**University of Leicester**

British Heart Foundation Centre of Research Excellence

PhD studentship

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| **Additional Supervisor** |  |

**Section 2 – *Project Information***

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| **Project Title** | Personalised Prediction of Sudden Cardiac Death Using LifeMap Features and Deep Learning |
| **Project Summary** | |
| Sudden Cardiac Death (SCD) causes over 3 million deaths globally each year, often resulting from ventricular arrhythmias that could be prevented by implantable cardioverter defibrillators (ICDs). However, current risk stratification methods are inadequate—most patients receiving ICDs never use them, while many high-risk individuals remain undetected. This project addresses this major clinical gap by developing advanced artificial intelligence (AI) models that integrate physiological insights from LifeMap—a technology developed by our team based on electrical restitution theory.  Patented LifeMap biomarkers, such as the Regional Restitution Instability Index (R2I2) and Peak ECG Restitution Slope (PERS), have shown a 21.6-fold increased risk prediction for SCD/VA in patients positive for both markers.  This PhD project will leverage large-scale retrospective datasets (n > 1000), including 24-hour Holter ECG recordings from patients with known SCD/VA outcomes. These include unique cohorts such as post-MI patients with preserved LVEF and athletes with arrhythmic events. The aim is to develop explainable AI models that use both LifeMap and conventional ECG features (e.g., HRV, PRD, QT variability), improving the accuracy and interpretability of risk prediction.  Machine learning techniques to be employed include logistic regression, random forest, XGBoost, and deep neural networks (CNNs, LSTMs, Transformers). Explainability methods such as SHAP, saliency maps, and attention mechanisms will ensure transparency in predictions. The final goal is to deliver a validated, interpretable AI model and a translational framework that could inform ICD decision-making in NHS clinical workflows.  The student will receive interdisciplinary training in cardiac electrophysiology, signal processing, machine learning, regulatory governance, and clinical research. They will also engage in national and international conferences and collaborations. | |
| References | |
| Nicolson WB, McCann GP, Smith MI, Sandilands AJ, Stafford PJ, Schlindwein FS, Samani NJ, Ng GA.  Prospective evaluation of two novel electrocardiogram-based restitution biomarkers for prediction of sudden cardiac death risk in ischaemic cardiomyopathy.  Heart. 2014;100(23):1878–1885. doi:10.1136/heartjnl-2014-305632  Ng GA, Mistry A, Li X, Schlindwein FS, Nicolson WB.  LifeMap: Towards the development of a new technology in sudden cardiac death risk stratification for clinical use.  Europace. 2018;20(FI2):f162–f170. doi:10.1093/europace/euy190  Barker J, Li X, Kotb A, Mavilakandy A, Antoun I, Thaitirarot C, Koev I, Man S, Schlindwein FS, Dhutia H, Chin SH, Tyukin I, Nicolson WB, Ng GA.\*\*  Artificial intelligence for ventricular arrhythmia capability using ambulatory electrocardiograms.  European Heart Journal – Digital Health. 2024. doi:10.1093/ehjdh/ztae004  Barker J, Li X, Khavandi S, Koeckerling D, Mavilakandy A, Pepper C, Bountziouka V, Chen L, Kotb A, Antoun I, Mansir J, Smith-Byrne K, Schlindwein FS, Dhutia H, Tyukin I, Nicolson WB, Ng GA.  Machine learning in sudden cardiac death risk prediction: a systematic review.  EP Europace. 2022; euac135. doi:10.1093/europace/euac135 | |
| **Specific entry requirements**  UK2:1 Bachelor degree, a relevant subject, such as clinical medicine, biomedical engineering is preferred. Experience with ECG signal analysis, machine learning, or data science would be an advantage.  Standard University of Leicester English language requirements | |