Project Details	
Project Code	MRCIIAR25Ca Woolley
Title	Neonatal Sepsis Detection Automation for Neonatal Intensive Care Units.
Research Theme	Infection, Immunity, Antimicrobial Resistance & Repair
Summary	Sepsis is a leading cause of death in infants, particularly in Neonatal Intensive Care Units (NICUs). Early detection is crucial for improving recovery chances. Using a high resolution and vast data set from a NICU in India, our project aims to develop an automated system to monitor physiological changes in real-time, providing early warnings of potential sepsis before clinical signs appear. Preliminary results show sepsis could be detected up to 72 hours earlier. This project seeks to refine and validate the system, potentially revolutionizing sepsis care in NICUs globally,saving lives and enhancing infant health outcomes.
Description	**Key Research Question** Can we develop an automated early alert system that uses real-time data signal analysis to detect neonatal sepsis before clinical signs become evident? Background Sepsis is the leading cause of death globally in infants and children under five years of age. In 2021, 7.7% of neonatal deaths in the UK were primarily attributed to sepsis. Worldwide, neonatal sepsis causes almost 2.5 million deaths, mostly in low and middle-income countries. The risk is particularly high for infants in a Neonatal Intensive Care Unit (NICU) as they are already vulnerable through prematurity and/or other health conditions. We have an ongoing data-sharing agreement with a tertiary NICU at SKS Hospitals in Salem, India. Using non-invasive probes, we have high-resolution data of 97 vital physiological parameters (e.g., heart rate, electrocardiogram, peripheral oxygen saturation, respiration, and peripheral temperature) from multiple preterm infants at risk of, or diagnosed with, sepsis. A preliminary investigation using machine learning and signal analysis strongly suggests statistically significant shifts in both the time and frequency domains of physiological data up to 72 hours before clinical suspicion of neonatal sepsis. We hypothesise that signal detection methods can identify changes in monitored physiological parameters and detect sepsis earlier, leading to earlier diagnosis and treatment for NICU infants. Reducing the period between infection and clinical detection of sepsis could lead to earlier treatment, improved chances of recovery, and faster recovery. We seek to automate the measurement of physiological changes in infants, relate them to sepsis outcomes, and provide an early alert system before clinical indications are noticeable. A successful prototype of a sepsis early alert system will underpin further large-scale funding for clinical trials to demonstrate the reliability and efficacy of our approach and development of a commercial product that can be used in any NICU, helping save and improve infant lives globally. **Project plan** -Identify Key Features: Objective: Analyse high-resolution data from NICUs to identify changes in physiological parameters that precede the clinical onset of sepsis.

	Determine the most indicative features of sepsis using machine learning (ML) and signal analysis techniques, combining wavelet and signal detection approaches. **Student Involvement:** The student will gain expertise in a variety of data analysis and feature extraction techniques and drive the project by working with the extensive NICU datasets, identifying patterns and features that predict early sepsis infection. -Develop Automated Detection System: Objective: Create algorithms capable of real-time analysis of physiological data streams to detect early signs of sepsis. Implement a prototype system that processes data from NICU monitors and provides early warnings to medical staff. **Student Involvement:** The student will develop highly employable coding and software development skills as they experiment with different ML models and select the most effective and general parameter and algorithm combinations based on sensitivity, specificity, and accuracy. The student will also lead the integration of these algorithms with real-time data processing capabilities, ensuring the system's operational efficiency. -Sepsis Metric Investigation: Objective: Combine the supervisory team's medical and mathematical expertise to investigate the physiological reasons for the correlations between features found in Objective 1a and sepsis. This understanding could reveal new clinical targets for treatment and/or suggest operational methods to reduce sepsis morbidity and mortality. Student Involvement: This role offers the student a unique opportunity to bridge mathematical models with clinical applications, enhancing their interdisciplinary research skills. They will have to drive the project's direction so that it is both numerically rigorous and clinically applicable. -Validation and Prototype Testing: **Objective:** Test the prototype using historical data from NICUs to validate its accuracy and reliability. Conduct pilot studies with new data and across different infant data streams, accounting for the variability of infant conditions and potential sepsis signals. Feeding back to our Indian collaborators, we will ascertain whether further genotyping data could be extracted from drawn blood, enhancing our discoveries through correlation with specific infection data. Student Involvement: In collaboration with NICUs, the student will design and execute validation tests, analysing the prototype's performance with historical data. Forming part of a feedback system, they will adjust their system around the NICU's operation, enhancing its accuracy and reliability. -Prepare for Clinical Trials: **Objective**: Plan for large-scale clinical trials to demonstrate the system's efficacy in real-world settings. Secure additional funding and partnerships for the commercialization of the system. Student Involvement: The student will play a key role in planning proposals for further funding and develop strategies for commercialization. This phase will allow the student to contribute to the practical application and potential market adoption of the system, providing valuable experience in translational research.

Supervisory Team	
Lead Supervisor	
Name	Dr Thomas Woolley
Affiliation	Cardiff
College/Faculty	MPLS
Department/School	Mathematics
Email Address	woolleyt1@cardiff.ac.uk
Co-Supervisor 1	
Name	Dr John Watkins
Affiliation	Cardiff
College/Faculty	BMLS
Department/School	Medicine
Co-Supervisor 2	
Name	Dr Stefania Vergnano
Affiliation	Bristol
College/Faculty	Faculty of Health Sciences
Department/School	Bristol Medical School, Department of Population Health Science
Co-Supervisor 3	
Name	Dr Aravind Ramesh
Affiliation	Bristol
College/Faculty	Faculty of Health Sciences
Department/School	Bristol Veterinary School