**Protocol CCU003\_04: Indirect effects of the first two years of the COVID-19 pandemic on secondary care for cardiovascular disease in the UK: an electronic health record analysis across three countries.**

**Lay summary**

Cardiovascular disease (CVD) is the greatest burden of disease in the UK and globally (1). The coronavirus (COVID-19) pandemic has been having unprecedented effects directly through infection, and indirectly through effects on individual patient behaviour and strain on health care systems. To measure the indirect effects of the pandemic on non-COVID-19 diseases such as CVD, we need a better understanding of the impact of the pandemic on the provision of CVD-related hospital services.

Using large scale population based electronic health records, in people admitted to hospital for one of six major CVDs or a related procedure in the UK, we aimed to study how treatment and prevention for cardiovascular disease has been indirectly effected during the pandemic.

**Background**

Health services for individuals with existing disease and acute illness have been profoundly affected by the coronavirus (COVID-19) pandemic. Cardiovascular disease (CVD) remains the leading cause of mortality and morbidity and pathways of treatment and prevention have been significantly affected (1-3). However, what is not clear is how such treatment and prevention pathways have been affected at system level, as previous studies have mostly concentrated on single diseases, particular parts of the patient pathway, or individual hospitals. Examining the “indirect” effect of the pandemic on individuals with CVD is important to monitor the broader impact of COVID-19, to plan responses to subsequent waves and future pandemics (3,4), and to help inform future budgeting and resource allocation decisions as the health care system recovers.

**Research Methods**

**Protocol**

This protocol is adapted from the 4C initiative which was developed by a group of seven cardiovascular clinicians with relevant clinical, epidemiological and health data science expertise and agreed with members of the CVD-COVID-UK collaboration, supported by the British Heart Foundation (BHF) Data Science Centre (4). It is also informed by a recent analysis using SUS data to investigate trends in admissions and procedures for acute coronary syndromes (5).

This is one of several studies included in the approved CVD-COVID-UK work package led by Professor Ami Banerjee entitled Direct and Indirect Effects (CCU003). This study is quantifying the indirect effects of the COVID-19 pandemic on the provision of cardiovascular disease-related hospital health care in the UK (CCU003\_04).

**Research question**

What are the population changes in provision of health care for CVD?

**Study design**

We will conduct a retrospective population-based analysis of diagnoses and treatments or procedures for selected CVDs in all NHS hospitals across the UK before and during the COVID-19 epidemic.

**Data sources**

* ***England****: National Health Service Digital;* APC HES: admitted patient care hospital episode statistics
* **Scotland**: Scottish National Safe Haven; Scottish Morbidity Record (SMR) 01 for General / Acute Inpatient and Day Case admission
* ***Wales****: SAIL Databank;* Patient Episode Database for Wales (PEDW).
* *Northern Ireland;* Not available at the time of this study

**Study population**

All individuals admitted to hospital with a diagnosis of CVD between 01 January 2020 and 31 December 2021, and all individuals admitted for a related CVD procedure in the same time period.

**Comparison population**

All individuals admitted to hospital with a diagnosis of CVD over the last 4 years (2016 to 2019), and all individuals admitted for a related CVD procedure in the same time period.

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**CVD phenotypes**

We will initially concentrate on six disease areas (but extend to all CVD after that):

* Acute coronary syndrome
* Heart failure
* Stroke and transient ischaemic attack
* Aortic aneurysm
* Peripheral arterial disease
* Venous thromboembolism

**Data collection**

All episodes of care for patients admitted to acute NHS hospital trusts in the UK for the six CVD diagnoses, defined using the ICD-10 codes as the first event in the period per person, will be identified in the Secondary Uses Service Admitted Patient Care (SUSAPC) database. We will use the same methodology as a prior study(4) to prevent over-counting of events, by linking episodes of care for every individual into continuous single hospital admissions (spells), and spells between hospitals (superspells).

**Analysis**

We will account for incompleteness and missing data, by restricting analyses to complete returner hospitals. In all analyses, data will be presented for 2019 as median (IQR) weekly recorded numbers. For 2020, a local polynomial regression smoothing function (locally estimated scatterplot smoothing) will be fitted through the weekly numbers (using the loess function in R with default settings). From 2020, weekly adjusted numbers (indicating the number of admissions in the preceding 7 days) will be plotted along with their approximate SEs (under the assumption that the numbers follow a Poisson distribution). Percentage changes in weekly admissions will be calculated by comparing the adjusted weekly admission number for the week with the lowest number of admissions observed for each event, with the mean weekly number during 2019; percentage changes will be presented with 95% CIs. Percentage changes in weekly admissions among subgroups will be calculated similarly, with tests for heterogeneity or trend across every subgroup presented(4). Sub-group analyses will include by demography (age, sex, ethnicity, social deprivation level), arterial territory, CVD event/episode type, referral vs diagnosis vs treatment activity for the specified CVD subtypes and phase of the pandemic/lockdown. We plan to incorporate results into an updateable web display(3).

**References**

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