

Research Assessment Exercise 2020

Impact Case Study

University: The University of Hong Kong (HKU)

Unit of Assessment (UoA): 22. Business

Title of case study: Improving Management and Quality of Care for Stroke Patients Using Data Analytics and Decision Support

(1) Summary of the impact

In this UoA a strong multi-disciplinary collaboration between economists, statisticians and data analysts, management scholars and clinicians has directly led to several impactful research initiatives. Stroke is a chronic disease that is the second leading cause of death in the world, the leading cause of death in China, and the fifth leading cause of death in Hong Kong, with enormous economic cost. By addressing the challenge of how to improve the clinical care pathway for stroke and bridge the evidence-to-care gap, **Shen** and colleagues from neurology, science and medicine demonstrated that adherence to evidence-based clinical guidelines significantly improves stroke care.

(2) Underpinning research

Haipeng **Shen** has been Professor of Innovation and Information Management at HKU Faculty of Business and Economics (FBE) since September 2015, and was conferred the Patrick S C Poon Professor of Analytics and Innovation in October 2018, for his work in using data analytics to improve management and quality of care for stroke patients. From July 2014 to August 2015, he was Visiting Professor at HKU, on academic leave from the University of North Carolina at Chapel Hill. His research evolves around the theme of data-driven decision-making in the face of uncertainty, including methodological research about analytical challenges imposed by big data and artificial intelligence, as well as interdisciplinary research in healthcare. He leads a cross-faculty HKU team with junior researchers from business, science, and medicine, and collaborates with leading neurologists in mainland China, Hong Kong, and the US. He provides expertise in designing medical studies, data collection, analysis of patient-level multi-modal healthcare data, as well as validation of interventions in the clinical world [5.1].

Although stroke is the leading cause of death in China, it has been shown that adherence to guidelines and to recommended stroke care metrics is suboptimal. The underpinning research has involved several high-level empirical studies demonstrating the positive role of adherence to stroke performance metrics in relation to patient outcomes [3.1&3.4-5]. It highlighted the significant need to develop a continuous quality improvement programme for the care of stroke patients in China [3.4], through comparing patient data from two phases of the China National Stroke Registry. The findings influenced the adoption of stroke care quality improvement as a national priority [5.2-4]. It also seeded a high-level quality improvement intervention study led by Shen and colleagues [3.1&3.5] - the Golden Bridge– Acute Ischemic Stroke (AIS) randomized clinical trial (RCT), to demonstrate that quality improvement interventions, such as adherence to guidelines, can indeed transform care quality and outcomes for stroke patients.

The AIS trial enrolled 40 hospitals from the China National Network of Stroke Research, an alliance of hospitals with a specialty in stroke care across China, randomly assigning 20 hospitals to be the treatment group, where stroke care for AIS patients would follow a targeted multifaceted quality improvement intervention, and the other 20 hospitals as the control group, where stroke care would be provided in the usual way. This study has had nationwide and global impacts on stroke management [5.5-6]. The significance and spread of this economic-, analytical- and managerial-led work into top-level clinical journals [3.1&3.4-5] evidences the take-up of the research into clinical understanding and hence practice. Shen's research is supported by the *Key Project Grant* from China's Ministry of Science and Technology, and by HKU's *Stanley Ho Alumni Challenge Fund*,

as well as internal seed funding and strategic grant allocation with FBE matching fund for Business Analytics and Big Data research.

A continuation of the research emerged from the earlier intervention studies and resulted in development of a mobile app to support stroke physicians and neurologists working in rural areas. The app incorporates the aforementioned guideline intervention and risk factors for stroke patients identified by Shen's earlier papers in the highly-rated journal *Stroke*, including identifying in-hospital stroke-associated pneumonia and other related medical complications.

(3) References to the research

The quality and high impact of the research is demonstrated by the following publications in top-tier journals, supported by grants from the government, HKU, and FBE. **Shen** is the lead statistician for data acquisition, statistical analysis, and results interpretation. [5.1] states that “*without Shen's involvement, the impact would not have been possible.*”

- [3.1] Wang, Y., Li, Z., Zhao, X., Wang, C., Wang, X., Wang, D., Liang, L., Liu, L., Wang, C., Li, H., **Shen, H.**, Bettger, J., Pan, Y., Jiang, Y., Yang, X., Zhang, C., Han, X., Meng, X., Yang, X., Kang, H., Yuan, W., Fonarow, G.C., Peterson, E.D., Schwamm, L.H., Xian, Y. and Wang, Y. (2018) ‘Effect of a Multifaceted Quality Improvement Intervention on Hospital Personnel Adherence to Performance Measures in Patients With Acute Ischemic Stroke in China A Randomized Clinical Trial’, **The Journal of the American Medical Association (JAMA)**, 320(3), 245-254. Impact Factor: 47.661

The patient follow-up concluded in July 30, 2016, 2 years after **Shen** joined HKU. The work was supported by the following interdisciplinary multi-institutional grant from Mainland China:

July 2017 – Dec 2020 *China Ministry of Technology National Key Project: 2017YFC1310903* ‘Big Data Analytics Methodology for Neurological Diseases Clinical Research’, Leader of Sub Project [**Shen**], amount CNY¥710,000

Shen is the project leader of HKU's interdisciplinary team, which includes two female junior researchers from Faculty of Science (Dr. Fei **Jiang**), and Faculty of Medicine (Dr. Hui **Zhi**), and two PhD students (Mr. Lutao **Dai** and Ms. Suxi **Zheng**).

The work in [3.1] has motivated one joint publication [3.2] of **Shen** and Dr. **Jiang** in a top-tier statistical journal on a methodology that can be transferred to other applications, and another joint publication [3. 3] of **Shen**, Dr. **Jiang**, and Dr. **Zhi** about Artificial Intelligence in Healthcare, which won the Most Influential Publication Award from the *China Stroke Association* in 2018.

- [3.2] **Jiang, F.**, Cheng, Q., Yin, G. and **Shen, H.** (2019) ‘Functional Censored Quantile Regression’, **Journal of the American Statistical Association**, published online. **Impact Factor: 2.297**
- [3.3] **Jiang, F.**, Jiang, Y., **Zhi, H.**, Dong, Y., Li, H., Ma, S., Wang, Y., Dong, Q., **Shen, H.** and Wang, Y. (2017) ‘Artificial Intelligence in Healthcare: Past, Present, and Future’, **Stroke and Vascular Neurology**, 2: e000101, 230-243. (Google citations: 260)

The following two papers are foundational work for the above [3.1-3]. The work started before **Shen** joined HKU, but was further developed and finished at HKU with the generous support from the university and FBE. In [3.4], **Shen's** analysis method made it possible to demonstrate that adherence to stroke performance metrics had increased over time, but there still existed a significant gap between guideline-based recommendations and clinical practice in the management of AIS in China. [3.5] published the protocol of the clinical trial, whose results are analyzed in [3.1].

- [3.4] Li, Z., Wang, C., Zhao, X., Liu, L., Wang, C., Li, H., **Shen, H.**, Liang, L., Bettger, J., Yang, Q., Wang, D., Wang, A., Pan, Y., Jiang, Y., Yang, X., Zhang, C., Fonarow, G.C., Schwamm, L.H., Hu, B., Peterson, E.D., Xian, Y., Wang, Y. and Wang, Y. (2016) ‘Substantial Progress

Yet Significant Opportunity for Improvement in Stroke Care in China’, **Stroke**, 47, 2843-2849. Impact Factor: 6.239

- [3.5] Wang, Y., Li, Z., Xian, Y., Zhao, X., Li, H., **Shen, H.**, Wang, C., Liu, L., Wang, C., Pan, Y., Wang, D., Bettger, J.P., Fonarow, G.C., Schwamm, L.H., Smith, S.C., Peterson, E.D. and Wang, Y. (2015) ‘Rationale and Design of a Cluster-Randomized Multifaceted Intervention Trial to Improve Stroke Care Quality in China: The GOLDEN BRIDGE-AIS’, **American Heart Journal**, 169, 767-774. Impact Factor: 4.171

(4) Details of the impact

The RCT in [3.1&3.5] showed that quality improvement interventions directly lead to enhanced quality of care and significantly better patient outcomes. New clinical vascular events were significantly reduced in the intervention group compared with the control group at three months (3.9% vs 5.3%), six months (6.3% vs 7.8%), and 12 months (9.1% vs 11.8%). Based on a 2013 estimate of 2.4 million new stroke events/year, the reduction corresponds to 33,600 fewer events at three months, 36,000 at six months, and 64,800 at 12 months. [3.4] highlighted that a continuous stroke quality improvement programme should be developed as a national priority in China and this has now happened, thanks to the clinical evidence provided by [3.1&3.5], as stated in the testimonial from the China Stroke Association (CSA) [5.2]:

*“the CSA has incorporated this successful model in its **2019 China Neurological Disease Clinical Guideline**, and implemented it in the Chinese Stroke Centre Alliance, with over 2,600 hospitals that provide stroke care across China.”*

Further evidence of this extensive research impact can also be found in [5.3]:

“A cluster randomised clinical trial (Golden Bridge—AIS) conducted in 2014 showed the feasibility and effectiveness of this multifaceted quality improvement intervention (box 3). It was shown to improve the adherence to evidence based performance measures of acute stroke care while reducing 12 month new vascular events and disability. Information technology was used to provide real time feedback on the quality of stroke care for physicians, directors, and hospitals. Using this successful model, the Chinese Stroke Association organised the Chinese Stroke Centre Alliance. Since 2015, over 2500 hospitals have joined this national, hospital based, stroke care quality assessment and improvement platform.”

The president of a participating intervention hospital reports in [5.4] that

“through participation in the study, the quality of care for our patients has increased dramatically, for example, the relapse rate of stroke has decreased 28.3%; the reputation of our hospital has been greatly enhanced, and the number of hospitalizations in neurology has increased from 1,750 to 5,525 since last year.”

Multiple media outlets in the US, mainland China and Hong Kong have reported the impact of [3.1&3.4-5] in bridging the evidence-to-practice gap in stroke care [5.5-10]. The reach of the impact is truly international and far-reaching: [5.5-6] are viewed extensively by stroke practitioners worldwide, in mainland China, and Hong Kong, while [5.7-10] are widely accessible in mainland China and Hong Kong.

The JAMA editorial [5.5] has already had 5,876 views:

*“This randomized clinical trial by Wang et al has achieved its broad objective of both providing **both stroke evidence and implanting practice change in 20 hospitals**... In many regards, this trial represents the best of evidence-based quality improvement efforts—the improvement in health outcomes is often greater than what would have been expected from the individual components alone. An outcome of the trial by Wang et al is the proof that effective stroke interventions can be implemented in China where the burden of stroke is the*

highest in the world. Trials like this one leave a lasting legacy because the coaching and follow-up and the demonstration that data collection can lead to better outcomes with practice change will leave each of the intervention hospitals with a platform of good-quality stroke care and a mechanism to keep improving.” [5.6] states that “this study adds to a growing body of literature suggesting that quality improvement initiatives can make significant changes in patient outcomes.”

The reach and spread of **Shen**'s work can be further evidenced through the team's recent research alliance with Dr. Gary Lau, Clinical Assistant Professor, Division of Neurology, HKU/Queen Mary Hospital. Dr. Lau has invited **Shen** and his team to collaborate on developing a mobile platform for stroke patients and their caregivers, throughout Hong Kong, Macau, and parts of Shenzhen, China. **Shen** is also invited to present the above work in the 1st HK Stroke Consortium on October 24, 2019. This sustained visibility with stroke practitioners and presence in key innovative clinical networks is an example of creative co-production of impactful research, deriving shared problems and then applying analytical and technical research-based expertise.

To create continuous and sustainable impact, Shen and his collaborators have now incorporated the intervention procedures in a mobile clinical support app, **StrokePro**, together with several risk scores identified in Shen's earlier publications in *Stroke*, the top neurology journal, that can help neurologists to identify risk factors while treating patients. The team has recruited 40 hospitals, spatially spread out across China, obtained ethical approvals, including the patient consent form, and is receiving data from 150+ (and counting) patients. Thus the future of this robust interdisciplinary research is assured and positively encouraged by a supportive strategy and culture in FBE. Direct HKU monetary investment has flowed into the work of this interdisciplinary team and there is a growing emphasis across FBE on rigour and relevance in relation to public policy, healthcare organizations and management practice.

(5) Sources to corroborate the impact

- [5.1] Testimonial from Professor DONG Qiang, Director of Neurology, Huashan Hospital
- [5.2] Testimonial from the China Stroke Association
- [5.3] China's response to the rising stroke burden (<https://www.bmj.com/content/364/bmj.i879>)
- [5.4] Testimonial from Professor WANG Yuxin, President of Hengshui Hospital
- [5.5] Bridging the Evidence-to-Practice Gap in Stroke Care (JAMA Editorial) (<https://jamanetwork.com/journals/jama/article-abstract/2687117>)
- [5.6] Quality improvement interventions increase adherence to performance measures for stroke in China (2 minute medicine) (<https://www.2minutemedicine.com/quality-improvement-interventions-increase-adherence-to-performance-measures-for-stroke-in-china/>)
- [5.7] 低成本综合性干预手段为脑血管防治开辟新途径 (A new cost-saving integrated intervention to improve stroke care) (ScienceNet.cn) (<http://news.sciencenet.cn/htmlpaper/20187215214363646679.shtm>)
- [5.8] JAMA 刊发王拥军教授团队卒中医疗质控研究！背后的付出有哪些你还不知道？(The making of the JAMA publication on stroke care research led by Prof. Wang's team) (Sohu) (http://www.sohu.com/a/239798053_217829)
- [5.9] 分析醫療數據 助中風患者降復發率 (Reducing relapse rate by analyzing the medical data of stroke patients) (Oriental Daily) (https://orientaldaily.on.cc/cnt/news/20190423/mobile/odn-20190423-0423_00176_061.html)
- [5.10] 大數據析中風 計啱藥量促療效 (The benefit of analyzing medical data on stroke patients) (Wen Wei Po) (<http://paper.wenweipo.com/2019/04/23/HK1904230031.htm>)