K4 - Data Analytics & Applications in Hong Kong Hospital Authority: Past, Present & Future

Ms Eva TSUI Lai-hing
BSoc.Sc., MSoc.Sc.(Applied Statistics)
Chief Manager, Statistics & Workforce Planning Department,
Hospital Authority, Hong Kong

Dr Anderson TSANG Chun-on
MBBS(Hons), FRCS(Edin)
Clinical Assistant Professor, Division of Neurosurgery,
The University of Hong Kong

Ms Eva Tsui was graduated from the University of Hong Kong, obtaining bachelor and master degrees with a major in Economics and Applied Statistics respectively. In 1994 she joined the Hospital Authority (HA) head office as a statistician, and since 2008 she has been the Chief Manager overseeing the Statistics Department with over 40 professional statistical staff. Her Department's mission is to translate HA's massive volume of administrative and clinical data into official statistics, useful information and actionable insights, supporting HA in informed decision making in wide-ranging aspects. She contributed to the development of a number of predictive models, analytic and projection tools which are applied corporate-wide. Recently she has been advancing the Department's technical expertise into big data analytics, tapping HA's unstructured data and in collaboration with academia.

Dr Anderson Tsang (MBBS, FRCS) obtained his medical degree in The University of Hong Kong, and completed his specialty training in Neurosurgery at Queen Mary Hospital, Hong Kong. With the support of the HMRF research fellowship scheme, he finished a clinical and research fellowship in endovascular stroke treatment in Toronto Western Hospital, University of Toronto. He is currently clinical assistant professor of Neurosurgery at the University of Hong Kong, with a research focus on endovascular intervention and cross-specialty translational research in cerebrovascular diseases.

Since inception in 1990 the Hong Kong Hospital Authority (HA) has implemented public healthcare IT systems, by phases and by modules incrementally, to collect patient-based administrative and clinical data across almost all aspects of hospital healthcare services. It is a sharing to illustrate how data analytics and statistical modelling skills have been applied to transform this huge volume of real-world data into useful information, and then into actionable insights, to inform clinical service planning and developments in HA, aiming for impacts on the healthcare system and population health.

The first illustrative case dated back to more than 10 years ago when HA intended to launch a community-based Hospital Admission Risk Reduction Program for the Elderly (HARRPE). It portrays a cycle commencing from needs assessment to data-driven tools, implementation and followed by evaluation. In view of the high caseload of elderly patients having unplanned readmission to medical wards within 28 days of hospital discharge, a risk prediction tool was developed to estimate the likelihood for individual elderly patients through a logistics regression model building and validation using over one million of episodes respectively. This Model relies on 14 predictor variables which have a standardized data definition across all HA hospitals and a sustainable data quality over time. The Community Health Call service was piloted in two hospital clusters, involving trained nurses to proactively make telephone calls to high risk elders (with predicted score higher than a predefined cut-off) and their carers within 48 hours after hospital discharge. This pilot intervention was evaluated to be effective in reducing A&E attendances, emergency medical admissions and acute bed days by around 20%, therefore leading to the set-up of one centralized Community Health Call Centre for overall HA in 2009. This risk prediction tool was also automated as a daily screening tool to identify high risk elders for the Centre. To an extent this a-decade-ago project had met the 5-V criteria of a big data application. While this Model is subject to regular review on its predictive performance, continuous data exploratory work is going on to identify additional predictor variables or explore new applications. The 15th predictor variable candidate is "polypharmacy" i.e. number of regular drug items taken. After a complex process to devise an operational rule to quantify this measure from huge volume of drug dispensing transactions, despite it is strongly associated with elderly unplanned readmission, it was ultimately discarded due to its marginal contribution towards overall predictive performance, after striking a balance between gain and investment regarding "small" versus "big" in application.

The second illustrative case is the first HA-HKU big data collaborative project which commenced in end 2017. In the current phase it is a research study aiming to develop a rapid automated tool to predict the likelihood of large vessel occlusion (LVO) based on HA's retrospective data of plain CT images and clinical information. The topic was chosen as LVO is the most severe form of acute ischemic stroke with a very high mortality rate as compared to other types of stroke, but it is highly treatable and the earlier the better. After a collaborative input towards the study design, a version-1 algorithm using the deep learning convolutional neural network model has been developed by HKU research teams, with predictive performance comparable to other validated instruments'. With additional data and expertise input from a panel of HA radiologists on image labelling, now it is being enhanced into version-2 algorithm. Next is to run the enhanced algorithm among a historical full-year cohort of ischemic stroke patients in the HA Data Collaboration Lab. To complement, HA's statistical team has developed text analytics algorithms based on regular expression and XGBoost models to automate extraction of stroke symptoms and GCS scores from free text discharge summary and transform them into structured data for HKU's algorithm to generate the predictive score for individual subjects. With an ultimate aim of translating this research findings and risk prediction algorithm into clinical practice at HA service locations, HKU is planning the next phase of translational research in collaboration with HA and its clinicians, also incorporating evaluation on the structure, process and outcome of the pilot implementation.