Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

typically to do advanced tests such as histamine challenge or skin prick. But the future default should be remote consultation, not face-to-face meetings.

Up to now, we have had to improvise, but telemedicine has gained huge momentum during the COVID-19 pandemic, and now we need to make ambitious plans. Preventable asthma deaths are still happening, and major factors include underuse of inhaled corticosteroids, overuse of short-acting β2 agonists, and above all, an asthma attack being treated as an isolated event instead of a red flag predictive of high future risk.[9,10] The imperative is to design remote monitoring systems not only to optimise distance outpatient consultations but also to improve outcomes.

Routine outpatient monitoring includes height, weight, spirometry, exhaled nitric oxide (in some cases), and physical examination including chest auscultation; all these measurements can be done at home. We have the technology for electronic stethoscopes on mobile telephones. Electronic dose counters for inhalers are also available, which could be used to identify underuse of inhaled corticosteroids and overuse of short-acting β2 agonists with remote Bluetooth technology. Our mobile telephones record where we have shopped and where we have dined, and they could potentially be used to record any unscheduled health visits, mandating an asthma review, with the permission of the family. We would need to devise an alert system so that contact is immediately made if agreed thresholds were met.

Remote collection of this information for all children with more than trivial asthma, combined with individual and societal behavioural change, could potentially reduce asthma attacks and improve outcomes. The challenge is to improve clinical practice post COVID-19, not default to the past.

We declare no competing interests. AB is funded by the Asthma UK Centre for applied research.

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COVID-19 recovery: potential treatments for post-intensive care syndrome

Published **Online**
October 13, 2020
https://doi.org/10.1016/S2213-2600(20)30457-4

The long-term effects of surviving COVID-19 have become a new focus of attention for clinicians and researchers. This focus has been driven partly by concerns about late ill-effects of a previously unknown virus, but recognised generic patterns of chronic disease after critical illness also exist. These patterns are termed PICS, an acronym both for post-intensive care syndrome and for persistent inflammation, immunosuppression, and catabolism syndrome. We recommend unifying post-COVID-19 research aims with those of PICS research and propose a novel approach to its management by repurposing drugs that are approved, inexpensive, and safe.

Severe COVID-19 pneumonia causes acute respiratory distress syndrome (ARDS). Intensive care unit (ICU) stays of patients with ARDS are lengthy and characterised by severe hypoxaemia, extrapulmonary organ failures, and a marked inflammatory response. Follow-up data from young (<30 years) populations with a range of critical illnesses and no comorbidities,

***Panel:* Considerations for research**

Post-intensive care syndrome (PICS) often occurs after prolonged critical illnesses, such as COVID-19-associated acute respiratory distress syndrome, and involves persistent inflammation, immunosuppression, and catabolism.

Substantial cardiovascular morbidity and mortality accompany PICS, even in young, fit populations without traditional cardiovascular risk factors.

The harms of potent anti-inflammatory drugs that are used to counter chronic cardiovascular disease and fibrosis are unquantified in PICS; further data could show whether these therapies offer some benefit.

Low-risk cardiometabolic and antithrombotic drugs might be beneficial and large international, multicentre trials are needed to formally test their efficacy.

Avoiding polypharmacy while prognostically enriching the trial population (and so increasing the study's signal-to-noise ratio) could be done through the use of clinical characteristics or cardiovascular and immune biomarkers to select patients more appropriate for specific trials.

Study designs should involve optimising discharge therapy before patients start any new trial drug and account for the fact that many survivors of critical illness already take one or more of the drugs of interest.

Involving individuals with PICS to help guide research priorities is crucially important to ensure that research remains patient-centred.

and studies assessing dose–responses (dose of illness *vs* response of morbidity) of organ dysfunction and tissue injury, suggest that an adverse long-term re-programming of multiple organ systems can occur during such critical illness.[1] People who survive lose weight and are debilitated, often with cognitive impairments. A hysteresis of body-mass recovery in different tissue compartments occurs and metabolic control is often disrupted, with the development of type 2 diabetes and adipose gain commonly reported in affected individuals. Organs undergo microscopic damage at the time of acute inflammation and display imperfect repair, with acute kidney injury and cardiovascular dysfunction transitioning to chronic kidney disease and post-ICU major adverse cardiac events.[1] These processes occur in the context of low-grade inflammation and functional immunosuppression, which predisposes individuals who survive admission to ICU, and particularly those with PICS, to secondary infections.[2] Although physical activity counters the proinflammatory effects of sedentarism, enhanced recovery programmes against a backdrop of residual inflammation have not translated to benefit, suggesting a potential role for pharmacological intervention.[3]

If prolonged critical illness, including that associated with COVID-19, causes patients to develop chronic inflammation, thrombosis, and fibrosis, antagonists of these processes might be beneficial for survivors. The CANTOS trial showed that major adverse cardiac events, lung cancer, and anaemia rates were reduced in groups with evidence of low-grade inflammation when treated for secondary prevention with the interleukin-1β (IL-1β) monoclonal antibody canakinumab.[4] However, our opinion is that the critical care specialty is not yet in a position to conduct large-scale trials of such powerful anti-inflammatory drugs in ICU survivors. The CANTOS and COLCOT trials showed that reducing IL-1β-related inflammation increases infection risk, an important consideration in the functionally immunosuppressed PICS population.[2] However, other established cardiometabolic therapeutics with good clinical rationale and excellent safety profiles already exist and hold great promise for ICU survivors. These drugs are in a prime position to be trialled immediately in large numbers of patients with COVID-19-associated PICS, and such studies might provide a better understanding of who, if anyone, might benefit from IL-1β targeting.

Non-randomised studies suggest that renin–angiotensin–aldosterone system (RAAS) inhibitors reduce mortality after discharge from the ICU in people who had critical illness with acute kidney injury, whereas preclinical studies suggest a potentially beneficial modulation of frailty in models of age-associated frailty.[5] The SSCILL trial aims to test whether a RAAS modulator with suspected anti-inflammatory and known antifibrotic effects could be used in this group of patients with PICS to reduce major adverse cardiac events.[6] However, other drugs, including RAAS modulators, should also be trialled while data for PICS biology accumulates. Statin trials in healthy patients with elevated high-sensitivity C-reactive protein (CRP) and older patients (>75 years) without atherosclerosis show how reductions in cardiovascular risk, high-sensitivity CRP, and rates of pneumonia and deep vein thrombosis can be achieved with low-risk drugs that, among other things, increase concentrations of

proresolution mediators (eg, resolvins).[7] Other drugs, or dietary supplementation with compounds that increase proresolution mediators and reduce thrombo-inflammation, might also be expected to reduce cardiovascular and overall morbidity in patients with PICS; cardiovascular trials of aspirin and icosapent ethyl provide evidence of efficacy. In the MANAGE trial,[8] a population having non-cardiac surgery, which overlaps and shares similarities with the PICS population through the presence of non-ischaemic myocardial injuries, was found to have reduced cardiovascular morbidity at follow-up when treated with the antithrombotic dabigatran; further trials of dabigatran in patients with PICS are warranted.

Modulators of metabolism could also counteract numerous problems reported in patients with PICS. Multiple phase 3 studies of SGLT2 inhibitors repeatedly show improvements in metabolic and fibrotic cardiorenal outcomes even in the absence of diabetes. Metformin could similarly improve cardiometabolic profiles while also modulating the immunoparesis noted during and after critical illnesses.[9] Systemic metabolism, energy balance, and immunity are neurally mediated through the sympathetic nervous system. β-Adrenoceptor blockers are anti-arrhythmics with proven benefit in the cardiovascular arena, but might also benefit patients with PICS by reducing systemic metabolic rate and catabolism, decreasing bone marrow replicative stress, and modulating immune dysfunction.[10] Nutritional supplements, such as niacin and folic acid, should also be trialled in PICS, because beneficial effects on muscle and the cardiovascular system, mediated through effects on DNA methylation and cellular energetics, are potentially attainable at low risk.[11]

Through large international, collaborative research projects, the ICU community has the opportunity to reduce readmission to hospital and the ICU while improving overall quality of life, healthspan, societal productivity, and the lifespan for people who have been in ICU (panel). The James Lind Alliance research prioritisation exercise in intensive care shows that patients would welcome trials in this area. Therefore, we propose that the ICU community should organise large, international, pragmatic, multicentre platform trials for ICU survivors, in a manner analogous to the RECOVERY trial, to potentially decipher whether or not these drugs can be efficacious for those who have survived critical illnesses such as COVID-19. We suggest that the research pathway for such trials should be based on prognostic enrichment through clinical and cardiovascular or immune biomarker profiles, and initially use established drugs that modify cardiometabolic risk in ICU survivors who might not have traditionally recognised cardiovascular risk factors, through randomised controlled trials led by intensive care specialists. We are already on the path to starting this process with SSCILL in sepsis, polytrauma, and ARDS, and we encourage others to join us.

For more on the **RECOVERY trial** see https://www.recoverytrial.net

MNB has received research awards from the UK Intensive Care Society for the pilot randomised controlled trial SSCILL. All other authors declare no competing interests.

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For more on **James Lind Alliance priority setting in intensive care** see https://www.jla.nihr.ac.uk/priority-setting-partnerships/intensive-care