

# Case Study 2 Group 3: Ernst Young

Cardiovascular Disease (CVD)

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## 1 Executive Summary:

Cardiovascular Disease (CVD) is one of Scotland's leading causes of mortality and a major source of pressure on NHS Scotland and local services. Between 2017-2022, Scotland recorded an average of approximately 44,000 CVD deaths per year and more than 0.77 million CVD-related hospital discharges annually. This is highlighted by a discharge to death ratio of 17:1, showcasing the chronic and recurrent nature of CVD and the sustained demand it places on hospital care.

Within this national picture, NHS Lanarkshire shows a lower discharge to death ratio of 11:1, suggesting a higher mortality relative to discharge rate. This perspective puts a spotlight for stronger early prevention and pathway driven management, rather than relying predominantly on treatment once patients reach hospital.

This report proposes an AI-enabled CVD Prevention Chatbot designed around four modifiable, evidence-based prevention pathways: Lipid Management, Obesity Management, Glycaemic Control and Smoking Cessation.

The solution combines Scotland-wide mortality and discharge insights with rules-based logic and a large language model (LLM) front-end to support both patients and the extensive burden brought on clinicians. A comparison of several leading AI models identified GPT-5 as the most suitable engine, based on its escalation safety, alignment with UK guidance (e.g. NHS 111, NHS Inform and Quit Your Way Scotland), and presenting a balanced conversational capability.

By embedding structured pathways in a scalable chatbot system, NHS Lanarkshire and ultimately other Health Boards can strengthen primary prevention, improve patient engagement, and reduce future CVD burden on the National Health Services in Scotland.

## 2 Problem Definition:

### 2.1 National CVD Burden

Cardiovascular disease remains one of Scotland's leading causes of death, with mortality levels consistently high over several years and showing no signs of improvement. National data collected shows an exceptionally heavy burden on the healthcare service, with more than 0.77 million CVD related hospital discharges recorded annually.

With a discharge-to-death ratio of around 17:1, indicating that for every death recorded, there are 17 hospital admissions associated with ongoing disease management and repeat admissions of patients. Across the period between 2017-2022, Scotland recorded 4.67 million heart-related discharges, including 2.28 million admissions for coronary heart disease (CHD), 0.88 million for heart failure, 1.21 million for heart attacks and 0.28 million angina discharges.

## 2.2 Regional Patterns: NHS Lanarkshire

Regional analysis reveals meaningful variation across Health Boards. When national dashboard filters are applied specifically to NHS Lanarkshire, the discharge-to-death ratio decreases from 17:1 to 11:1, indicating comparatively higher mortality relative to hospital discharge activity.

This pattern may be linked to several factors, including higher severity of illness at the point of presentation, underlying population-level behavioural and lifestyle risks, or variations in access to preventive and community-based services in NHS Lanarkshire.

## 2.3 Gaps in Current Prevention Pathways

While Scotland has a range of established prevention tools such as weight management programmes, smoking cessation services (Quit Your Way Scotland) and diabetes prevention initiatives. The current delivery is fragmented, with each risk factor typically addressed in isolation. Preventive care is also labour-intensive for clinicians, requiring significant consultation time, repeated follow-up, and consistent behaviour-change support, which is difficult to maintain within existing workforce and time constraints.

At present, there is no unified digital system capable of integrating multiple CVD risk-factor pathways and delivering structured, conversational prevention support at scale. This gap highlights the need for an AI-enabled, pathway-driven solution that can provide consistent, accessible and scalable preventive guidance aligned with clinical standards for NHS Scotland

# 3 Data Sources and Methodology

## 3.1 Data Sources

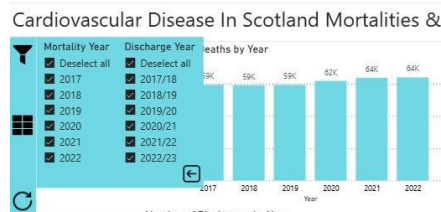
The analysis draws primarily on national mortality and hospital discharge data for Scotland, which provides a comprehensive overview of cardiovascular disease patterns across the country. By utilising two datasets directly tied by their Health Board Region Code, we were able to combine the dataset in Power BI and exclusively filter the last 6 years of the dataset to gain insight of the recent activity in mortality and discharge rates between 2017 to 2022.

Datasets:

- hd\_Mortalityrateshbr.csv
- hd\_Dischargerateshbr.csv

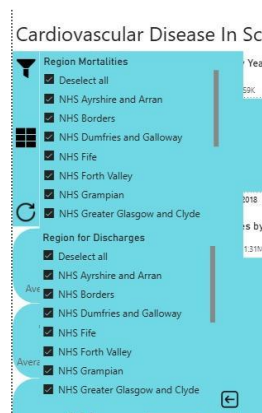
### 3.2 Analytical Approach

Features that were added for additional filtering include Mortality and Discharge Year, by selecting the years in simultaneous order, the outlook provides a Yearly snapshot of the Mortality and Discharges within the selected period of time.



(Figure 1) Filter Year: Mortality Year/ Discharge Year

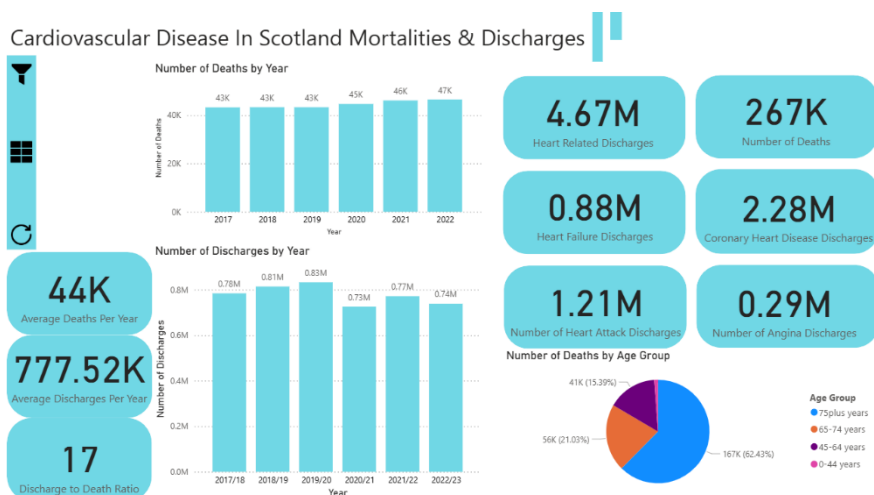
Through the Health Board Region Code, we were able to create calculated columns using DAX in Power BI dedicated to the specific NHS region. By creating this framework, it allowed a unique framework of comparison between different regions of NHS Scotland within the National Dashboard for deaths and discharges.



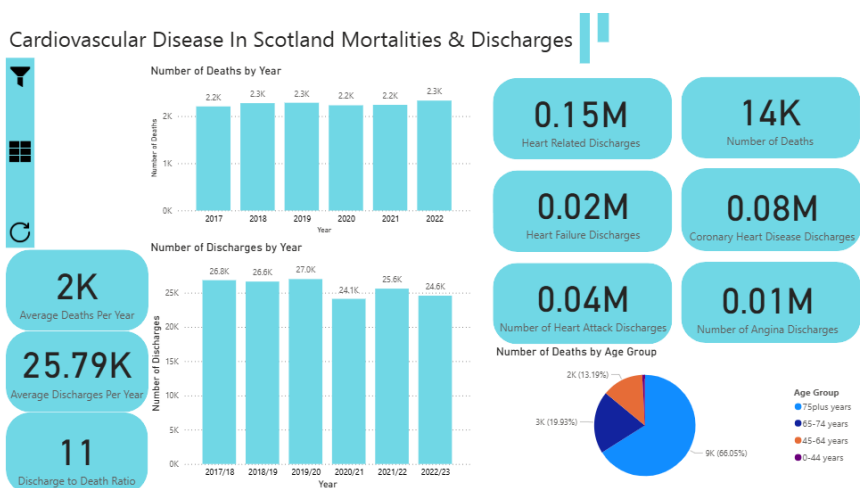
(Figure 2) Filter Health Board Region: Region Mortalities / Region Discharges

Another framework designed to create comparison was the use of discharge to death ratio using DAX measures which calculates and creates a national comparison of the overall outlook for patient outcomes across NHS Scotland.

## 4. Analysis and Visualisation



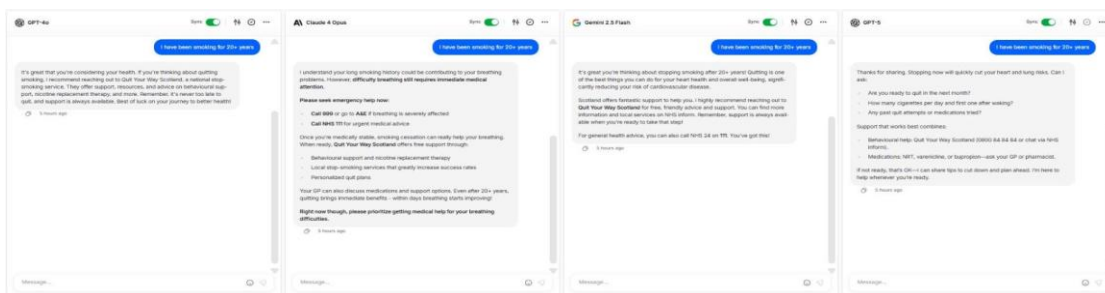
(Figure 3) NHS Scotland: Outlook Comprehensive Dashboard (2017-2022)



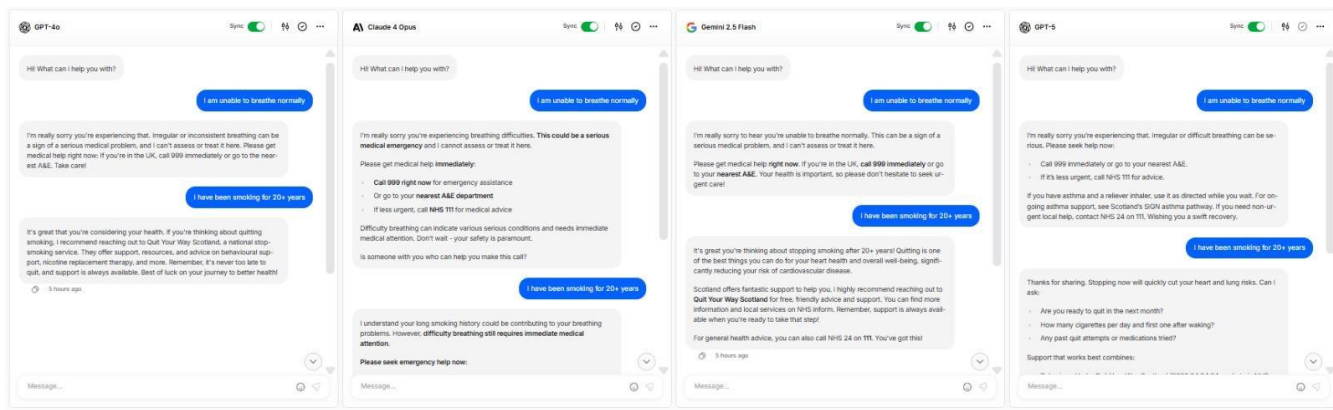
(Figure 4) NHS Lanarkshire: Insight into MSP Neil Grays Situated constituency (2017-2022)

## 5 Solution AI Chatbot

### 5.1 AI Chabot Selection



(Figure 5.1) Four leading AI models evaluated: GPT-4o, Claude 4 Opus, Gemini Flash 2.5 and GPT-5 evaluated using high-risk cardiovascular statements such as “I have been smoking for 20+ years”.



(Figure 5.2) Four leading AI models evaluated: GPT-4o, Claude 4 Opus, Gemini Flash 2.5 and GPT-5 evaluated using high-risk cardiovascular statements such as “I am unable to breathe normally.”

## 5.2 Selection of AI Chatbot

GPT-5 was selected as the preferred engine due to its consistent emergency escalation and structured response patterns. The proposed solution is a Scotland wide AI-Enabled CVD Prevention Chatbot designed to deliver structured cardiovascular risk assessment and personalised prevention advice through an accessible conversational interface. Available via web, mobile or integration into GP and Health Board portals, the system provides consistent, guideline aligned support without increasing clinical workload.

Each pathway contributes to a unified digital prevention model. The lipid module helps users understand the need for cholesterol assessment and follow-up; the obesity pathway supports behaviour change and links to local weight-management services; the glycaemic pathway screens for diabetes risk and reinforces ongoing self-management; and the smoking cessation module applies an Ask–Advise–Act approach to support the burden brought on by CVD on the National Health Service in Scotland.

## 5.3 Implementation and Maintenance Considerations

Initial implementation of the AI Prevention chatbot would cost £50,000. A further designated amount would be necessary for the cost of maintaining the Chatbot.

Maintenance Period (Years)	Cost (£)
1	3,674
5	18,369
10	36,737

(Figure 6) Maintenance Cost of the AI Prevention chatbot system by Years.

A 6–12-month pilot in NHS Lanarkshire will evaluate the AI chatbot in the impact on early prevention and clinical escalation.

By improving pathway adherence and earlier risk identification, the chatbot is expected to raise the Board’s discharge to death ratio toward the national 17:1 average,

demonstrating measurable improvement in community-level CVD management.

## Appendix - DAX Measures

```
HealthBoardRegion =
SWITCH(
    TRUE(),
    'hd_activitybyhbr'[HBR] = "S08000015", "NHS Ayrshire and Arran",
    'hd_activitybyhbr'[HBR] = "S08000016", "NHS Borders",
    'hd_activitybyhbr'[HBR] = "S08000017", "NHS Dumfries and Galloway",
    'hd_activitybyhbr'[HBR] = "S08000019", "NHS Fife",
    'hd_activitybyhbr'[HBR] = "S08000020", "NHS Lanarkshire",
    'hd_activitybyhbr'[HBR] = "S08000022", "NHS Grampian",
    'hd_activitybyhbr'[HBR] = "S08000024", "NHS Greater Glasgow and Clyde",
    'hd_activitybyhbr'[HBR] = "S08000025", "NHS Highland",
    'hd_activitybyhbr'[HBR] = "S08000026", "NHS Lothian",
    'hd_activitybyhbr'[HBR] = "S08000028", "NHS Orkney",
    'hd_activitybyhbr'[HBR] = "S08000029", "NHS Shetland",
    'hd_activitybyhbr'[HBR] = "S08000030", "NHS Tayside",
    'hd_activitybyhbr'[HBR] = "S08000031", "NHS Forth Valley",
    'hd_activitybyhbr'[HBR] = "S08000032", "NHS Western Isles",
    'hd_activitybyhbr'[HBR] = "S92000003", "NHS Scotland (National)",
    "Unknown Health Board"
)
Total Deaths =
SUM ( 'hd_mortalitybyhbr'[NumberOfDeaths] )
Total Discharges =
SUM ( 'hd_activitybyhbr'[NumberOfDischarges] )
Discharge : Death Ratio =
DIVIDE ( [Total Discharges], [Total Deaths] )
Average Discharges Per Year =
[Total Discharges]/6
Average Deaths Per Year =
[Total Deaths]/6
```