Project Details	
Project Code	CMD27Ex Dennis
Title	Data-Driven Precision Medicine in the Hospital: Advanced Blood Glucose Analytics to Improve Inpatient Diabetes Care
Research Theme	Cardiometabolic Disease
Project Type	Dry lab
Summary	20%-30% of NHS hospital beds are occupied by people with diabetes, who often experience poorer clinical outcomes due to unstable blood sugar levels (adverse glycaemia). This project harnesses cutting-edge electronic patient record data to tackle this major clinical challenge. Using advanced data science and 'glucometrics', the standardised analysis of inpatient glucose data, the student will quantify adverse glycaemia, evaluate its impact on clinical complications, and use machine learning to develop and validate predictive models to identify high-risk patients. The research aims to individualise inpatient care, reduce hospital-acquired complications, and improve the safety of hospital stays for people living with diabetes.
Description	Background Around 20% of all NHS hospital beds are occupied by individuals living with diabetes. Having diabetes diagnosis associates with poorer clinical outcomes and longer lengths of stay. In-hospital hyperglycaemia is independently associated with clinical outcomes including hospital-acquired infections, acute kidney injury, and mortality.1-2 Improving glucose control has been shown to reduce post-operative infection rates. Similarly, hypoglycaemia in hospital can lead to seizures, falls, neurological injury, and cardiovascular complications.3 Assessing and optimising glycaemic control in-hospital to reduce hyper and hypoglycaemia (together: adverse glycaemia) is therefore essential to patient care. Day to day glucose management in hospitals uses capillary glucose measurements that are routinely uploaded and stored in electronic form. Glucometrics is the term that has been developed for analysing and reporting ward glucose measurements in a standardised form. With the adoption of hospital electronic patient records (EPR) it is now possible to link point of care glucose measures with other care processes such as insulin administration and clinical outcomes. The Royal Devon University Healthcare NHS Foundation Trust is one of the early adopters of the EPIC EPR, providing 6-years of comprehensive longitudinal data on inpatient care including glycaemia. This data is now accessible for research for patient benefit in the new South-West Secure Data Environment (https://www.southwestsde.nhs.uk/), set up by the NHS for research, with a data sharing agreement with Royal Devon recently established. Aim To apply glucometrics using Royal Devon inpatient data to quantify inpatient glucose control and associations with clinical outcomes, and identify high risk patient cohorts. Objectives 1. To establish a reproducible pipeline to process glucometrics data from EPIC.

	2. To describe in-hospital glycaemia in people with diabetes by admission type and reason (e.g. surgery type). 3. To describe the incidence of hospital-acquired clinical outcomes in people with adverse glycaemia, including infections, diabetic ketoacidosis, severe hypoglycaemia, Hyperosmolar Hyperglycemic State, new foot ulceration. 4. To describe the relationship between glucometric measures of hyperglycaemia and hypoglycaemia on length of stay and clinical complications. 5. To explore risk stratification and prediction approaches to identify patients at high risk of adverse glycaemia. Brief Study Design Study population All adults with diabetes admitted to hospital in the Royan Devon NHS Trust EPIC dataset from 2020-data extraction, accessed via the South-West Secure Data Environment. People without diabetes will be included to define a matched comparator population to compare clinical outcomes. Glucometrics assessment Point-of-care blood glucose measurements will be used to assess glycaemic control using the glucometrics models proposed by Goldberg et al.,4 by standard units of analysis including population, patient-stay, and patient-day. Clinical outcomes • Mortality • Length-of-stay • Hypoglycaemia including hypoglycaemic rescue • Hospital-acquired Diabetic ketoacidosis • Hospital-acquired Hyperosmolar Hyperglycaemic State • Hospital-acquired Diabetic foot ulcers • Hospital-acquired infections • Hospital-acquired Acute kidney injury • Inpatient cardiac events • Inpatient falls • Inpatient stroke • Unplanned hospital readmission Stratification by admission type Elective and emergency admissions; hospital wards (e.g. general medical, general surgical, cardiology, neurology, neurosurgery, orthopaedic); Healthcare Research Groups to represent clinically meaningful groupings of patient activity as derived primarily from procedure (OPCS) and diagnosis (ICD-10) codes, for example distinct groups for people admitted for emergency abdominal surgery, cardiothoracic surgery, vascular bypass surgery, and diabetic foot infection. Predictor variables To support matching and risk prediction, a restricted set of pre-specified variables will explored including sociodemographic features (e.g. age, sex, ethnicity, deprivation), diabetes-related features (e.g. routine blood tests, medication (insulin, other oral antidiabetic agents including GLP-1

	receptor agonists), micro and macrovascular complications), major comorbidities, processes of care, and procedure history. Methodology To model for longitudinal inpatient blood glucose levels and clinical events the student will apply advanced epidemiological and statistical methods. This will the glucometrics analysis itself, which could involve novel application of AI and machine learning methodologies to better capture variation over time. In addition, there will be an opportunity to apply propensity matching to define comparator populations, and advanced survival analysis prediction modelling methods, again potentially using machine learning, to model associations between glycaemia and clinical outcomes. External validation Reproducibility of findings and risk stratification approaches will be tested in independent validation at a different hospital, or temporally in updated Royal Devon data. Student ownership The student will be supported to flexibly develop and refine the project objectives and develop their own statistical analysis plan which will be submitted for approval by the South-West Secure Data Environment data access committee. There will be the opportunity to focus on specific clinical outcomes and modelling frameworks which can be aligned to the interests of the student. For example, there is a great opportunity to apply cutting edge AI and machine learning approaches (e.g. frontier modelling) to model glucometrics and better predict clinical outcomes. References 1. Barmanray RD et al.J Clin Endocrinol Metab.2024;109(11):e2048-e56. 2. Lepper PM et al. BMJ.2012;344:e3397. 3. Kyi M et al. Diabet Med.2018;35(6):816-23. 4. Goldberg PA et al. Diabetes Technol Ther.2006;8(5):560-9.
Can be completed part time?	Yes
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