities.[5]

On March 8 and 9, planning for the next response, which includes defining a new hub and spoke system for time-dependent pathology, increasing ICU capacity further, and reinforcing stronger containment measurement in the community, has begun, as well as discussions of what could have been done differently.

First, laboratory capacity to test for SARS-CoV-2 should have been increased immediately. Laboratory capacity reached saturation very early. This can add extra stress to a system and affect the ability to make accurate diagnoses and allocate patients appropriately.

Second, in parallel to the surge ICU capacity response, a large, dedicated COVID-19 facility could have been converted more quickly. On day 1 of the crisis, it was not possible to predict the speed and extent of the contagion. Importantly, the forecasts show that increasing ICU capacity is simply not enough. More resources should be invested to contain the epidemic.

As of March 8, Lombardy was quarantined and strict self-isolation measures were instituted. This may be the only possible way to contain the spread of infection and allow resources to be developed for the time-dependent disease.

As of March 10, Italy has been quarantined and the government has instituted stronger containment measures, including strict self-isolation measures. These containment measures and individual citizen responsibility could slow down virus transmission.

While regional resources are currently at capacity, the central Italian government is providing additional resources, such as transfers of critically ill patients to other regions, emergency funding, personnel, and ICU equipment. The goal is to ensure that an ICU bed is available for every patient who requires one. Other health care systems should prepare for a massive increase in ICU demand during an uncontained outbreak of COVID-19. This experience would suggest that only an ICU network can provide the initial immediate surge response to allow every patient in need for an ICU bed to receive one. Health care systems not organized in collaborative emergency networks should work toward one now.

ARTICLE INFORMATION

Published Online: March 13, 2020. doi:10.1001/jama.2020.4031

Conflict of Interest Disclosures: Dr Grasselli reports receiving payment for lectures and travel support for conferences from Getinge, payment for lectures from Draeger Medical, payment for lectures and an unrestricted research grant from Fisher & Paykel, payment for lectures from Thermofisher, and receiving payment for lectures and travel support for conferences from Biotest. Dr Pesenti reports receiving personal fees from Maquet, Novalung/Xenios, Baxter, and Boehringer Ingelheim. Dr Cecconi reports consulting for Edwards Lifesciences, Directed Systems, and Cheetah Medical.

Additional Contributions: We acknowledge the COVID-19 Lombardy ICU Network for their remarkable efforts to provide care for the critically ill patients with COVID-19 (listed in the Supplement).

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