AI analytics predict COVID-19 patients' daily trajectory in UK intensive care

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Credit: Imperial College London

Researchers used AI to identify which daily changing clinical parameters best predict intervention responses in critically ill COVID-19 patients.

The investigators used machine learning to predict which patients might get worse and not respond positively to being turned onto their front in intensive care units (ICUs) – a technique known as proning that is commonly used in this setting to improve oxygenation of the lungs.

While the AI model was used on a retrospective cohort of patient data collected during the pandemic's first wave, the study demonstrates the ability of AI methods to predict patient outcomes using routine clinical information used by ICU medics.

The researchers say the approach, where each patient's data were analyzed day-by-day instead of only on admission, could be used to improve guidelines in clinical practice going forward. It could be applied to potential future waves of the pandemic and other diseases treated in similar clinical settings.

This is the first study that examines daily COVID-19 patient data, using AI to understand the clinical response to the rapidly changing needs of patients in ICUs. Led by a team from Imperial College London and Royal Brompton and Harefield hospitals for the COVID-ICU Consortium, the research is published today in the journal Intensive Care Medicine.

First author and clinical science lead Dr. Brijesh Patel, from Imperial's Department of Surgery & Cancer and senior intensivist at Royal Brompton Hospital, said: "Most studies look at the health of a patient on admission to ICU, and whether they were discharged or sadly died. In ICU there is a huge amount of information which we use at the bedside to manage patients on a day-by-day basis, and our study focuses on how the patients' state changed daily.

"This helped focus our attention on which specific parameters matter the most, and how the importance of each parameter changes over time.

This dynamic understanding is vitally important when trying to understand a new life-threatening disease and to know when and in whom each intervention works."

The prone position is used in ICUs to help improve blood oxygenation in people with severe acute respiratory distress syndrome, and has been used extensively during the pandemic. However, proning did not help all COVID-19 patients and, when used in patients who will not benefit, can delay the start of other sequential treatments like using extracorporeal membrane oxygenation (ECMO), a life-support machine that takes over for the heart and lungs to oxygenate blood and pump it round the body. Better analysis of proning implementation and prediction of failed proning could lead to more personalized applications.

Dr. Patel said: "ECMO is currently the last resort for many patients, after all other less invasive interventions such as prone position have failed, but it has associated risks. Over 20% of all patients on a mechanical ventilator were referred to and received management advice from one of the five national ECMO centers. Patients appropriately placed early onto ECMO show better outcomes. However, only 4% of referred patients received ECMO, which is due to a number of reasons, but one of which could have been delays in assessment of responsiveness to interventions like prone position.

"Advanced analytics to enable tracking of disease allows patient care to be streamlined so that the window of opportunity for any intervention is not missed. The data from this national evaluation enabled us not only to examine how our management decisions affected disease course but importantly where we could improve."

The new findings show that the AI model identified factors that determined which patients were likely to get worse and not respond to interventions like proning. The researchers found that during the first

wave of the pandemic, patients with blood clots or inflammation in the lungs, lower oxygen levels, lower blood pressure, and lower lactate levels were less likely to benefit from being proned. Overall, proning improved oxygenation in only 44% of patients.

Senior author and data science lead Professor Aldo Faisal, Director of Imperial's Center in AI for Healthcare at the Departments of Computing and Bioengineering said: "In the ever-changing landscape of the pandemic, clinicians are constantly learning and adapting to patient needs, which themselves change every day. Critically, we have set up a standing digital service evaluation of UK ICUs, getting day-by-day treatment data from ICUs across the nations. Our machine learning tool could help track patient progress in real time and help inform ICU guidelines by filling the gaps of patient care—reflecting back to clinicians to identify best practice quickly and benefit from sharing.

"More than one year on, we're still learning how the course of COVID-19 affects the body, and how this can change day-by-day. Data science and the daily data feeds from ICUs across the country help us learn much faster how best to treat individual patients based on their daily symptoms and needs."

The researchers analyzed data from 633 mechanically ventilated COVID-19 patients across 20 UK ICUs during the first wave of the COVID-19 outbreak (1 March—31 August 2020). They examined the importance of factors associated with disease progression, like blood clots and inflammation in the lungs, as well as treatments given and whether the patient ultimately died or was discharged.

They used this data, which was collected daily by legions of medical students, nurses, doctors, audit, research and data staff, to design and train the AI tool which then made predictions on factors that determine outcomes.

Dr. Patel added: "Our findings could help inform ICU guidelines and clinicians going forward, and AI could play a pivotal role in how we learn about and adapt to COVID-19 disease progression on a daily basis. Our mantra within the NHS is to innovate and improve patient care and this form of national evaluation helps us to understand our own biases as clinicians. We hope our findings will help and encourage more research to be undertaken that focuses on the daily needs of patients."

The researchers continue to collect patient data and are currently analyzing findings from the second wave of the pandemic. They note that in the first wave there were limited drug treatments available, so more COVID-19 patients may have been triaged directly to ICU for breathing support. However, in the second wave, proven treatments such as steroids and tociluzimab, pioneered by other Imperial researchers, were more widely available, so those who progressed to ICU had a different disease profile, as they were patients who were inherently resistant to these initial drug treatments.

Professor Faisal said: "Findings from the first and second wave will differ because approaches to treating patients in ICU evolved with the pandemic. However, our AI tool kit is already set up across UK ICUs to monitor daily patient data and adapt to the changing situation."

More information: undefined undefined et al. Natural history, trajectory, and management of mechanically ventilated COVID-19 patients in the United Kingdom, *Intensive Care Medicine* (2021). DOI: 10.1007/s00134-021-06389-z

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