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OPTIMISING CARDIOLOGY SERVICES: FORECASTING AND SIMULATION FOR STRATEGIC PLANNING

Elizabeth M. Williams

Cardiff University
Abacws, Senghennydd Rd, Cardiff CF24 4AG
WilliamsEM20@cardiff.ac.uk

Mark Tuson

Cardiff University
Abacws, Senghennydd Rd, Cardiff CF24 4AG
TusonM@cardiff.ac.uk

1 BACKGROUND

Cardiovascular diseases continue to be the leading cause of death globally, responsible for approximately 17.9 million fatalities each year (World Health Organisation, 2025) . The prevalence of these conditions is anticipated to rise due to aging populations, increasing life expectancy and the growing burden of lifestyle-related risk factors such as obesity, hypertension and diabetes (Bhupathiraju and Hu, 2016). This trend underscores the urgent need for healthcare systems to forecast future demand accurately, enabling effective resource allocation, improved patient outcomes and the implementation of preventive strategies to mitigate the impact of these diseases (Soyiri and Reidpath, 2012, Varnosfaderani and Forouzanfar, 2024).

Central to the management of cardiovascular conditions is the catheterisation laboratory (cath lab), where critical diagnostic and therapeutic procedures are performed (Dalen and Alpert, 2018). The efficient operation of cath labs is vital for timely interventions, particularly in acute coronary syndromes and other life-threatening cardiac events. However, the rapid growth in demand for these specialised services presents significant challenges in resource planning and capacity management, necessitating data-driven approaches to optimise their use.

This study is conducted in collaboration with the Cardiology Department at Cardiff and Vale University Health Board, where rising demand for cardiology services, coupled with resource constraints, necessitates strategic planning. The research aims to provide insights that support decision-making to optimise resource allocation, improve patient flow and enhance the quality of care for patients with cardiovascular conditions. The findings are expected to contribute to sustainable healthcare service delivery in response to evolving needs.

2 APPROACH

Historical data from cardiology outpatient visits, inpatient admissions and day-case procedures were analysed to identify trends and seasonal patterns influencing patient volumes. Time-series forecasting techniques, incorporating demographic changes and observed post-pandemic demand surges, were applied to project five-year capacity requirements. The forecasts segmented demand by elective and unscheduled cases to highlight distinct resource needs. This approach enables healthcare planners to anticipate service utilisation, address potential bottlenecks and align resource allocation with projected patient flows, enhancing the overall efficiency of cardiology service delivery.

In this study, a discrete event simulation (DES) model was developed to represent patient flow and resource usage within the cardiology department. The model captures the dynamic nature of patient arrivals, waiting times and service processes. The model simulates individual patient pathways, from admission through diagnostic and therapeutic procedures, including cath lab utilisation and bed occupancy. Key parameters, such as procedure durations, staff availability and resource constraints, were incorporated to reflect real-world operations. By allowing scenario exploration, the DES model

provides actionable insights into optimising bed capacity and cath lab scheduling, helping to achieve target utilisation levels and reduce patient waiting times while ensuring resource efficiency.

3 IMPACT

The outcomes of this collaborative research with Cardiff and Vale University Health Board have directly influenced strategic planning within its Cardiology Department. Forecasting and simulation results have highlighted the rising demand for cardiology services and the urgent need for additional cath lab resources. The discrete event simulation model validated the impact of increased cath lab capacity on patient flow, showing significant potential for reducing wait times and achieving operational targets, such as 85% utilisation rates. These data-driven insights are now forming the foundation of a business case to secure investment in additional cath lab infrastructure and associated resources. By integrating robust forecasting and simulation evidence, this business case aims to ensure sustainable service delivery, enhanced patient outcomes and improved capacity to meet future demand. This collaboration demonstrates the value of combining academic research with practical healthcare challenges to drive informed decision-making and long-term healthcare improvement.

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