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Because of their complex care needs, many elderly patients are discharged from hospitals only to be readmitted for multiple stays within the following twelve months. John Abisheganaden and his fellow authors describe Singapore's Hospital to Home program, a community care initiative fueled by artificial intelligence.

Elderly patients, especially those who suffer from multiple chronic ailments and have complex care needs, often find it difficult to take care of themselves after they leave the public hospital where they have stayed for several days. As a result, many are readmitted over the next twelve to twenty-four months.[1,2]

To reduce readmissions, the Singapore public healthcare system devised the Hospital to Home (H2H) program, launched in April 2017, providing a nationwide community care framework that offers post-hospital help to this special group of patients, many of whom are frail and in need of additional medical and social support. The H2H program helps at-risk patients safely transition back to their home and community in a timely manner.

But how to predict who should be in the program? Many of the patients to be screened have complex post-discharge support needs and a high risk of returning to the hospital, not just once but several times over the subsequent twelve months. The Ministry of Health therefore deployed an artificial intelligence (AI) prediction model, trained on admissions and demographic data, to perform the initial screening of patients to determine whether they should be enrolled in the H2H program.

The AI prediction model trained on data from the National Electronic Health Record (NEHR) system, which flowed into the Business Research Analytics Insight Network (BRAIN) platform – a centralized business intelligence, analytics, and AI processing platform serving a wide range of data analytics needs across Singapore's public healthcare system. Within BRAIN, a scheduler system triggers the prediction model to run daily for all patients recently admitted to public hospitals, generating a patient readmission risk score for each.

The data used to train the AI prediction model includes more than 1,000 indicators that fall into three categories: sociodemographic characteristics, past hospital use, and past medical conditions. These indicators include the patient's age, number of non-elective inpatient admissions, total length of hospital stays in the past two years, total number of specialist outpatient visits, emergency department visits in the past year, and much more.

The AI prediction model

The machine learning method used for the model is a gradient boosting algorithm. We considered it essential that we be able to clearly explain the model, so we did not use deep learning methods. The gradient boosting algorithm allows us to readily show the relative influence of each variable on the results. As a result, clinician experts can check if these relative influences are in keeping with their clinical judgement.

The prediction model then identifies patients, admitted within the past twenty-four hours to a public hospital,

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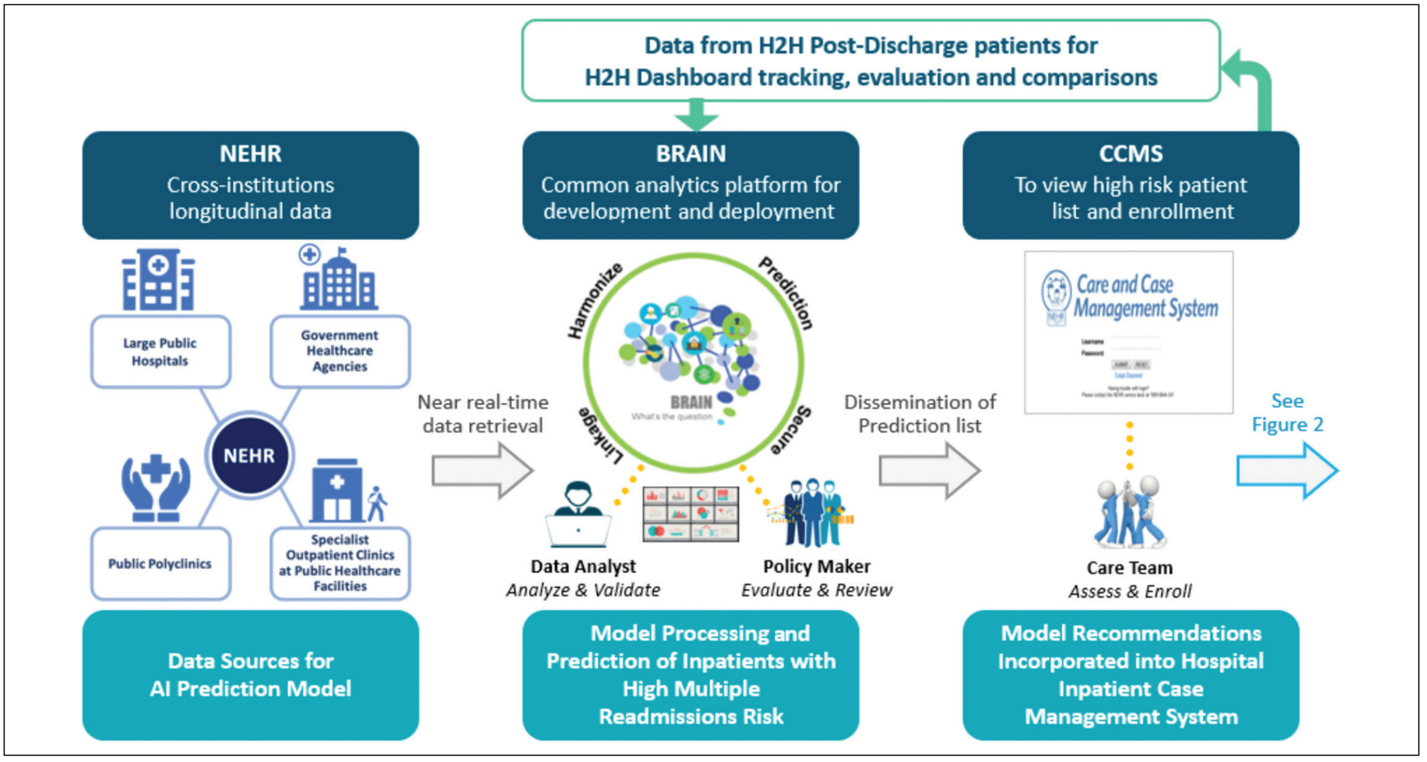
Figure 1: Major Information Systems Used for the Multiple Readmissions AI Prediction Model



who are at high risk of multiple readmissions over the next twelve months. This result is incorporated into the hospital's care and case management system (CCMS) – a platform that provides a standardized view of each current patient and includes admission details, demographics, and past medical intervention history in the public health system.

After hospital staff use the predictive model to recommend patients for the H2H program, they vet them personally, using their clinical judgement to narrow the list of candidates for the program. Once chosen, patients who agree to enroll in the H2H program receive counseling and education about the program during the remainder of their hospital stay.

After they leave the hospital, an interdisciplinary team including doctors, nurses, allied health professionals, social workers, and community care coordinators provide these patients with further care and support through home visits and phone follow-ups.

Impact on patient engagement

Without the AI prediction model, the nurses who screen for for the H2H program in each public hospital would have to spend about half of every day manually screening the entire patient list and visiting wards to assess newly admitted patients.

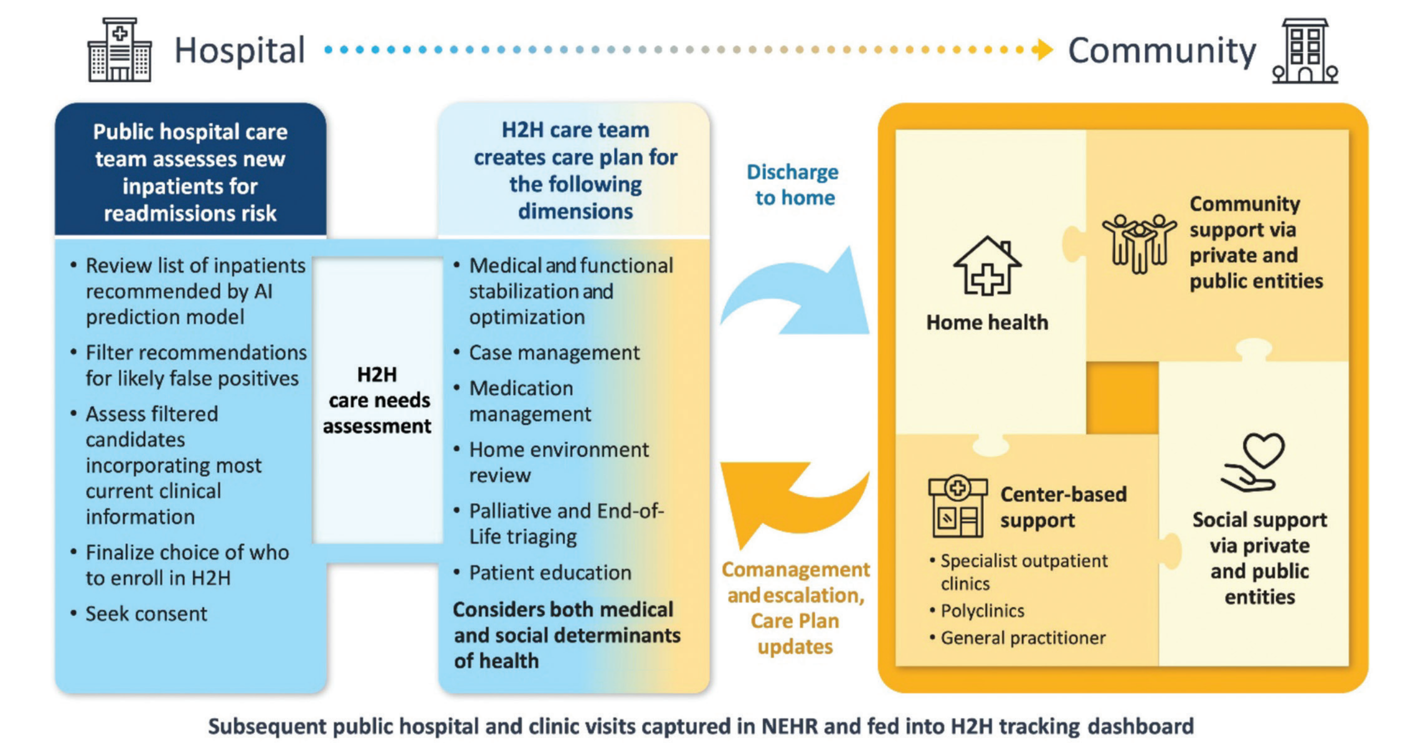
This process would be impractical and too time intensive to carry out every day, in every ward of every public hospital. One large public hospital estimated that, without the AI prediction model, it would need fifteen nurses, rather than five, to complete daily screenings for the H2H program. The cost would be prohibitive.

The AI prediction model lightens that workload by identifying the 10 to 15 percent of patients who are at high risk of multiple readmissions over the next twelve months. The screening nurses, as well as doctors and other clinicians in the program, can then focus on vetting this smaller group without having to screen the other 85 to 90 percent.

Singapore's public hospitals admit more than 450,000 patients every year, around 40 percent of them aged 65 and older.[3] Using the AI prediction model reduces the average daily vetting workload from more than 1,200 total patients per day to an average of between 123 and 183 per day (10 to 15 percent of the national average of daily admissions), making screening much more manageable.

In addition, the AI prediction model's faster selection process gives the H2H multidisciplinary care team more time to engage with patients during their hospital stay. This additional engagement time is crucial for preparing patients and their families for what to do after leaving the hospital.[4]

Figure 2: Hospital to Home Patient Assessment, Care Plan Creation and Post-Hospital Support Process



Without the AI prediction model, it would have taken three times longer for the current number of nurses to do the initial screening of patients for the H2H program. The second step of clinical vetting would then be delayed by two to three working days, which in turn would reduce the time left to explain to patients and their families what to do after discharge.

Doctors, nurses, and other members of the H2H care team appreciate the lighter workload and this savings in time, which lets them focus on the patients – both inpatients who are being enrolled into the program and discharged patients in the community care network.

Downstream benefits

The impact of the AI prediction model goes far beyond the H2H candidate selection process. Patients in the program tend to have reduced hospital stays in the 180 days after enrolling. Between April 2019 and April 2021, the average number of bed days saved across three of our major hospitals ranged from three to seven days per H2H patient.

To calculate the number of bed days saved, we compared patients who were enrolled in the H2H program to an unenrolled group who were of a similar age and Charlson Comorbidity Index (CCI) score.[5,6] We compared the total number of bed days in the 180 days after an index admission with those in the 180 days prior.[7]

> Without the AI prediction model, it would have taken three times longer for the current number of nurses to do the initial screening of patients for the H2H program

As clinicians, we know that shorter hospital stays benefit both the patient and the hospital.

Lessons for engagement

The AI prediction model allows human clinicians to efficiently and effectively engage with customers, in this case the hospital inpatients. After the enrolled patients are discharged and return home, they are assured close engagement with their H2H care team, which includes home visits from social workers and community health workers as well as phone and video conferencing with medical practitioners. This close interaction improves patients' health results and reduces hospital stays by avoiding future readmissions. This AI prediction model works behind the scenes to support human workers, and by doing so, allows our healthcare workers to engage directly and more deeply with their patients. ■

Author Bios

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Endnotes

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7. The formula used is as follows: Net Change in Bed Days = Average Change in Bed Days of Enrolled Patients – Average Change in Bed Days of Non-Enrolled Patients of the same CCI score (control group); where Change in Bed Days = Cumulative Bed Days 180 days post the Index Admission– Cumulative Bed Days 180 days prior to the index admission.