AI predicts demand for hospital beds for patients coming through emergency department

September 8 2022

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An artificial intelligence tool developed by researchers at UCL alongside staff at UCLH is being used to predict how many patients coming

through the emergency department will need to be admitted into the hospital, helping planners manage demand on beds.

The tool, described in a new paper in *npj Digital Medicine*, estimates how many hospital beds will be needed in four and eight hours' time by looking at live data of patients who have arrived at the hospital's emergency department.

In the study, the research team showed that the tool was more accurate than the conventional benchmark used by planners, based on the average number of beds needed on the same day of the week for the previous six weeks.

The tool, which also accounts for patients yet to arrive at hospital, also provides much more detailed information than the conventional method. Instead of a single figure prediction for the day overall, the tool includes a probability distribution for how many beds will be needed in four- and eight-hours' time and provides its forecasts four times a day, emailed to hospital planners.

The research team is now working with UCLH on refining the models so that they can estimate how many beds will be needed in different areas of the hospital (e.g. beds on medical wards or surgical wards).

Lead author Dr. Zella King (UCL Clinical Operational Research Unit and the UCL Institute of Health Informatics) said, "Our AI models provide a much richer picture about the likely demand on beds throughout the course of the day. They make use of patient data the instant this data is recorded. We hope this can help planners to manage patient flow—a complex task that involves balancing planned-for patients with emergency admissions. This is important in reducing the number of canceled surgeries and in ensuring high-quality care."

Alison Clements, Head of Operations, Patient Flow & Emergency Preparedness, Resilience & Response at UCLH, said, "This AI tool will be hugely valuable in helping us manage admissions and patient flow at UCLH. Our next step is to start using the predictions in daily flow huddles. We look forward to continuing work with UCL to refine the tool and expand its predictive power across the hospital."

The researchers trained 12 machine learning models using patient data recorded at UCLH between May 2019 and July 2021. These models assessed each patient's probability of being admitted to the hospital from the emergency department based on data ranging from age and how the patient arrived in hospital, to test results and number of consultations, and combined these probabilities for an overall estimate of the number of beds needed.

They then compared the models' predictions to actual admissions between May 2019 to March 2020, finding they outperformed the conventional method, with central predictions an average of four admissions off the actual figure compared to the conventional method, which was on average 6.5 admissions out. After COVID hit, the researchers were able to adapt the models to take account of significant variations both in the numbers of people arriving and the amount of time they spent in the emergency department.

Senior author Professor Sonya Crowe, Director of the UCL Clinical Operational Research Unit, said, "Most applications of AI in health care so far have focused on clinical questions whereas the tool we have developed with UCLH aims to help the operational side of health care—that is, how it is run and managed.

"This work was possible thanks to the close collaboration between researchers at UCL and staff at UCLH. Our approach is tailored to systems at UCLH but we hope it can also be adapted by hospitals

elsewhere."

Lorraine Walton, Clinical Operations Manager at UCLH for Bed Management, said, "The benefit of this tool is that it can be responsive to real time changes in patient demand and characteristics. These changes may be short term or long term. We found for instance that the tool could be adapted for use during the pandemic. Importantly this tool will help to improve patient experience and outcomes once refined."

Each of the 12 models focused on data at different time intervals since the patient's arrival: the first model focused only on data recorded at the moment of arrival, the second on data recorded in the first 15 minutes, while model 12 focused on data recorded over 12 hours. This is because factors varied in importance depending on the time that had elapsed and on how much other data was available. For instance, in model 1, the method of arrival at the hospital was an important factor, but became less so in later models. Using the 12 models together was more accurate than using fewer models, the researchers found.

More information: Zella King et al, Machine learning for real-time aggregated prediction of hospital admission for emergency patients, *npj Digital Medicine* (2022). DOI: 10.1038/s41746-022-00649-y

Provided by University College London