EDITORIAL

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The COVID-19 pandemic through the lens of the *Anaesthesiology Intensive Therapy* journal: What have we learned?

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Five years ago, the world was plunged into chaos, which affected all spheres of daily life, for three years. In March 2020, the World Health Organization (WHO) announced the COVID-19 pandemic caused by a previously unknown species of coronavirus called SARS-CoV-2 [1]. The pandemic lasted until its official end in May 2023 [2].

As of today, according to WHO data, a total of 777,126,421 COVID-19 cases and 7,079,925 deaths have been reported [3]. The virus, primarily transmitted via droplets and airborne particles, causes mild symptoms in most cases. Unfortunately, in some of the infected, pneumonia and acute respiratory distress syndrome (ARDS) develop, with many of those patients requiring escalating respiratory support measures, including invasive mechanical ventilation, as well as intensive care in general. Additionally, regardless of severity of the disease, an infected patient might require more or less urgent surgery, further increasing the anaesthesiologists' involvement in COVID-19.

These circumstances and undoubtedly increased workload put additional strain on our colleagues across the world, and, while increasing the necessity to face and overcome new obstacles, also created the opportunity (and necessity) for constant sharing and updating knowledge. This paper aims to summarise the vast extent of COVID-related analyses, reviews, commentaries and guidelines that have been published in our journal.

NOT ONLY LUNGS

Throughout the initial reports on SARS-CoV-2 infection, the emphasis was mainly placed on respiratory pathology, but one should not forget that the pathogen also alters the circulatory system. Jasiński *et al*. [4] summarized the mechanisms of COVID-19 that led to circulatory insufficiency. There are several potential routes by which the virus can affect the circulatory system – as a primary insult, and secondary to virus-induced pathology. It is well known that SARS-CoV-2 uses angiotensin-converting enzyme 2 (ACE2) as a portal of entry into human cells. With these receptors located in the myocardium, microcirculatory pericytes, and different layers of arterial and venous vessels wall, it is easy to understand how the virus damages the circulatory system. The pathogen also led to dysregulation of ACE2 receptors, causing dysregulation of the renin-angiotensin-aldosterone system and potentially influencing the anti-inflammatory effect of angiotensin. The second mechanism of COVID-19 pathology in the circulatory system is the host's immunological response to viral infection. The third mechanism that may lead to circulatory failure in COVID-19 is the association with endothelial dysfunction. Authors have described in detail the aspects of haemodynamic monitoring and treatment. It should be remembered that COVID-19 patients may not be the best candidates when considering some methods of fluid responsiveness assessment, since stroke volume or pulse pressure variation assessment will not be reliable for COVID-19 ARDS patients with type "H" lungs. In those patients with reduced compliance, a low tidal volume ventilation strategy is used. Inability to perform inspiratory hold will reduce the utility of the end-expiratory occlusion test. The same problem may arise with the use of uncalibrated pulse contour-derived measurements in the prone position. In terms of potential cardioprotective drugs, the data on the routine use of beta-blockers, levosimendan or dexmedetomidine are inconclusive. In the authors' opinion, data on COVID-19 do not suggest a different attitude than that presented in Surviving Sepsis Campaign (SSC) for COVID-19 and previous SSC guidelines.

While respiratory failure was the most relevant cause of COVID-related morbidity, it has been found that the virus could cause gastrointestinal symptoms and clinicians should remember that not only patients with pronounced respiratory presentation can be a source of infection. Moreover, it has been shown that gastrointestinal issues can precede respiratory symptoms [5].

AIRWAYS, AEROSOL, AND PERSONAL PROTECTION

Anaesthesiologist and intensivists were at a high or very high exposure level because of the risk of close contact with infectious material. It was extremely important to learn how to decrease the possibility of contamination. At the beginning of the pandemic, basic information about the virus, the associated risks and personal protection when treating sick, critically ill patients, as well as instructions for safe airway instrumentation, was published [6–8].

Aerosol-generating procedures such as endotracheal intubation and bronchoscopy carried particularly high infection risk for the providers [6]. At the same time, other interventions such as bag valve mask ventilation, surgical airway management, and non-invasive ventilation were also proven to carry increased risk. Chest compressions and defibrillation during cardiopulmonary resuscitation (CPR), airway suctioning before and after intubation, bronchoscopy, nebuliser treatment, manipulation of an oxygen mask, defibrillation, and insertion of a nasogastric tube were identified as potentially risky. No significant risk was identified for bi-level positive airway pressure (BiPAP) mask manipulation, endotracheal aspiration, the suction of body fluids, mechanical ventilation, manual ventilation, manual ventilation after intubation, high-frequency oscillatory ventilation, or administration of oxygen (including high-flow nasal oxygen, HFNO). The above also implied that regional (vs. general) anaesthesia was safer for the anaesthesiologists. The emphasis was placed on proper use of protective personal equipment, avoiding disconnection of the respiratory circuit, postponing manoeuvres with endotracheal/tracheostomy tubes until the infection is cured. The technique of CPR in a pronated patient was also described, in which, as a measure limiting the risk of contamination, early intubation, performed by an experienced anaesthesiologist, was indicated [7].

The need to increase availability of videolaryngoscopy (VL) – as a measure to both increase first-pass success and minimise risk of transmission through increasing the distance between the operator's and the patient's airways – was advocated from the very beginning [8, 9]. As reported by Saracoglu *et al*. [10], who surveyed European anaesthesiologists, the pandemic had a major effect on availability of VL (making it virtually universal) and as much as tripled its routine use for all cases.

During the course of the pandemic, it was found that percutaneous tracheostomy, when performed using precautions, such as apnoea-moments, personal protective equipment, checklists, and clear protocols, was relatively safe [11]. Generally, the tracheostomy procedure in COVID-19 patients seemed to be safe: A systematic review and meta-analysis (including 4366 patients) revealed no reported evidence of risk of the disease attributable to participating in tracheostomy procedures [12].

Obstetric anaesthesia posed certain unique challenges in the context of minimising patient-provider transmission. While most elective procedures can be rescheduled until an infected patient is cured, delivery is inevitable and cannot be postponed. Additionally, SARS-CoV-2 infection in obstetric patients may be associated with an increased risk for adverse outcomes including preeclampsia, preterm delivery, unscheduled Caesarean delivery, and mechanical ventilation. In the context of COVID-19, in this population, like in other patients, general anaesthesia (GA) should be avoided in all but the most critically ill patients, with combined spinal-epidural and dural puncture epidural being optimal for minimizing catheter failure rates and risk of conversion to GA [13].

While active infection significantly increases the risks associated with general anaesthesia, a single centre analysis of SARS-CoV-2 infected paediatric patients, who had to undergo anaesthesia for urgent surgery, revealed no overall difference in the rate of complications (when compared to non-infected children) [14].

RESPIRATORY MECHANICS AND SUPPORT

Respiratory insufficiency was the most common symptom in hospitalised patients, as we soon found out when dealing with a surge in the numbers of mechanically ventilated patients. Unfortunately, the weaning process was not easy, and in many cases successful recovery from the acute phase of pneumonia was not guaranteed. As reported by Pestana *et al*. [15], some COVID-19 patients, after 10 days of lung protective ventilation, developed a ventilatory pattern compatible with acquired restrictive pulmonary disease. In those who did not survive, fibrotic changes were confirmed on autopsies. Naturally, with the surging numbers of patients, the number of complications also increased, as reported, among others, by Venkateswaran *et al*. [16]. In a retrospective study, the authors found the incidence of barotrauma-related events (mostly pneumothorax) in ICU patients to be 3.6%. Such events were associated with mortality, with lengths of (surprisingly) high-flow nasal oxygen therapy and mechanical ventilation being relevant risk factor. The article, along with the ensuing correspondence [17, 18], drew attention to the underappreciated risks associated with HFNO and emphasized a rational approach to titration of both HFNO and PEEP during invasive mechanical ventilation. The aspect of bacterial superinfections, being another potential complication of treatment, was elucidated and analysed in a small sample by Sysiak-Sławecka *et al*. [19].

In terms of not novel, but not so common treatment techniques, prone positioning became more often used, and, importantly, we realised that with all the necessary technical precautions maintained, the time of pronation can be safely increased. In their study, Sastre *et al*. [20] used the prone position in 84 of 94 patients with a median of 24 hours per session (IQR 24–30). In another study, patients were pronated for at least 16 hours, with the repetition of proning after 4 hours, if necessary [21].

The pandemic was "a golden era" for high flow nasal oxygenation (HFNO). The need for oxygenation and mechanical ventilation greatly increased. Due to a lack of ventilators, anaesthetic machines served as ventilators and operating theatres were transformed into ICUs. At the same time, some of those who were still able to breath spontaneously desperately needed a high oxygen concentration. HFNO devices spread within the hospitals. On one hand it was the solution for oxygen-depleted patients, while on the other hand, its aggressive use as well as delaying tracheal intubation could be detrimental for the lungs. It was not the solution for everyone. Schmidt *et al*. [22] described its effectiveness – it was higher if the patients had elevated saturation, decreased FiO_2 and reduced C-reactive protein on day 4 – so they were less sick compared to those in whom the effectiveness was worse. As soon as in 2020, we obtained data showing that HFNO can serve as a tool in weaning COVID-19 patients from mechanical ventilation, but the clinician must check the patient's condition so as not to miss the right time for tracheal intubation [23].

During the pandemic, the need for extracorporeal membrane oxygenation (ECMO) increased. Since this technique is performed only in designated centres and is reserved for severely hypoxaemic patients, in whom mechanical ventilation is not sufficient, the need for patient transportation to ECMO centres led to the creation of a mobile VV-ECMO (veno-venous ECMO) programme. The outreach teams initiated VV-ECMO support in the referring hospital with subsequent transport to the ECMO centre. The authors concluded that despite the high mortality (80.3%) in 86 COVID-19 pneumonia patients transported on VV-ECMO, the transportation (either road or aerial) was not associated with an increased risk of complications [24].

REORGANISATION OF WORK

During the pandemic, hospitals were forced to immediately reorganise their work [25]. Soon it was found that the medical resources were lacking, and it was extremely important to triage the patients [26]. Without this practice, without protocols based on the chance for survival, taking into the account the post-COVID quality of life and potential consumption of medical resources versus the set goal, the overall outcomes would be worse.

The importance of adapting new procedures extended beyond rational allocation of resources. Because of the extremely high number of patients and increased risk of contamination during transport, the diagnostics of respiratory insufficiency changed to less complicated methods. Patient transport through hospital corridors had to be restricted – not only due to the above epidemiological concerns, but also because of the critical state of many of them. Those who required diagnostic imaging were mainly those with severe respiratory failure and were not the best candidates for transport. Despite the fact that computer tomography was still the gold standard, its usefulness for infected, critically ill patients was severely limited during the pandemic, and ultrasonography, a bedside tool, became more and more useful and more widely used. For that reason, the Polish consensus of the study group for point-of-care lung ultrasound for intensive care COVID-19 patients was published as early as 2020 [27]. With its concise form, we obtained a straightforward and informative guide for clinicians who perform ultrasound. Despite ultrasonography's usefulness, one has to keep in mind that the pathology visualised in lung ultrasound in the course of COVID-19 is not specific to coronavirus infection. Authors have emphasised that those patients often have comorbidities, such as heart failure or – less common, but possible – lung fibrosis. In such circumstances, pathologies affecting the interstitial space may overlap, thereby limiting the differential diagnosis based on the ultrasound findings.

Having performed a retrospective analysis of nutritional data from multiple Polish ICUs, which emphasised discrepancies between centres and the lack of clear guidance, Danel *et al*. [28] suggested that – in the context of the pandemic – appropriate guidelines and standardisation of the nutritional procedure should also be sought.

As discussed by Pasternak *et al*. [29], the COVID-19 pandemic also contributed to development and popularisation of telemedicine, which, when combined with advancements in artificial intelligence, could lead to reorganisation of yet another aspect of anaesthesiologists' work – pre-anaesthetic assessment.

SUMMARY

Nowadays the pandemic is over, and vaccines are widely available. According to a WHO statement from 5.05.2023, "COVID-19 is now an established and ongoing health issue which no longer constitutes a public health emergency of international concern" [2].

However, the memories of that period will stay with us for a long time. From a practical perspective, the novel approaches, safety precautions and treatment methods that we learned during the pandemic will inevitably influence – and possibly enhance – our clinical practice in the years to come.

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