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Global lessons learned from COVID-19 mass casualty incidents

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Summary

With healthcare systems rapidly becoming overwhelmed and occupied by patients during a pandemic, effective and safe care for patients is easily compromised. During the course of the current pandemic, numerous treatment guidelines have been developed and published that have improved care for patients with COVID-19. Certain lessons have only been learned during the course of the outbreak, from which we can learn for future pandemics. This editorial aims to raise awareness about the importance of timely stockpiling of sufficient amounts of personal protection equipment and medications, adequate oxygen supplies, uninterrupted electricity, and fair locally adapted triage strategies.

Keywords: COVID-19; electricity; oxygen; pandemic; personal protective equipment; preparedness; stockpiling; triage

Healthcare systems worldwide are under pressure from a pandemic of a 'new' disease by a 'new' respiratory pathogen: COVID-19 caused by SARS-CoV-2.^{1,2} It seems that there is no prospect of a near-term end as we are startled by new waves of patients in different parts of the world with each new month.³ The disaster continues to unfold in places where vaccinations are scarce, but also in places with higher vaccination rates where it mainly affects the unvaccinated or those who are unable to develop sufficient antibodies in response to vaccination. Every day, countless people around the world are admitted to hospitals or seek medical support, depending on how healthcare is organised locally. As in any pandemic, we are in intense need of hospital beds, healthcare personnel, protective equipment, and medicines. But what makes this current pandemic 'special' is an increased, at times extreme, need for oxygen, and also, to a lesser extent, an increased need for ventilators.

In most individuals, infection with SARS-CoV-2 will pass unnoticed, and in those with symptoms, COVID-19 usually presents as a common cold or flu. However, some individuals develop pulmonary infiltrates that alone or in combination with venous thromboembolism lead to acute (hypoxaemic) respiratory failure.¹ And in some of these patients, other organs are affected as well. COVID-19 is thus primarily a respiratory disease, and in its severe forms may end in multiorgan failure.

In the earliest stages of the COVID-19 pandemic, the unknown nature of the 'new' respiratory pathogen meant that it posed a terrible threat to health professionals. We quickly realised that we could protect ourselves sufficiently.

Unfortunately, many countries witnessed severe shortages of personal protection equipment (PPE), in particular face masks. Multiple factors contributed to this shortage. In many places, the unprecedented increase in the number of cases resulted in rapid consumption of existing stockpiles and reserves. Hoarding and panic buying were common, creating an acute shortage of PPE and dramatic increases in price. In many nations, PPE had to be imported since it was not locally produced, and imports were severely hampered by travel bans imposed early in the pandemic. These factors resulted in severe scarcity of PPE, and increased reliance on improvised, usually less efficient, PPE. Very early in the pandemic, several European countries donated large amounts of PPE to China, but weeks later these countries found themselves in trouble with dire shortages of PPE. In many places, controlling bodies to monitor and ensure the quality of the locally produced or reused PPE were lacking, endangering the safety of scarce trained healthcare workers.^{4,5}

On a patient level, the focus shifted to testing non-specific and specific treatments for the new disease. International partnership quickly arose, collaborating on the design and analysis of large classic clinical trials, and platform trials combining initially separated clinical trials to obtain answers to clinical questions more rapidly than ever before, providing evidence that certain strategies such as early administration of steroids⁶ and other anti-inflammatory drugs,⁷ and timely anticoagulant therapy,^{8–10} are effective, while other treatments such as antivirals, antimalarials,¹¹ and antiparasitic therapies¹² are not. Unfortunately, we also faced shortages in these therapies, including 'affordable' treatments such as

steroids and anticoagulant therapy, especially in low- and middle-income countries.¹³ Even high-income countries experienced medication shortages, for example, in The Netherlands, in October 2021 there was a shortage of tocilizumab, with a new national wave lurking.

The pandemic was initially felt as a major threat for critical care services, which in part was true since the number of expensive ICU beds has always been limited, even in rich countries, and these units can easily be overwhelmed in a respiratory disease pandemic. In the first waves worldwide this had a major impact on normal processes, as many planned admissions had to be postponed, causing indirect harm to other patients who could not be admitted to the overcrowded ICUs.¹⁴ More important, it created a shortage of ventilators,¹⁵ as many hospitals in many countries felt they needed to enlarge their critical care services, in particular ventilatory care, expanding beyond the physical boundaries of existing units, including recovery rooms, or even operation rooms. Then the concerns were that care, especially ventilatory care, could become inappropriate, as many extra nurses and doctors were needed at the bedside of the rapidly growing group of critically ill patients who needed invasive ventilation, with many of them having little or even no experience in invasive ventilation. Interestingly, we learned quickly that many patients may not have needed invasive ventilation after all,^{15,16} and many could be treated with noninvasive supplementary oxygen alone. An individualised approach for ventilatory support other than early intubation and invasive ventilation could be effective and potentially conserve resources. Meanwhile, we rapidly learned that ventilation characteristics in COVID-19 were not so different from those in patients with acute respiratory failure as a result of other causes, and that ventilation could be more 'lung-protective' than ever reported, especially with the use of lower tidal volumes.¹⁷

The real challenge, though, was the large number of patients needing oxygen therapy, even without the need for invasive ventilatory support, including CPAP or noninvasive ventilation. Indeed, only ~14% of patients with COVID-19 develop severe disease and only ~5% become so critically ill that they need admission to an ICU for acute respiratory failure and other forms of organ dysfunction.^{18,19}

Thus, the challenge turned from a 'fight for ventilators' into a 'cry for oxygen'.²⁰ The large number of patients in need of supplementary oxygen and the high individual needs for oxygen combined with a lack of infrastructure for oxygen supplementation in some places created a perfect storm. Worldwide, we have seen examples of such oxygen shortages in resource-limited settings, such as Nepal, India, Brazil, and Myanmar,¹³ but also in highly developed countries.

This shortage of oxygen could be aggravated by the use of high-flow oxygen systems, such as high-flow nasal oxygen (HFNO).²¹ Even though there is strong evidence supporting its use in patients with acute hypoxaemic respiratory failure,²² compared with low-flow oxygen systems or invasive ventilation, it increases oxygen consumption because of much higher oxygen flows required and delays in titrating the fraction of inspired oxygen when safe oxygenation targets are reached. Hyperoxaemia is not only deleterious for the patient with acute respiratory distress syndrome,²³ but also is important in terms of oxygen consumption at the hospital level. Closed-loop oxygen titration systems can optimise oxygen administration in patients with mild acute hypoxaemic respiratory failure treated with HFNO, increasing the time patients spend within an optimal saturation range by decreasing the time

spent above a safe target range.²⁴ Another important issue is that 'stand-alone' HFNO devices often lack batteries, meaning that in case of an electricity outage, the therapy is abruptly interrupted with serious consequences for the patient.

It took time to understand these problems, and to take appropriate actions. In resource-limited settings, panic among the public led to hoarding of oxygen cylinders,²⁵ which was unanticipated. Oxygen plants were, and still are, limited to a few large healthcare centres, with some plants non-functional or not repaired. Also, piped oxygen systems are not usually maintained, leaving this hospital system with leakage from the pipelines and flowmeters, inadequate oxygen pressure, etc. Together with poor local healthcare policy, this magnified the oxygen shortages. Better anticipation, establishment of more oxygen plants, and regular maintenance, together with a better healthcare system focused on basic healthcare needs could have mitigated these problems.

In places hit hard by oxygen scarcity, the value of rational use of oxygen could not be overemphasised. These strategies range from oxygen sparing measures such as forgoing the use of high oxygenation targets, avoiding oxygen wastage, use of oxygen checklists, and awake prone positioning.^{26,27} In COVID-19 patients treated with HFNO, awake prone positioning not only decreases the need for tracheal intubation, but has an oxygen sparing effect.²⁸ For instance, if the fraction of inspired oxygen can be lowered from 80% to 60% with proning, at a flow rate of 60 L min⁻¹, the total amount of oxygen needed decreases from ~3000 to ~2000 L h⁻¹, a reduction of a third. Some limitations inherent to resource-limited settings, such as inconsistent supply of electricity, further compound the problem, hindering the use of alternative sources of medical oxygen such as oxygen concentrators. The limited capacity of trained healthcare workers was rapidly overwhelmed. Unlike oxygen cylinders and the oxygen concentrators, the unmet need of trained healthcare workers remains hard to fulfil.

The surge in patients and the scarcity of resources during the COVID-19 pandemic also raised the importance of triage. Triage not only means that certain treatments, such as ventilatory support, are provided mainly to patients with a realistic chance of survival if that care is provided, not necessarily to all patients who need it acutely. Triage is a continuous process of evaluation, and re-evaluation, of patients who may need escalation of care; for example, a patient may not yet need invasive ventilation, but may do so later, and this can change very fast in patients with acute respiratory failure. This places another burden on the already overwhelmed hospital systems. In every pandemic or mass casualty incident, triage should be based on resource allocations,²⁹ which requires appropriate governance at different levels of the healthcare systems. However, when resources are insufficient, they should be allocated with the maximum equity while trying to preserve as many lives as possible.³⁰ What were the most important global lessons learned from COVID-19-related mass casualty incidents? In the places hit worst by the pandemic, the disease was underestimated and preparedness was suboptimal. The focus was on interventions such as invasive ventilation, which would potentially benefit only a very limited number of patients with already a poor prognosis, rather than on simple interventions such as consistent availability and appropriate use of medical oxygen by trained healthcare workers, and also sufficient stockpiling of PPE and medications.

It is imperative to apply the lessons learnt from this pandemic and at the cost of millions of lives lost to be better

prepared for future pandemics. The axiom to 'do less for more, not more for less' is relevant worldwide, facilitated by sufficient stockpiling of PPE and medications, uninterrupted oxygen and electricity supplies, and fair triaging, which are more important than ventilators overall.

Authors' contributions

Jointly drafted the editorial and revised it critically for important intellectual content, gave final approval of the version to be submitted, and agreed to be accountable for all aspects of the work: all authors.

Declarations of interest

The authors declare that they have no conflicts of interest.

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Reimagining health preparedness in the aftermath of COVID-19

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Summary

Efficiency is an essential part of sustainable healthcare, especially in emergency and acute care (including surgical) settings. Waste minimisation, streamlined processes, and lean principles are all important for responsible stewardship of finite health resources. However, the promotion of efficiency above all else has effectively subordinated preparedness as a form of waste. Investment in preparedness is an essential part of resilient healthcare. The ongoing COVID-19 pandemic has exposed the gap between efficient processes and resilient systems in many health settings. In anticipation of future pandemics, natural disasters, and mass casualty incidents, health systems, and individual healthcare workers, must prioritise preparedness to be ready for the unexpected or for crises. This requires a reframing of priorities to view preparedness as crucial insurance against system failure during disasters, by taking advantage of lessons learnt preparing for war and mass casualty incidents.

Keywords: COVID-19; efficiency; health systems; mass casualty incidents; preparedness; resilience

Efficiency is not the enemy of resilience, but subordinating preparedness has left hospitals and health systems exposed during the COVID-19 pandemic. In the tight budgets and rising costs of healthcare, preparedness for an over-the-horizon event can seem an unnecessary expense, a waste, or at worst, a luxury. In the health management world of lean targets and just-in-time supply models, investing for just-in-case has not been prioritised.¹

Former US Health and Human Services Secretary Michael Leavitt presciently said, in 2007, 'Everything we do before a pandemic will seem alarmist, everything we do after a pandemic will seem inadequate'.² Our day to day is now a realisation of that statement. Multiple health systems across high-, middle-, and low-income nations have come up lacking against the COVID-19 pandemic, and so how do we, in healthcare, reset our preconditions for future success and prioritise resilience in healthcare as our next great challenge and opportunity?³ There are several lessons to be learned from experiences of preparing for war and in the management of mass casualty incidents (MCIs) that are of particular relevance to anaesthetists and hospitals.

Ready now and future ready

Much has been made during the COVID-19 pandemic of the 'frontline' worker 'fighting' against an unseen 'enemy'. The warfighting metaphor fits for some of the challenges in confronting an evolving pandemic. However, there is more to it than acknowledging the individual heroism of many healthcare workers. Professional defence forces are, for example, obsessively focused on readiness.^{4,5} Deployments to war are thankfully rare, so most military personnel will spend the majority of their careers maintaining readiness and being prepared, rather than actively at war. Large-scale 'war games' and multinational exercises, involving years of planning, often tens of thousands of troops, and many millions of dollars, are seen as an essential investment in both national preparedness and threat deterrence.^{6,7}

Whilst hospitals and clinicians are busy treating patients most of the time, we should never be too busy to prepare. COVID-19 has revealed the inadequacy of health system preparedness across a range of domains, including workforce, physical infrastructure, and equipment.^{8–10} To be future ready for the next disaster, hospitals and health systems must adopt