Scientists develop algorithm to help relieve pressure on the NHS

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New research suggests an algorithm could be used to help optimise the sharing of healthcare resources during the COVID-19 pandemic, preventing NHS intensive care units (ICU) from becoming

overwhelmed.

The study, led by Queen Mary University of London, proposes a load balancing method to transfer critical ICU patients across hospitals and optimally allocate new patients, which could help to reduce stress on health systems in the second wave and potential subsequent waves to come.

The research team, which included scientists from the University of Exeter and the University of Bristol, tested the algorithm using available data from both the UK's NHS and Spanish health system. They showed that this mathematical approach could help redistribute up to 1000 ICU patients that otherwise likely wouldn't receive the appropriate intensive care.

During the pandemic, demand for ICUs varies across a country, with some hospitals receiving substantial numbers of patients early on in an outbreak whilst others are unaffected. These differences in demand create an opportunity to balance the load of patient admissions across hospitals, by rerouting patients from areas of high demand to local hospitals that have spare capacity.

Rerouting and load balancing solutions have a long history in areas such as computer networks, where usually different tasks are assigned to different interconnected servers and the servers can communicate and transfer tasks in order to minimise the global processing time. In this study, the researchers adopted a similar approach to manage ICU resources in hospital networks, where the "load" to be allocated is the amount of ICU patients or ventilators, and the rerouting takes place across hospitals.

Using the algorithm the researchers showed that when ICU demand is uniform across the country it is possible to enable access for up to 1000

additional cases in the UK in a single step of the algorithm, without needing to increase capacity. In more realistic scenarios, where we see differences in demand across hospitals or regions, the scientists found their new method could balance about 600 beds per step in the Spanish system when sharing resources locally, and over 1300 using countrywide sharing, potentially saving a large percentage of these lives that would otherwise not have access to ICUs.

It is hoped this mathematical approach could also be used to help reduce demand when the epidemic begins to decline, allowing hospitals to return back to normal as efficiently as possible.

Dr. Leon Danon, Senior Lecturer in Data Analytics at the University of Exeter, said: "The current COVID-19 pandemic has put many national health systems under significant pressure, particularly for ICUs and ventilators. So far balancing patient loads in times of high demand has occurred spontaneously, for example with hospitals sharing daily information on demand and availability of resources with colleagues in other local hospitals. Whilst this quick action can help in the immediate, once multiple hospital become overwhelmed the pattern of demand becomes more complex and a more systematic approach is needed. Our load sharing methodology can help to prevent health services becoming overwhelmed by the excessive demand for intensive care, which is particularly critical when the second wave we are experiencing can now be coupled with the flu season."

Dr. Lucas Lacasa, Reader in Applied Mathematics at Queen Mary, said: "We have validated that the method works with realistic data from the UK and Spain, and shown it can be used to load balance patients in real time. We are currently in the process of exploring how to operationalise the method within the healthcare system, and are developing a user-friendly interface for the NHS, or other health systems across the globe, to be able to embed this technology within the set of measures each

country is already deploying to manage the pandemic."

"The method is easily portable to other countries as well, and whilst this load sharing algorithm has primarily been developed for the current pandemic, there's no reason a similar approach couldn't be used to load balance other healthcare resources."

The study is published in *PLOS ONE*.

More information: A flexible method for optimising sharing of healthcare resources and demand in the context of the COVID-19 pandemic, *PLOS ONE*, 2020.

Provided by Queen Mary, University of London