Outcomes of intensive care unit patients with COVID-19: a nationwide analysis in Russia

The COVID-19 pandemic continues to evolve rapidly in many countries and poses a challenge for critical care services. Nevertheless, the outcomes of intensive care unit (ICU) patients with COVID-19 remain ill-defined. In a recent meta-analysis of 24 observational studies that included 10,150 patients, Armstrong et al. reported an ICU mortality rate of 41.6% [1]. The authors suggested that mortality rates have reduced from above 50% to approximately 40% over time. However, only seven studies reported outcome data for all patients, whereas the proportion of patients discharged from ICU at the time of publication varied from 24.5% to 97.2% in the remaining studies. Moreover, six out of the seven studies with known outcomes in all cases were small and included only 101 patients in total.

In a nationwide study, we evaluated the mortality rate in 1522 consecutive ICU patients with SARS-CoV-2 pneumonia who had completed their hospital stay (death or recovery) up to 7 July 2020. According to the government decision, medical records were submitted via the internet by COVID-19 hospitals located in 70 regions across Russia to the Federal Center at the Sechenov University, Moscow, that provided advice on critical care of patients. Diagnosis of SARS-CoV-2 pneumonia was established both by polymerase chain reaction (PCR) and CT scanning. In patients with a negative PCR, SARS-CoV-2 pneumonia was defined as severe acute respiratory infection with typical CT scan findings [2] and no other obvious aetiology.

Clinical and baseline characteristics of patients with severe COVID-19 admitted to ICU are presented in Table 1. Most patients were > 40 y and had various chronic illnesses, e.g. cardiovascular disease, type-2 diabetes and obesity. Among 1522 patients in this study, 995 (65.4%) died, and 527 (36.4%) recovered. The 14 and 28 day mortality rates were 44.0% and 63.6%, respectively. The most common causes of death were acute respiratory distress syndrome (93.2%), cardiovascular complications (3.7%) and pulmonary embolism (1.0%). The mortality rate was low in patients requiring oxygen therapy (only 10.1%) and significantly higher in patients who required non-invasive (36.8%) or invasive (76.5%) ventilation. The highest mortality rate (86.6%) was reported in patients with septic shock. Median (IQR [range]) duration of mechanical ventilation was 6 (3–12 [1–62]) days in deceased patients and 13 (7–21 [1–40]) days in recovered patients. Mortality rates in Moscow and Moscow province were higher (74.5% and 78.6%, respectively) than in the other regions of Russia (50.2%). However, patients from the regional hospitals had less severe disease and more frequently required only oxygen therapy (24.7% vs. 4.9% in Moscow and 8.2% in Moscow province). Mortality rates were similar in PCR-confirmed and unconfirmed cases (63.5% and 68.9%, respectively).

In summary, the average mortality rate was 65.4% in Russian ICU patients with SARS-CoV-2-induced acute

Table 1 Baseline and clinical characteristics of patients with severe COVID-19 admitted to ICU in Russia. Values are median (IQR [range]) or number (proportion).

	Values
Age; y	62 (53–71 [17–99])
Sex; male	864 (56.8%)
Region of Russia	
Moscow	740 (48.6%)
Moscow province	182 (12.0%)
Other regions	600 (39.4%)
Positive PCR for SARS-CoV-2	995 (65.4%)
Respiratory support	
Oxygen therapy	199 (13.1%)
Non-invasive ventilation	95 (6.2%)
Invasive ventilation	1228 (79.1%)
ECMO	7 (0.5%)
Cardiovascular disease	976 (64.1%)
Arterial hypertension	905 (59.5%)
Coronary artery disease*	234 (15.4%)
History of stroke	113 (7.4%)
Atrial fibrillation	161 (10.6%)
Type-2 diabetes	406 (26.7%)
Obesity	396 (26.0%)
Bronchial asthma	35 (2.3%)
Chronic obstructive pulmonary disease	78 (5.1%)
Solid tumours	63 (4.1%)
Haematological disease	27 (1.8%)
Auto-immune rheumatic diseases†	17 (1.1%)
HIV infection	6 (0.4%)

PCR, polymerase chain reaction; ECMO, extracorporeal membrane oxygenation.
*History of definite myocardial infarction or interventions on coronary arteries.
†Rheumatoid arthritis, systemic sclerosis, psoriatic arthritis, systemic lupus erythematosus or ankylosing spondilitis.

respiratory distress syndrome, although it varied widely depending on the level of respiratory support and indications for ICU admission. These factors should be taken into account in future studies to avoid a skewed picture of mortality in ICU patients with COVID-19.

S. Moiseev
S. Avdeev
M. Brovko
N. Bulanov
E. Tao
V. Fomin
Sechenov First Moscow State Medical University, Moscow, Russia
Email: avt420034@yahoo.com

No competing interests declared.

References

1. Armstrong RA, Kane AD, Cook TM. Outcomes from intensive care in patients with COVID-19: a systematic review and meta-analysis of observational studies. *Anaesthesia* 2020; **75**: 1340–9.
2. Salehi S, Abedi A, Balakrishnan S, Gholamrezanezhad A. Coronavirus disease 2019 (COVID-19): a systematic review of imaging findings in 919 patients. *American Journal of Roentgenology* 2020; **215**: 87–93.

doi:10.1111/anae.15265

Opening operating theatre doors after aerosol-generating procedures is not a high-risk action

Throughout the COVID-19 pandemic, airway management procedures designated as being 'aerosol generating' have been undertaken in a number of locations, including operating theatres. Air handling in most operating theatres is designed to maintain a positive pressure inside the theatre relative to the corridor outside. This has led to understandable concerns among staff working in theatre suites regarding the risk of exposure to virally contaminated aerosols generated within the operating theatre. A particular concern has been about the safety of opening the theatre doors to move the patient at the end of a case, before completion of sufficient 'room rest time' after an aerosol-generating procedure. Here we provide an explanation of why we think this poses minimal risk to staff present in lower pressure areas outside the operating theatre.

Consider an aerosol-generating procedure performed on an at-risk patient in one theatre. Even with the doors closed, operating theatres are not sealed, and a significant volume of air continuously leaks out into the adjacent lower pressure areas. In one author's hospital, the engineering department estimated the leak from a single theatre to be 700 $l.s^{-1}$. This large flow results from the very high air exchange rates typical of operating theatres (25–90 $exchanges.h^{-1}$ in different theatres at the same institution). Of note, this air leak is predominantly filtered clean air. This high flow of clean air into the operating theatre rapidly dilutes any aerosols present [1], affording significant protection from viral transmission to the staff working inside. Any aerosols in air leaking from the theatre are further diluted, both in the large volume of air in the corridors outside and by equivalent volumes of clean air leaking from adjacent operating theatres (most of which at any one time will be free of any risk of SARS-CoV-2 virus). At one hospital, based on gas flows measured at the main entrance of a nine-theatre operating suite, the engineering department estimated the combined leakage to be 100,000 $l.s^{-1}$. This results in a massive dilution of any potentially contaminated aerosol particles leaving the operating theatre such that the infection risk, even to staff not wearing personal protective equipment (PPE), seems extremely low.

When theatre doors are opened, it can be assumed that air will move down the pressure gradient between the theatre and the corridor outside, to equalise pressures. The concern is that this will lead to a large egress of potentially aerosol-containing gas. The largest measured pressure difference between theatre and corridor of which we are aware is 30 Pa, although the pressure gradient may be as low as 4 Pa. One Pascal is 100,000th of an atmosphere. Pressure is inversely proportional to volume, so the gas in an operating theatre pressurised to 30 Pa would only have to expand by 30/100,000ths of its original volume in order to equalise with atmospheric pressure. If the volume of the theatre is, for example, 280 m^3 (7 m × 4 m × 10 m), then 30/100,000ths

