

## Impact case study (REF3)

<b>Institution:</b> University of Hertfordshire		
<b>Unit of Assessment:</b> 17 – Business and Management Studies		
<b>Title of case study:</b> Novel decision support modelling to increase efficiency of healthcare provision, reduce costs and improve patient experience		
<b>Period when the underpinning research was undertaken:</b> 2011 – 2020		
<b>Details of staff conducting the underpinning research from the submitting unit:</b>		
<b>Name(s):</b>	<b>Role(s) (e.g. job title):</b>	<b>Period(s) employed by submitting HEI:</b>
Eren Demir	Professor of Decision Sciences	2010 – present
Reda Lebcir	Reader in Management Systems	2004 – present
<b>Period when the claimed impact occurred:</b> 1 August 2013 – 31 December 2020		
<b>Is this case study continued from a case study submitted in 2014? N</b>		
<b>1. Summary of the impact</b> (indicative maximum 100 words)		
<p>The NHS has long been under pressure to both improve patient care and deliver efficiency savings. Research at the University of Hertfordshire Business School has developed decision support systems and quality management models for healthcare organisations that have identified optimal service configurations and management practices. Involving collaborations with three NHS trusts and two private healthcare companies, the research has achieved the following key impacts:</p> <ul style="list-style-type: none"> <li>- Increased service efficiency, including 2,000 additional cataract procedures and a reduction of 4,800 A&amp;E attendances per year in one NHS trust, and a 16% rise in attendances at retinal services in another.</li> <li>- Improved patient care, including shorter waiting times that increased compliance with government targets on treatment times by 25% in one NHS department.</li> <li>- Significant budgetary savings, including increased income of £0.6m for one NHS service.</li> <li>- Commercial and operational benefits for healthcare companies, leading to better care.</li> <li>- Better informed decision making by Public Health England to manage the impact of the Covid-19 pandemic on health services in the East of England.</li> </ul>		
<b>2. Underpinning research</b> (indicative maximum 500 words)		
<p>The NHS is a highly complex organisation; it sees one million patients every 36 hours and employs 1.5 million people. While it seeks to provide each patient with the best possible care, its ability to meet quality standards is affected by budgetary constraints, meaning efficient use of limited resources is paramount. Research at University of Hertfordshire Business School, led by Demir and Lebcir, has explored the use of systems thinking approaches and modelling in healthcare management, and has developed decision support tools to optimise service provision.</p> <p>Initial research involved developing a novel modelling approach to predict patients at high risk of hospital readmission, using data on 963 patients with chronic pulmonary obstructive disease (COPD) and asthma. As an alternative to logistic regression (a popular, yet often inaccurate method of predicting patient-specific probabilities), Demir demonstrated the efficacy of using more flexible, data-driven models that better represent complex nonlinear relationships [3.1]. He highlighted their applicability as decision support tools for disease management. Demir and Lebcir then developed, within the context of neonatal care, three unique methodologies based on length of stay modelling, physical patient pathways and system dynamics modelling to improve patient flow through the health system [3.2].</p> <p>Working with NHS trusts and healthcare companies, Lebcir and Demir used these techniques to develop a computer-based Discrete Event Simulation (DES) model that could be adapted to specific care services [3.3-3.5]. A DES model simulates dynamic interactions and behaviours within a complex system in order to compare strategic options and identify which would be the most effective. In healthcare, it enables providers to maximise resources and meet current and future demand, taking into account all factors (e.g. staff availability, appointment duration and demand, budgets). National datasets, clinical reports and interviews with clinicians were used to build the DES models. Every clinic visit involves multiple activities including diagnostic testing,</p>		

treatment and follow-ups. Resources are consumed at each stage of this process, and the resource needs of each patient are unique depending on the severity of their condition. DES modelling accommodates this level of detail, offering decision makers (from clinicians to finance directors) a safe virtual environment in which to test a range of 'what if?' scenarios.

The DES model was applied to ophthalmology and Parkinson's Disease (PD) services in three NHS trusts between 2014 and 2017. The models investigated four key questions: (i) What sort of interventions should we spend our money on? (ii) Where will we get the most value from our investment? (iii) How will we explain the choices we have made? (iv) How can we make our services more effective and efficient? The model was used to represent cataract service pathways at University Hospitals of Leicester NHS Trust. It showed that the number of surgeries each year could be increased by 40% at no extra cost, finding that non-human resources (e.g. pre-surgery rooms) were being underutilised [3.3]. At Maidstone and Tunbridge Wells NHS Foundation Trust, the model was adapted to simulate retinal services. It demonstrated the feasibility of expanding and reorganising service provision to accommodate increasing numbers of patients, identifying a clear return on investment [3.4]. The model was used at Salford Royal NHS Foundation Trust to evaluate the clinical and financial benefits that could be achieved through increased integration of community services in delivery of PD care. Results showed that time and staffing pressures would be alleviated; hospital visits would fall by 25%, leading to a 32% reduction in clinical staff time and a 26% reduction in hospital treatment costs [3.5].

Systems thinking principles underpinning 3.2, which highlights the importance of adopting a holistic approach to business improvements, were applied to the development of a quality improvement model designed to strengthen management practices within private healthcare organisation CuroCare (now Sequence Care). At the time, CuroCare was responsible for mental health provision across seven hospitals and three care homes in Hertfordshire. The researchers used action research to collect data from staff and patients. They used this to build a model focused on embedding a culture of learning and knowledge sharing. This model was applied within the organisation, with a positive impact on patient satisfaction and quality of care [3.6].

The combined body of work led to the team's inclusion in an ESRC-funded project [G1], led by Imperial College London, to explore how to optimise antibiotic usage along surgical pathways with the twin aim of addressing antimicrobial resistance and improving clinical outcomes. Applying the methodologies in 3.1-3.6, Lebcir co-led the system dynamics workstream, modelling the impacts of parallel clinical interventions. A simulation model demonstrated that maximum compliance with prescribing practices was achieved through increased compliance among senior staff (more than junior) and faster laboratory turnaround of blood cultures and microbiologist reviews [3.7].

### 3. References to the research (indicative maximum of six references)

**3.1** Demir, E. (2014). A decision support tool for predicting patients at risk of readmission: a comparison of classification trees, logistic regression, generalized additive models, and multivariate adaptive regression splines. *Decision Sciences*, 45(5), 849-880.

<https://doi.org/10.1111/deci.12094>

**3.2** Demir, E., Lebcir, M., & Adeyemi, S. (2014). Modelling length of stay and patient flows: methodological case studies from the UK neonatal care services. *Journal of the Operational Research Society*, 65(4), 532-545. <https://doi.org/10.1057/jors.2013.51>

**3.3** Demir, E., Southern, D., Rashid, S., & Lebcir, M. (2018). A Discrete Event Simulation model to evaluate the treatment pathways of patients with Cataract in the United Kingdom. *BMC Health Services Research*, 18(1), [933]. <https://doi.org/10.1186/s12913-018-3741-2>

**3.4** Demir, E., Southern, D., Verner, A., & Amoaku, W. (2018). A simulation tool for better management of retinal services. *BMC Health Services Research*, 18(1), 759. [759].

<https://doi.org/10.1186/s12913-018-3560-5>

**3.5** Demir, E., Vasilakis, C., Lebcir, M., & Southern, D. (2015). A simulation-based decision support tool for informing the management of patients with Parkinson's disease. *International*

Journal of Production Research, 53(24), 7238-7251.

<https://doi.org/10.1080/00207543.2015.1029647>

**3.6** Lebcir, M., & Sideras, J. D. (Accepted/In press). Total Quality Management in Healthcare: The Importance of Learning and Knowledge Sharing to Support Implementation. British Journal of Healthcare Management.

**3.7** Zhu, N. J., Ahmad, R., Holmes, A., Robotham, J. V., Lebcir, M., & Atun, R. A. (2020). System dynamics modelling to formulate policy interventions to optimise antibiotic prescribing in hospitals. Journal of the Operational Research Society.

<https://doi.org/10.1080/01605682.2020.1796537>

#### Underpinning grant

**G1** ESRC (ES/P00831/1). SPIRES: Optimising antibiotic use along surgical pathways: addressing antimicrobial resistance and improving clinical outcomes. £1,688,708. 2017 – 2022.

#### **4. Details of the impact** (indicative maximum 750 words)

Novel decision support models developed through research at the University of Hertfordshire Business School were applied to clinical settings. The findings increased service efficiency, reduced costs and improved patient care for NHS ophthalmology (which accounts for nearly one in ten NHS hospital outpatient appointments) and Parkinson's Disease services, and privately-run mental health services. Through this process, two private healthcare companies have benefitted commercially and operationally, which in turn has raised patient care standards. These modelling techniques were also applied to an evaluation of the impact of Covid-19 on health services in the East of England, aiding decision making by Public Health England (PHE).

#### **Increasing service efficiency, achieving budgetary savings and improving patient care at NHS trusts**

In 2016, the cataract services at University Hospitals of Leicester NHS Trust's Ophthalmology Department were under severe pressure from growing patient demand, which had risen 30% in three years. The previous year, there had been more than 200,000 outpatient attendances, 5,500 day-case procedures and 25,000 emergency eye casualty attendances [5.1]. NHS services are expected to treat 90% of patients within 18 weeks of referral but, despite working at full capacity, the referral to treatment (RTT) waiting time at the Trust had fallen to around 70% [5.1]. Around 460 cataract surgeries were being performed each month, yet a backlog of 10,000 patients were waiting for surgery and short-notice cancellations were on the rise due to an increase in the number of older patients with co-morbidities [5.1].

Demir and Lebcir's DES model was used to simulate multiple scenarios for the reconfiguration of cataract services, modelling what would occur if the number of procedures carried out each week were increased by steps of 5% (i.e. its impact on resource utilisation, staffing hours and finances) in order to identify the optimal configuration [3.3]. As an example, it demonstrated that increasing the number of cataract procedures carried out per theatre list from six to eight increased throughput by 36% (at no extra cost) from 5,542 to 7,521 per annum [5.1]. These findings (and others) led to the Trust formally approving the service changes recommended by the modelling [5.1]. The changes led to the following 'significant' improvements over 2017-2018 [5.1]:

- Shorter waiting lists which increased RTT compliance from 70% to 95%.
- Reduction in patient complaints and improved patient experience.
- Increased income of £0.6m.

These outcomes led to the Trust approving a request for further service changes, which included implementing a three-session day to increase clinic capacity and patient choice and offering evening and weekend sessions to meet outpatient demand [5.1]. The Trust's Ophthalmology General Manager wrote [5.1]: *The service also implemented a Rapid Access Clinic to provide*

*urgent appointments, reducing the attendances to Eye Casualty and Accident and Emergency by 4,800 attendances a year.'*

Also in 2016, Demir and Lebcir worked with the Ophthalmology Department at Maidstone and Tunbridge Wells NHS Foundation Trust to model the Trust's retinal service. The service was running at full capacity, having experienced a '*dramatic increase*' in the number of diabetic macular oedema (DMO) patients, who require regular intravitreal injections of ranibizumab [5.2]. Demir forecasted service demand over 12 months, demonstrating that higher demand would continue [5.2]. The service required one of two changes: additional clinic sessions, which is an expensive option (due to clinician time), or the recruitment of additional 'nurse injectors', the lower cost option. The DES model was used to evaluate multiple scenarios, including the impact of introducing two additional nurse injectors if demand continued to increase by 5% every month [3.4]. It found that recruiting two nurse injectors would increase attendances by 16% and follow-up attendances by 10%, without increased use of consultant time. [5.2]. As a result, the Trust's Ophthalmology General Manager wrote [5.2]: "*Recruiting two nurse injectors ... meant that we were able to treat more patients, thus a decrease in waiting list. ... Nurse-injectors paved the way for specialist nurses to deal with follow-up attendances, reducing the burden on consultants, enabling them to treat new and existing patients (in accordance with NICE guidelines). This meant that more patients receive optimal treatment and retain vision with better outcomes. Without the simulation model, it would have been impossible for the us to recognise that such a simple intervention could lead to a significant impact on our services.*" The modelling carried out for 3.4 was featured at length in the Macular Society's annual journal Digest [5.3], which is distributed to their professional members – over 8,000 eye care professionals worldwide.

The collaboration with Salford Royal NHS Foundation Trust involved modelling the impact of treating progressively larger numbers of PD patients in the community as opposed to in hospitals. The finding of a 26% reduction in hospital treatment costs meant, despite an increase in the cost of community services, a reduction in overall costs for treating PD by 10% [3.5]. The findings were disseminated via a policy brief to NHS trusts in Hertfordshire and Essex. A clinical academic working in clinical practice at East and North Herts NHS Trust wrote [5.4]: '*I can clearly see how this has had a downstream impact on our clinical services. Parkinson disease is under-resourced nationally and locally so this study is an important step-forward in addressing not only what should be provided but also to streamline a limited resource, with an emphasis on more community-based provision, which is in line with patient preferences in this population.*'

### **Delivering commercial and operational benefits to private healthcare companies**

Representatives of healthcare companies Johnson & Johnson Vision and Pathway Communications (now part of Spirit Healthcare Group) collaborated with Demir and Lebcir on the modelling studies [3.3-3.5]; they were co-authors on the published journal papers. Noting that the DES model for NHS cataract services could be utilised within any NHS Trust in the UK, Johnson & Johnson Vision's Director of Market Access said the research '*enabled us to better understand the operational nature of NHS cataract services in greater detail*' [5.5]. This supported the company's business development aims as it seeks to support NHS cataract services by evidencing '*the process of re-designing their services and finding the most efficient and effective delivery of care to patients*' [5.5]. The Managing Director of Spirit Access Ltd (part of Spirit Healthcare Group) said the collaborations had strengthened the company's business relationship with Johnson & Johnson Vision and formed a '*significant*' element of their public relations strategy within the healthcare industry [5.6]. It also led to a follow-up project with Johnson & Johnson Vision and York Teaching Hospital NHS Foundation Trust [5.6].

The quality improvement (QI) model reported in 3.6 was implemented within CuroCare over a 12-month period from October 2012, with the sustained benefits obtained by the company falling within the eligible REF 2021 impact period. CuroCare became Sequence Care Group in November 2014. Sequence Care, which specialises in care for people with learning disabilities, mental health needs, autism and complex behaviours, runs 16 residential services in London and the Home Counties. The company reported that the implementation of the QI model



increased staff awareness and knowledge of care quality standards and also strengthened staff recruitment and selection processes. Local patient and staff groups were set up at each site to encourage cross learning, share best practice and address quality problems. Decision-making was also distributed from senior management to other staff [5.7].

Representative comments from the company's staff and senior managers included [5.7]: 'More training is now run locally, which helps staff absorb knowledge because it seems more personal to them ... There's more learning that happens, which changes the way we operate' (Care Director); 'We've changed our audit process to make it less of a blame culture and turned it into a fix it culture ... [the model] 'has become a theme in the organisation' (HR Manager); 'It's been received positive[ly] by care managers as well. At the time it [the model] was launched there was much discussion in the media about values of compassion and values of nursing and we were seen to be ahead of the game before Government' (Marketing Director).

### **Modelling the spread of Covid-19 in the East of England to aid Public Health England decision making**

Lebcir's system dynamics modelling work under the ASPIRES grant [3.6, G1] was applied to the modelling of the Covid-19 pandemic and its impact on NHS services throughout 2020. In June 2020, Lebcir was invited to become a member of the PHE/NHS COVID-19 modelling steering group for East of England (EoE), a region with a population of around 6.24m (date 2019). This was based on his track record of applying health systems modelling to address various health management and public health challenges [5.8]. The Covid-19 modelling group comprises academics from the Universities of Cambridge, East Anglia and Hertfordshire (Lebcir) with members also from Public Health England (PHE) and NHS trusts in the EoE region.

The group carried out modelling work to inform PHE and NHS decision making in EoE in the following areas: predicting capacity requirements for acute services; forecasting Covid-19 infection rates, hospitalisations and deaths; assessing the effect of lockdown and regional tier policies on the spread of the disease; the management of resources; modelling the impact of the vaccination programme [5.8]. PHE commented: '*At the peak of the pandemic, the regional modelling projections informed regional bed planning and surge capacity. The upper limits of estimations informed decisions regarding resource commissioning. The analysis provided by the regional modelling colleagues and informed by the steering group reassured us that our decisions were evidence-driven and accounted for worst-case scenarios.*' Lebcir was made an Honorary Registrar of PHE in November 2020 as a result of his '*insightful support*' and contribution to this work [5.8].

### **5. Sources to corroborate the impact** (indicative maximum of 10 references)

- 5.1** Corroborating statement from the former Ophthalmology General Manager at University of Leicester University Hospitals NHS Trust. Can be contacted for further corroboration.
- 5.2** Corroborating statement from the former Ophthalmology General Manager at Maidstone and Tunbridge Wells NHS Foundation Trust.
- 5.3** Digest (2017), Macular Society (see pages 65-69).
- 5.4** Corroborating statement from a Florence Nightingale Clinical Professor of Nursing at East & North Hertfordshire NHS Trust.
- 5.5** Corroborating statement from the Director of Market Access, Johnson + Johnson Vision (Surgical, Europe, Middle East & Africa).
- 5.6** Corroborating statement from the Managing Director of Spirit Access Limited (part of Spirit Healthcare Group and formerly Pathway Communications Limited).
- 5.7** Corroborating statements from Care Director, HR Manager and Marketing Director at CuroCare (now Sequence Care Group).
- 5.8** Corroborating statement from the Deputy Director Healthcare Public Health and Workforce: PHE – East of England & PHE lead.