Institution: University of Bath

Unit of Assessment: C17 Business and Management Studies

Title of case study: Supporting and improving decision making to enhance health and care delivery within the NHS

Period when the underpinning research was undertaken: 2014–2020

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Christos Vasilakis	Professor, previously Senior Lecturer, Teaching Fellow	August 2013 – present
Güneş Erdoğan	Professor, previously Reader	October 2014 – present
Neophytos Stylianou	Research Associate (Researcher in Residence) previously Teaching Fellow	November 2015 to May 2017

Period when the claimed impact occurred: 2015–2020

Is this case study continued from a case study submitted in 2014? No

1. Summary of the impact

Since its creation in 2014, research at the University of Bath Centre for Healthcare Innovation and Improvement (CHI^2) has generated new ways to organise and utilise available healthcare resources. Using operational research and management science, CHI^2 researchers work alongside healthcare clinicians and managers to drive improvements in data availability and quality, in analytical capacity, and in the ability to influence change. The research has underpinned changes in maternity services design across Bath and North East Somerset (BANES), Swindon and Wiltshire, shaped improvements in acute stroke care performance, and created innovative tools to support capacity planning for NHS Clinical Commissioning Groups during the COVID-19 pandemic. CHI^2 has engaged and informed a broad community of healthcare practitioners through its online learning offering, with over 12,000 active learners from over 100 countries.

2. Underpinning research

The University of Bath's Centre for Healthcare Innovation and Improvement (CHI^2), which is led by Professor Vasilakis and has a network of over 200 members from 40 organisations, has raised over GBP1,300,000 in research income since its launch. The multidisciplinary team of researchers specialise in the use of operational research and management science (OR/MS) to improve decision-making and to bring about service and quality improvements (R1). CHI^2 researchers use systems modelling, simulation and analytics methods, as well as quantitative and qualitative research methods, to analyse complex operational and decision-making problems, as demonstrated in the following examples.

CHI^2 developed a researcher-in-residence scheme with the Royal United Hospitals (RUH) Bath NHS Foundation Trust to identify, understand and address current priorities for the Trust that are amenable to OR/MS. In 2015, a key area of research was identified around the need to improve acute stroke service performance. CHI^2 research into **acute stroke services** showed that implementation of standardised flow as part of national guidelines, and a specific care pathway,

require careful negotiation between different professionals, and that such a process can be dysfunctional when implemented across patient pathways and services (R2). The research improved process and implementation strategies that enhanced the delivery of acute stroke care, including the implementation of thrombolysis on the stroke ward and the addition of an extra bay for stroke patients (S1, S2).

The researcher-in-residence programme, through engagement with the maternity unit at RUH, led to further research in 2016 with the Bath and North East Somerset, Swindon and Wiltshire (BSW) Local Maternity System (LMS). In 2016, BSW sought to deliver a 5-year Maternity Transformation Programme to reconfigure and improve the delivery of **maternity services** for the 920,000 people within the region (R3). A CHI[2] team evaluated and developed models of maternity service provision through quantitative and geographic analysis (R3, R4). They created a novel, open-source decision-support system, the FLP (Facility Location Problem) Spreadsheet Solver, to identify the optimal location for maternity services to improve patient access and care (R4). The resulting recommendations were included in a wide three-year consultation (2016–2019), which included a 14-week public consultation exercise and a survey, and a subsequent formal decision-making process that selected this option as part of the transformation (S2, S3a, S3b, S4).

In 2018, CHI[2] developed an open-source, free-to-use **patient pathway simulation** tool in the R programming language and software environment. This was achieved in collaboration with NHS Bristol, North Somerset and South Gloucestershire (BNSSG) Clinical Commissioning Group (CCG) and was funded by a Health Foundation Advancing Applied Analytics grant. The tool models the dynamics of pathways, linking wards, clinics and surgeries. It represents the patient pathway as a network of 'queues' between services, among which patient movements are simulated. It promotes insights into pathway dynamics through the visualisation of patient flow, bottlenecks and waiting times. The tool was used to conduct what-if and sensitivity analyses in relation to the case of centralising acute stroke care services. Simulation results showed that different approaches to introducing the differential care needs of patients into the model had an impact on capacity estimation, which in turn informed decisions concerning the number of beds in the acute and community care settings of the care system (R5). In partnership with BNSSG CCG and University Hospitals Bristol NHS Foundation Trust, a similar modelling methodology and open access tool has recently been developed in response to COVID-19 to model the impact of critical care capacity on the number of deaths due to rejected hospital admissions (R6).

3. References to the research

R1 Pitt, M., Monks, T., Crowe, S. & Vasilakis, C. (2015). 'Systems modelling and simulation in health service design, delivery and decision making', *BMJ Quality and Safety* 25(1), pp. 38–45. DOI: 10.1136/bmjqs-2015-004430

R2 Frangeskou, M., Lewis, M. A. & Vasilakis, C. (2020) 'Implementing standardised flow: Navigating operational and professional dependencies', *International Journal of Operations and Production Management* 40(7/8), pp. 1177–1199. DOI: 10.1108/IJOPM-06-2019-0493

R3 Stylianou, N., Frangeskou, M., Erdoğan, G. & Vasilakis, C. (2018) 'Analysis of the provision and allocation of maternity services in the RUH catchment area: Final report of the analysis of the geographic allocation of maternity services', University of Bath, Bath, UK: Bath Centre for Healthcare Innovation and Improvement, p. 29. Available at: https://researchportal.bath.ac.uk/en/publications/analysis-of-the-provision-and-allocation-of-maternity-services-in

R4 Erdoğan, G., Stylianou, N. & Vasilakis, C. (2019) 'An open-source decision support system for facility location analysis', *Decision Support Systems* 125, 113116 pp. 1-12. DOI: 10.1016/j.dss.2019.113116

R5 Vasilakis, C. & Wood, R. M. (2020). 'Analyst-driven development of an open-source simulation tool to address poor uptake of O.R. in healthcare'. *46th meeting of the EURO Working Group on Operational Research Applied to Health Services*, 26–31 July, Vienna:

Austria. https://researchportal.bath.ac.uk/en/publications/analyst-driven-development-of-an-open-source-simulation-tool-to-a

R6 Wood, R., McWilliams, C., Thomas, M. J., Bourdeaux, C. & Vasilakis, C. (2020) 'COVID-19 scenario modelling for the mitigation of capacity-dependent deaths in intensive care', *Health Care Management Science* 23(3), pp. 315–324. DOI: 10.1007/s10729-020-09511-7

4. Details of the impact

Research at CHI^2 has generated new ways to organise and utilise available healthcare resources, having impacts as described in the following examples.

Transforming maternity services design across Bath, Wiltshire and Swindon

Maternity services within BANES, Wiltshire and Swindon Local Maternity System (BWS LMS), which provides services each year to the 250,000 women of child-bearing age within the region (S3c), have been significantly influenced by CHI^2 research (R3, R4). From four candidates, the CHI^2 open source 'Facility Location' decision-support tool identified Frome and Chippenham as the preferred locations to continue supporting births. This recommendation was included in a Pre-Consultation Business Case that was put to public consultation, and was the preferred option to underpin the planned transformation (S2, S3a, S3b, S4). The public consultation process was further supported through a report produced by CHI^2 with the results of the analysis (S5), which was made available through the 3 Clinical Commissioning Groups' consultation websites and distributed to all interested partners on request (S3). The outcome of the consultation report was central to the decision-making of the governing bodies of the CCGs and Trusts in relation to change in maternity provision (S3, S4). The Interim Chief Operating Officer, RUH Bath NHS Foundation Trust stated that the research was "*incredibly insightful*" and offered "*more choice to women in our area and enable[s] us to make the best use of our resources to ensure women and families have the same access or level of service across our maternity services*" (S2). These service changes have affected over 20,000 births and over 200,000 outpatient appointments in the region since 2019 (S3c).

Improving acute stroke care performance at the Royal United Hospital Trust

Performance improvements stemmed directly from our research into the care process for patients with suspected acute stroke. This included creating the capacity for thrombolysed patients on the stroke ward (in addition to the Emergency Department) in 2015. The then Director of Medicine at RUH stated that "*the research was crucial in identifying areas of the pathway that were not working, the key barriers to implementation and the ways these could be addressed... These insights informed the design and implementation of the acute stroke delivery, including the implementation of thrombolysis into the stroke care ward (extra bay)"* (S6). They continued, "*These changes ... resulted in the improvement in our acute stroke performance*" (S6). This is reflected in the Care Quality Commission's inspection report, which highlighted that "*The stroke service performance in the Sentinel Stroke National Audit programme had improved with an overall rating above the national average*", increasing from a low rating of D to the best, of A, during the 3 years encompassing the research (S1).

Developing new tools to support capacity planning for NHS Clinical Commissioning Groups (CCGs)

Working in a collaboration between CHI^2 and Bristol, North Somerset and South Gloucestershire (BNSSG) CCG and funded by The Health Foundation, an open-source Pathway Simulation tool was developed that enabled BNSSG CCG to make improvements in its community services for stroke patients (R5). Managing healthcare demand and capacity is especially difficult in the context of the COVID-19 pandemic. The 'PathSimR' tool was recently adapted to model the likely impact of critical care capacity on the number of deaths attributed to patients unable to access an intensive care unit bed (R6). Without this specialist resource, patients are more likely to die. The modelling study and accompanying tool estimated the extent to which such capacity-dependent deaths might be mitigated through initiatives involving non-pharmaceutical interventions and supply-side measures to increase surge capacity or reduce lengths of stay. The tool was applied to all hospitals in the BNSSG CCG catchment area of approximately

1,000,000 people to model the critical care bed requirements due to COVID-19 (S7). In addition, the tool was also used to model operations in Bristol's new mass vaccination centre by estimating the optimal number of individuals that could be safely vaccinated based on the appropriate workflow, the number of staff working in each vaccination pod, and the size of waiting room areas. As the Associate Director of Business Intelligence for NHS BNSSG CCG testifies:

> "*The simulation results and insights [from the tool] played a key role in our decisions around the benefits of expanding the existing stock of critical care beds from pre-pandemic levels to different levels of surge capacity. It also played a critical role in designing the new mass vaccination centre at Ashton Gate stadium, informing decisions on the optimal throughput of individuals through each vaccination 'pod' which, in accordance with our modelling results, was set at 416 individuals per shift. … this tool [is] being implemented not just in our own NHS system (modelling capacity, COVID scenarios) but in other areas of the Trust (workforce planning and resumption of elective surgeries) and also externally to the NHS in other areas including Public Health (mortuaries)"* (S7a).

The Head of Modelling and Analytics for the Bristol, North Somerset and South Gloucestershire CCG attested "*The tool is now being routinely used within the CCG, providing crucial support for live delivery projects, such as the multi-million pound reconfiguration towards a centralised stroke service*" (S7b).

Improving awareness and understanding of the role of operational research in supporting quality improvement

Collaborative work between CHI^2 and West of England Academic Health Science Network (WEAHSN) led to the development of an accredited Massive Open Online Course (MOOC) – 'Quality Improvement in Healthcare: Making the Case for Change' (S8). Since its launch in 2016, the course has had over 25,000 enrolments over 13 runs, including almost 12,000 active learners from over 100 countries (40% of participants are UK-based). Of those completing the post-course questionnaire in the last 5 runs, 94% have indicated that the course has met or exceeded their expectations; 95% reported that they have learnt new knowledge or skills; 66% said that they will be applying their learning, and 74% that they will be sharing the learning they acquired (S8). The MOOC has been recommended by the Royal College of Physicians, BMJ (the publisher of one of the most prestigious medical journals), National Quality Improvement and Clinical Audit Network, Maternal and Neonatal Health Safety Collaborative, Oxford Academic Health Science Network, and Aged Care Insite, an Australian magazine (S9).

In summary, CHI^2 has improved understanding, decision-making and practice in healthcare operations. According to the Director of Innovation and Growth at the West of England Academic Health Science Network: "*CHI^2 has become the de facto destination for healthcare innovation, improvement and analytics expertise in the entire region*" (S10).

5. Sources to corroborate the impact

S1. Care Quality Commission. (2016) 'Royal United Hospital Bath Quality Report', p. 18. Available at: https://www.cqc.org.uk/sites/default/files/new_reports/AAAF7325.pdf

S2 Testimonial from Interim Chief Operating Officer, Royal United Hospitals Bath NHS Foundation Trust, dated 5 November 2020.

S3a BSW LMS. (2018) *'Transforming Maternity Services Together: Pre-Consultation Business Case: Version 6 Final'* (pp. 22, 25, 26, 78, 98, 103). Available at: http://www.transformingmaternity.org.uk/documents/BSW_LMS_PCBC_appendices.pdf

S3b BSW LMS. (2019) '*Transforming Maternity Services Together: Final Decision* (video)', available at: http://www.transformingmaternity.org.uk/, (transcript) available at: https://youtu.be/oz42dQKLhH0

S3c BSW LMS. (2018) '*Transforming Maternity Services Together: NHS Consultation Website',* Available at: http://www.transformingmaternity.org.uk/about.asp

S4	NHS Wiltshire Clinical Commissioning Group. (2020) *Press release: Proposal to transform local maternity services is approved.* January 16. Available at: http://www.transformingmaternity.org.uk/documents/news/2020_01_16_Proposal_to_transform_local_maternity_services_is_approved.pdf
S5	Smith-Lickess, S., Stylianou, S. & Vasilakis, C. (2019) '*Report of the analysis and results of the public consultation survey "Transforming* Maternity Services Together, Have Your Say*"*'. Centre for Healthcare Innovation and Improvement, University of Bath School of Management, p. 82. Available at: http://www.transformingmaternity.org.uk/documents/Transforming_Maternity_Services_Together_Have_Your_Say-FinalReport-October2019.pdf
S6	Testimonial from Associate Medical Director & Senior Responsible Officer for the Ageing Well Programme, B&NES, Swindon and Wiltshire. Former Divisional Director for Medicine, Royal United Hospital Bath, dated 18 November 2020.
S7a	Testimonial from Associate Director Business Intelligence | Business Intelligence Team, NHS Bristol, North Somerset & South Gloucestershire Clinical Commissioning Group (BNSSG CCG), dated 2 December 2020.
S7b	Wood, R. (2019) '*Developing a versatile tool for modelling pathway capacity in NHS Organisations'*, The Health Foundation. https://www.health.org.uk/improvement-projects/developing-a-versatile-tool-for-modelling-pathway-capacity-in-nhs-organisations
S8	Smith-Lickess, S. & Vasilakis, C. (2020) 'Analysis of interim results of the study to evaluate massive open online course (MOOC) on quality improvement in healthcare', Centre for Healthcare Innovation and Improvement, University of Bath School of Management.
S9	Recommendations for the MOOC:
S9a	British Medical Journal. https://improve.bmj.com/improve_post/quality-improvement-in-healthcare-the-case-for-change/
S9b	Royal College of Physicians, Quality Improvement Hub. 2017 (July). *Quality Improvement Resources: Education and Training Courses*. https://www.rcplondon.ac.uk/file/7258/download
S9c	Maternal and Neonatal Health Safety Collaborative Programme, accessed 18 January 2021.https://www.weahsn.net/what-we-do/enhancing-patient-safety/maternal-neonatal-health-safety-collaborative/
S9d	Oxford Academic Health Science Network, 9 August2017. http://www.patientsafetyoxford.org/news/946/
S9e	Aged Care Insite website screenshot. News item 'Sandwich generation focus of free courses on caring for family', 6 September 2017 [available on request].
S9f	Severn Postgraduate Medical Education, NHS Health Education England, accessed 5 January 2021. https://foundation.severndeanery.nhs.uk/about-us/quality-improvement/learning-about-quality-improvement/
S10	Director of Innovation and Growth, testimonial on behalf of the West of England Academic Health Science Network, dated 3 November 2020.