Expert Report for the UK Covid-19 Public Inquiry

Module 3 – the impact of the Covid-19 pandemic on healthcare systems in the UK

Ischaemic heart disease:

Deaths, data and delivery of care

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Author statement

"We confirm that this is our own work and that the facts stated in the report are within our own knowledge. We understand our duty to provide independent evidence and have complied with that duty. We confirm that we have made clear which facts and matters referred to in this report are within our own knowledge and which are not. Those that are within our own knowledge we confirm to be true. The opinions we have expressed represent our true and complete professional opinions on the matters to which they refer."

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Abbreviations

Abbreviation	Name
HES	Hospital Episode Statistics
NHS	National Health Service
NSTEMI	Non-ST elevation myocardial infarction
PCI	Percutaneous coronary intervention
STEMI	ST elevation myocardial infarction
UK	United Kingdom

Preamble

Report Authors

Professor Chris P Gale

I am a UK trained medical doctor (MB;BS, London Hospital Medical School), Honorary Consultant Cardiologist (FRCP, London), and Professor of Cardiovascular Medicine (BSc (Hons), London Hospital Medical College; PhD, University of Leeds; MSc, University of Leeds; MEd, University of Leeds).

Currently I work at the University of Leeds and the Leeds Teaching Hospitals NHS Trust as Professor of Cardiovascular Medicine and Honorary Consultant Cardiologist.

Qualifying in medicine at the London Hospital Medical College (1994) and obtaining a BSc (Hons) in Psychology at the London Hospital Medical College (1991), I worked as a Junior Doctor at the Royal London Hospital. After becoming a Member of the Royal College of Physicians (1999), I was awarded a Medical Research Council Clinical Training Fellowship and completed a PhD in molecular biology at the University of Leeds (2004). I undertook speciality training in cardiology principally at the Leeds General Infirmary, where I was a Walport and later a National Institute for Health Research Academic Clinical Lecturer (2006), then achieving a National Institute for Health Research Clinician Scientist Award, (2009) and subsequently National Institute for Health Research Clinical Trials Fellowship (2015). I hold a Masters in Clinical Education (2003), and a Masters in Biostatistics and Epidemiology (2012).

I was appointed Honorary Consultant Cardiologist at York Teaching Hospitals NHS Trust in 2010.

I was Honorary Reader of University College London at the Institute of Cardiovascular Sciences, University College London between 2012 and 2017.

I was appointed Professor of Cardiovascular Medicine at the University of Leeds in 2017.

I was Head of Department of Clinical and Population Sciences at the University of Leeds between 2018 and 2019.

I was appointed Honorary Consultant Cardiologist at the Leeds Teaching Hospitals NHS Trust in 2019.

As Honorary Consultant Cardiologist at the Leeds Teaching Hospitals NHS I practise clinical cardiology with particular interests in general cardiology, post myocardial infarction survivorship and chronic heart failure.

I was appointed Co-Director of the Leeds Institute for Data Analytics at the University of Leeds in 2019.

My research interests include the investigation of cardiovascular quality of care and clinical outcomes. I am particularly interested in atrial fibrillation, heart failure and ischaemic heart disease, and the early and efficient detection of cardiovascular diseases. I lead a research group at the Leeds Institute for Cardiovascular and Metabolic Medicine, University of Leeds. I hold major research awards from the National Institute for Health Research, British Heart Foundation and Horizon 2020. I have published over 350 research manuscripts in peer reviewed journals and have nearly 100,000 citations.

I am a Fellow of the Royal College of Physicians of London, Fellow of the European Society of Cardiology and member of the British Cardiovascular Society.

I am founder and past co-Chair of the National Institute for Clinical Outcomes Research (NICOR) Research Board, University College London, and have been a member of the United Kingdom National Clinical Audit for heart attack (Myocardial Ischaemic National Audit Project, MINAP) Steering Group since 2006.

I hold a number of international leadership positions including Chair of Data Science Group of the EuroHeart project, Chair of the European Society of Cardiology global non-ST elevation myocardial infarction registry, founder and Chair of the Global Working Group on Cardiopulmonary risk, and member of the European Society of Cardiology ST elevation myocardial infarction registry.

I am founder and immediate past Chair of the European Society of Cardiology Quality Indicator Committee.

I was Chair of the European Society of Cardiology EurObservational Research Programme between 2018 and 2020.

I was a member of the European Society of Cardiology Board between 2018 and 2020.

I was secretary of the European Society of Cardiology Acute Cardiovascular Care Association between 2015 and 2018.

I have been a member of the National Institute for Health and Care Excellence (NICE) Indicator Advisory Committee since 2016.

I am Deputy Editor of European Heart Journal Quality of Care and Clinical Outcomes, and have been so since its inception in 2014.

I am or have been Chair or a member of the Data Monitoring Committee and / or Trial Steering Committee for a number of national and international randomised clinical trials in cardiovascular disease.

I currently serve as a member of a number of national and international research grant awarding bodies including: British Heart Foundation Project Grants Committee – panel member, Independent Research Fund Denmark, Clinical Science – panel member, and Independent Research Fund Denmark, Medical Science – external reviewer.

I currently serve as the expert reviewer for the Portuguese national public funding Agency for Research and Development (Fundação para a Ciência a Tecnologia) Clinical and Translational Research Panel for the assessment of Research and Development Units across Portugal.

I have served on the following research grant awarding body panels: British Heart Foundation/Turing Data Science Awards – panel member, National Institute for Health Research Research for Patient Benefit – panel member.

I am an external reviewer for a number of research grant awarding bodies including: British Heart Foundation and National Institute for Health Research.

I was a member of the British Cardiovascular Society Guideline Committee between 2015 and 2017. I was a member of the European Society of Cardiology Clinical practice Guidelines Oversight Committee between 2018 and 2020. I was a Task Force member for the 2020 European Society of Cardiology Clinical Practice Guidelines for the management of acute coronary syndrome in patients presenting without persistent ST-segment elevation.

I am an academic reviewer for several peer-reviewed medical journals such as The Lancet, European Heart Journal and Heart.

I co-chair The Lancet Regional Health – Europe Commission on Inequalities and Disparities on Cardiovascular Health.

Dr Ramesh Nadarajah

I am a UK trained medical doctor (MB;BChir, Cambridge University Medical School), Cardiology Speciality Registrar (MRCP, London), National Institute for Health Research Clinical Lecturer in Cardiology (University of Leeds), and Health Data Research UK Fellow (PhD, University of Leeds).

Currently I work at the Leeds Teaching Hospitals NHS Trust as a Cardiology Speciality Registrar and at the University of Leeds as a National Institute for Health Research Clinical Lecturer in Cardiology and Health Data Research UK Fellow.

Qualifying in medicine from Cambridge University Medical School (2013) and obtaining an MA (Hons) in Neuroscience (2014), I worked as a Junior Doctor at a number of hospitals in London. After becoming a Member of the Royal College of Physicians (2016), I was awarded a British Heart Foundation Clinical Research Training Fellowship and completed a PhD in the prediction of atrial fibrillation from routinely collected data at the University of Leeds (2024). I am undertaking speciality training in cardiology principally at the Leeds General Infirmary.

As a Cardiology Speciality Registrar I am specialising in heart failure and preventative cardiology.

My research incorporates the use of large routinely-collected datasets to answer clinical questions and develop and validate prediction models, particularly in the area of atrial fibrillation, heart failure, and coronary artery disease.

I am a member of the Royal College of Physicians of London, member of the European Society of Cardiology, and member of the British Cardiovascular Society.

I am Associate Editor of European Heart Journal Quality of Care and Clinical Outcomes.

I am an external reviewer for grant awarding bodies (including the National Institute of Health and Care Research and the Medical Research Council) and medical journals.

Scope of the report

1. The date range for this report ('the relevant period') is from 1st March 2020 (the month in which the UK went into its first lockdown) to 28th June 2022 (the end date for the Inquiry as specified in the Terms of Reference).

2. As instructed, this report on 'Ischaemic Heart Disease' focuses on the impact of the Covid-19 pandemic on the diagnosis, care and treatment of ischaemic heart disease, including how diagnostic and treatments pathways for ischaemic heart disease were maintained during the pandemic, and the impact of delays to diagnosis and/or care and treatment on patient outcomes.

3. It also considers how the healthcare system maintained and prioritised care pathways for ischaemic heart disease, and explores how alternative or innovative approaches to non-pandemic care could be applied in the event of a future pandemic.

4. The report considers the four nations of the United Kingdom and acknowledges where there is absence of data or information for nations. Where this report refers to 'the NHS', this should generally be assumed to refer to the publicly-funded healthcare systems across the whole UK, as many experiences of cardiac care during the pandemic were similar. However, there were also important differences and each nation is specified where this is the case. The authors have no direct experience of clinical practice in the devolved nations, so our conclusions here are based on the published work of others - noting that there are substantial differences in the extent of available information for England compared with the devolved nations.

5. Given that ischaemic heart disease may be categorised as acute (acute coronary syndromes) and chronic (chronic coronary syndromes), this report will provide details of the above parameters according to the two clinical categories (Byrne et al., 2023, Knuuti et al., 2020).

6. Given the prevention of ischaemic heart disease is a National Health Service priority in the UK, this report also provides information pertaining to the identification and treatment of cardiovascular risk factors for ischaemic heart disease (NHS, 2019).

Executive summary

7. This report provides expert opinion about the impact of the Covid-19 pandemic on the healthcare system, including healthcare for ischaemic heart disease. It includes information about the causes, types and treatments of ischaemic heart disease. It specifically addresses acute coronary syndromes, chronic coronary syndromes and the prevention of ischaemic heart disease in the NHS.

8. The report describes the impact of the Covid-19 pandemic on the number of admissions to hospital with acute coronary syndrome, and the reduced clinical activity for chronic coronary syndrome and the prevention of ischaemic heart disease. The report provides details about how the NHS maintained and prioritised specific pathways for ischæmic heart disease. There is a section in the report about the collection and reporting of data about ischaemic heart disease before and during the Covid-19 pandemic. The report discusses and provides opinion about the resilience of the UK's secondary and tertiary healthcare systems to the Covid-19 pandemic for ischaemic heart disease and contextualises this internationally. Finally, the report offers expert opinion about the successes and shortcomings of the UK healthcare system approach to the management of people with ischaemic heart disease, and provides four recommendations for preparedness of the UK healthcare system against external stressors that would impact upon people with, or at risk of, ischaemic heart disease.

9. The report is founded on information published in the literature, and supplemented with experiential knowledge and expert opinion. At this stage, it should be recognised that evidence from the literature is weighted towards people with acute coronary syndrome, and there is much less published information about people with chronic coronary syndrome and the prevention of ischaemic heart disease. Moreover, there is much less published information about the devolved nations than that available for England.

10. Ischaemic heart disease is the most common form of heart and circulatory disease. It affects over two million people in the UK, and often manifests as a heart attack or angina. In the UK ischaemic heart disease is the most common cause of premature death, with over 100,000 admissions with heart attack and nearly 70,000 deaths each year. Timely evidence-based treatment of heart attack saves lives and reduces the chance of complications from a heart attack such as a further heart attack, heart failure and stroke. The treatment of angina improves quality of life and reduces the risk of heart attack, and the identification and modification of risk factors for ischaemic heart disease decreases the likelihood of the development of ischaemic heart disease. The UK has national clinical pathways for the identification and timely treatment of people with ischaemic heart disease.

11. The Covid-19 pandemic witnessed a substantial decline in admissions with heart attack, and there was a considerable decrease in clinical activity for people with and at risk of ischaemic heart disease. There was an excess in acute cardiovascular deaths in the community, beyond that which would normally be expected for that time of year. The onset of the decline in admissions with heart attack and the excess cardiovascular mortality tallied and was widespread across the UK. However, the onset of the decline in admission with heart attack before the first UK lockdown. The expected response of the public to seek help for symptoms of a heart attack was delayed. It is not known why this occurred. It is likely to be because the public were fearful of coming to hospital, and/or wanted to protect essential clinical services for people with Covid-19, and/or died from Covid-19 in the community. Nonetheless, it is likely that many people with a heart attack that was not treated will have died before coming to hospital, or survived only to present at a later date and with more advanced disease or a clinical complication of a heart attack.

12. Information about the changes in NHS activity, standards and outcomes for heart attacks was only possible because in the UK data are routinely collected in clinical and administrative databases. During the Covid-19 pandemic access was provided to clinicians and academics to link and analyse the datasets to provide rapid reporting of the situation as it unfolded, and for research about Covid-19 and cardiovascular disease. This was used to inform the cardiovascular community and public.

13. During the Covid-19 pandemic there was a heightened sense of purpose and professionalism in the cardiovascular community. Critical and early decisions were made by cardiovascular healthcare leaders to ring-fence the UK national primary percutaneous coronary intervention (PCI) service for heart attack, and standards of clinical care for people admitted with a heart attack were maintained. Publicity campaigns about seeking help for symptoms of a heart attack were delivered by the British Heart Foundation, British Cardiovascular Society and NHS England, amongst others. Still, it is apparent that not everyone with or at risk of ischaemic heart disease had equal care and outcomes. Delayed access to care has resulted in long waiting times for specialist investigation and treatment for ischaemic heart disease. The unique model of reporting of the UK cardiovascular data assets was halted, and the author of the report is not aware of a strategy or provision to continue a similar activity.

14. The report recommends:.

    - **First**, that the care of people with ischaemic heart disease is prioritised during and after periods of external stressors.
    - **Second**, that a UK National Cardiovascular Data Centre for monitoring ischaemic heart disease (and wider cardiovascular diseases) should be established.
    - **Third**, that there is enhanced preparedness of clinical services for people with and at risk of ischaemic heart disease.
    - **Fourth**, that during periods of external stressors there are effective decisions and communication with the public and healthcare professionals alike.

Ischaemic heart disease

Preface

15. This section provides an introduction to ischaemic heart disease. It defines ischaemic heart disease, describes its burden, the underlying pathophysiological process, its risk factors, describes the two types of ischaemic heart disease (acute coronary syndromes and chronic coronary syndromes), and details the prevention of ischaemic heart disease. In brief, ischaemic heart disease is a common, long-term health condition that may present as an emergency and/or non-emergency that if not detected and treated results in death and disability.

Introduction to ischaemic heart disease

16. Ischaemic heart disease is a condition whereby the heart does not receive enough blood and oxygen. It is sometimes referred to as coronary heart disease which is the term given to heart problems caused by narrowed heart (coronary) arteries (blood vessels that feed the heart). The World Heart Organisation defines ischaemic heart disease as a disease of the blood vessels supplying the heart (WORLD HEALTH ORGANISATION, 2021).

17. According to the Health Survey for England, in 2017 more men than women had ischaemic heart disease (6% and 3%, respectively) (NHS Digital, 2017).

18. Ischaemic heart disease is more prevalent in lower income households, with 22% of adults aged 35 years and over in the lowest income quintile and 16% in the highest income quintile reporting any cardiovascular disease according to the 2017 Health Survey for England (NHS Digital, 2017).

19. Ischaemic heart disease is due to the build-up of fatty material (atheroma) on the inner lining of the coronary arteries. This process is called atherosclerosis. Atheroma in the coronary arteries is also called plaque.

20. Atherosclerosis is a natural process that starts early in life. A majority of people don't know they have atherosclerosis in their coronary arteries. This is because it takes many years for atheroma to build-up and cause symptoms.

21. Atheroma doesn't usually cause symptoms until the build-up of the fatty deposits is restricting the blood flow to the heart.

22. Atherosclerosis occurs due to a number of factors. These are termed risk factors. Some risk factors can be controlled, and some cannot.

23. The risk factors for atherosclerosis and therefore ischaemic heart disease that can be controlled are:

    - high blood pressure (hypertension);
    - high blood fat (dyslipidaemia);
    - diabetes;
    - smoking;
    - unhealthy diet;

- obesity and overweight; and
- low levels of exercise (physical activity).

Each of these can be identified and tackled in individuals to reduce their risk of ischaemic heart disease.

24. There are other modifiable factors for ischaemic heart disease that are non-medical. These are called social determinants of health. They are the conditions in which people are born, grow up, work and live. They are factors such as: income, education, job security, working conditions, food insecurity, housing, pollution, and access to quality health services. Typically, people living in areas of socioeconomic deprivation have more ischaemic heart disease. The social determinants of health can be influenced by policy.

25. The risk factors for atherosclerosis and therefore ischaemic heart disease that cannot be controlled are:

    - family history of ischaemic heart disease;
    - age; and
    - ethnic background.

    Even though these factors cannot be modified, being aware of them can help highlight the importance of measuring and addressing the modifiable risk factors for ischaemic heart disease.

26. If the coronary arteries become narrowed (due to build-up of fatty material inside them) the supply of blood to the heart can be restricted. The blood supplying the heart contains oxygen and nutrients, which are essential to maintain the health and function of the heart.

27. There are a variety of symptoms associated with ischaemic heart disease. The predominant ones include:

    - chest pain;
    - breathlessness; and
    - fatigue.

    Symptoms of fatigue and breathlessness are relatively non-specific, and can signal other diseases. Moreover, ischaemic heart disease can present with other, and more non-specific, symptoms such as:

    - sensation of one's heart beating (palpitations);
    - sickliness (nausea);
    - feeling faint (presyncope);
    - blackout (syncope);
    - abnormal chest sensation;
    - sensations in one's arms, back and/or abdomen;
    - difficulty breathing; and

- swollen ankles.

Each of these can be associated with, or signal, other diseases, and they may not be specific for ischaemic heart disease.

28. Broadly speaking, ischaemic heart disease can occur as an acute (emergency) or chronic (non-emergency) situation. The acute presentations of ischaemic heart disease are termed acute coronary syndromes (Byrne et al., 2023). The chronic presentations of ischaemic heart disease are termed chronic coronary syndromes (Knuuti et al., 2020). Whilst there is a clinical dichotomy for the purposes of diagnostic and treatment pathways, it is recognised that people with ischaemic heart disease can have both acute coronary syndromes and chronic coronary syndromes simultaneously. Once an individual has a presentation and diagnosis of chronic coronary syndrome, this is a long-term established condition. An individual with an acute coronary syndrome may only experience this once in a lifetime or on multiple occasions, and in essence has coronary artery disease and therefore a chronic coronary syndrome. Overall, ischaemic heart disease is recognised as a long-term health condition.

I - Acute coronary syndromes

Definition and diagnosis

29. Acute coronary syndromes encompass a spectrum of emergency ischaemic heart disease conditions (Byrne et al., 2023). This includes acute myocardial infarction (heart attack) and unstable angina.

30. The classical acute (emergency) presentation of ischaemic heart disease is with acute myocardial infarction.

31. The diagnosis of acute myocardial infarction is associated with a blood test that shows that there has been injury (necrosis) to the heart muscle. When the heart muscle is damaged due to acute myocardial infarction it releases a protein called troponin. High sensitivity troponin is the recommended biomarker blood test and it is routinely used to help diagnose acute myocardial infarction (Byrne et al., 2023).

32. There are two types of acute myocardial infarction, ST segment elevation myocardial infarction (STEMI), and non-ST segment elevation myocardial infarction (NSTEMI).

33. The differentiation between the two types of acute myocardial infarction, STEMI and NSTEMI, is based upon changes that are seen on a 12-lead electrocardiogram.

34. A 12-lead electrocardiogram is a routine test that measures the speed of the heart (rate), the type of heart beat (rhythm), and the electrical activity of the heart. The 12-lead electrocardiogram is performed by placing patches (electrodes) on the surface of the chest, arms and legs. The test takes a few minutes and is painless. A 12-lead electrocardiogram is usually one of the first heart tests that a patient will have if a healthcare professional suspects that there is something wrong with their cardiovascular system.

35. In cases of unstable angina, there is no damage or injury (necrosis) to the heart muscle, and the high sensitivity troponin is not elevated. In unstable angina, there is reduced blood supply to the heart muscle, called myocardial ischaemia.

36. According to the 2023 European Society of Cardiology Clinical Practice Guidelines, the diagnosis of myocardial infarction is associated with troponin release, and is made based on the fourth universal definition of myocardial infarction (Byrne et al., 2023). The fourth universal

definition of myocardial infarction states that the clinical definition of myocardial infarction denotes the presence of acute myocardial injury detected by abnormal cardiac biomarkers in the setting of evidence of acute myocardial ischaemia (Thygesen et al., 2018). The criterion for myocardial injury is the detection of an elevated troponin value above the 99th percentile upper reference limit. The injury is considered acute if there is a rise and or fall of troponin values.

37. According to the 2023 European Society of Cardiology Clinical Practice Guidelines, unstable angina is defined as myocardial ischaemia at rest or on minimal exertion in the absence of acute heart muscle necrosis (Byrne et al., 2023). It is characterised by specific clinical findings of prolonged (greater than 20 minutes) angina at rest; the new onset of severe angina; angina that is increasing in frequency, longer in duration, or lower in threshold; or angina that occurs after a recent episode of myocardial infarction.

38. According to the fourth universal definition of myocardial infarction, there are five main types of myocardial infarction (Thygesen et al., 2018).

    - Type 1 myocardial infarction is caused by fatty deposits (atheroma) in the blood vessels that feed the heart (atherothrombotic coronary artery disease). The acute myocardial infarction is usually caused by a piece of the fatty deposit breaking off (atherosclerotic plaque disruption), and a blood clot forming around it to try to repair the blood vessel wall. The clot may completely block the artery resulting in STEMI or partially block the blood vessel resulting in NSTEMI.

    In brief, the other types of myocardial infarction are:

    - Type 2: mismatch between oxygen supply and demand not due to atherosclerotic plaque disruption;
    - Type 3: death before there is time to take blood for biomarker (troponin) measurement;
    - Type 4: due to keyhole surgery to the blood vessels to the heart (percutaneous coronary intervention); and
    - Type 5: due to open heart surgery to the blood vessels to the heart (coronary artery bypass grafting surgery).

Presentation and symptoms

39. Acute coronary syndromes are associated with a broad range of clinical presentations, from patients who are symptom free at presentation to patients with ongoing chest discomfort/symptoms to patients with cardiac arrest, electrical/haemodynamic instability or cardiogenic shock.

    - Cardiac arrest occurs when the heart stops beating suddenly; if not treated immediately the person will die. A study of 28,729 cases of out of hospital cardiac arrest across 10 English ambulance service regions serving a population of 54 million people in 2014 found that a cardiac cause was the leading reason for cardiac arrest. Less than one in ten people survived to hospital discharge (Hawkes et al., 2017).
    - Cardiogenic shock is a life-threatening condition in which the heart cannot pump enough blood to meet the needs of the body. It is most often caused by a heart attack.

- Electrical/haemodynamic instability means the activation of the heart and or the pumping ability of the heart is disturbed; in some circumstances this can be associated with cardiac arrest and cardiogenic shock.

40. The symptoms of an acute myocardial infarction (heart attack) vary from person to person. They can include:

    - chest pain that occurs suddenly and does not go away;
    - pain that occurs or spreads from the chest to the arms, neck, jaw, back or abdomen;
    - pain may be severe, but for some people it is mild or uncomfortable. Usually it is a heaviness, or tightness, or sometimes a burning pain;
    - sickliness (nausea) and or vomiting;
    - feeling faint (presyncope);
    - sweaty;
    - breathlessness;
    - blackout (syncope); and
    - Sometimes people have a feeling of anxiety, or have difficulty catching their breath.

41. It is possible to have a heart attack without any of the symptoms described in the paragraph above.

    41.1. It is recognised that women with acute myocardial infarction can present with a wider range of or different (accompanying) symptoms, though commonly have similar symptoms to those of men (Gentile et al., 2021).

    41.2. The elderly and those with diabetes may not feel the pain of acute myocardial infarction in the same way as younger people and those without diabetes (Ängerud et al., 2013, Canto et al., 2000). As such, a heart attack can sometimes be termed 'silent' (Singleton et al., 2020). This can lead to delays in both diagnosis and access to treatment (Ängerud et al., 2013, Canto et al., 2000), as well as adverse clinical outcomes such as higher rates of death and heart failure (Singleton et al., 2020).

    41.3. Notably, people with NSTEMI can experience less severe or fewer symptoms than people with STEMI (Canto et al., 2000, Fujino et al., 2017).

    41.4. People with unstable angina can experience any of the symptoms described in paragraph 76, but usually fewer and less severe than the symptoms in acute myocardial infarction.

Epidemiology

42. Chest pain accounts for about 6% of all Emergency Department attendances in England and Wales, representing approximately 700,000 visits annually (Goodacre et al., 2005).

43. In 2019/2020, in the UK, the majority of heart attacks were NSTEMI (65%), with the remainder being STEMI (35%) (Weston et al., 2022).

44. In the UK, there are about 100,000 hospital admissions each year due to acute myocardial infarction; (British Heart Foundation, 2024c) including 80,000 in England, 5,600 in Wales, 3,800 in Northern Ireland, and 10,000 in Scotland.

45. In the UK, the number of admissions with STEMI between 2012/2013 and 2019/2020 has remained stable at about 30,000 per annum (Weston et al., 2022).

46. In the UK, the number of admissions with NSTEMI has increased from about 80,000 per annum in 2012/2013 to about 88,000 in 2019/2020 (Weston et al., 2022).

47. In the UK, the incidence of NSTEMI and unstable angina per 100,000 population has remained similar between 2010 and 2017 (2010: 5.4 per 100,000 and 2017; 4.9 per 100,000) (Weight et al., 2023).

48. According to the 2021 Myocardial Ischaemia National Audit Project, for 2019/2020 in England, Wales and Northern Ireland the median age for STEMI was 65 years and the median age for NSTEMI was 71 years (NICOR, 2021).

49. According to the 2021 Myocardial Ischaemia National Audit Project, for 2019/2020 in England, Wales and Northern Ireland approximately two male patients are admitted to hospital with acute myocardial infarction for every female patient admitted to hospital with acute myocardial infarction. The proportion of men to women was higher for STEMI than NSTEMI (72% men with STEMI vs. 66% men with NSTEMI) (NICOR, 2021).

50. According to the 2021 Myocardial Ischaemia National Audit Project, for 2019/2020 in England, Wales and Northern Ireland 23% of people admitted to hospital with a heart attack and who had no previous history of coronary artery disease had diabetes mellitus (NICOR, 2021).

51. According to the 2021 Myocardial Ischaemia National Audit Project, for 2019/2020 in England, Wales and Northern Ireland 31% of people admitted to hospital with a heart attack had a body mass index of 30 kg/m2 or greater (obesity) (NICOR, 2021).

52. According to the 2021 Myocardial Ischaemia National Audit Project, for 2019/2020 in England, Wales and Northern Ireland 10% of admissions to hospital with a heart attack were from ethnic minorities, most of which were from Black and Asian ethnic groups (NICOR, 2021).

53. On average, people with NSTEMI tend to be older and have more additional medical conditions (comorbidities) than people with STEMI (Alabas et al., 2019).

Care pathways and treatments

54. Acute coronary syndrome is a medical emergency. Its treatment is time critical and its diagnosis should be made without delay.

55. For STEMI there is strong evidence to support the fact that emergency treatment (reperfusion) to open up the blocked artery supplying the heart is associated with better clinical outcomes, including fewer deaths (Anderson and Morrow, 2017).

56. The National Institute for Health and Care Excellence recommends that coronary reperfusion therapy - either primary percutaneous coronary intervention (primary PCI - a keyhole surgery to open the blocked artery supply in the heart) or fibrinolysis (clot busting drug treatment to open the blocked artery supply in the heart) - is delivered as quickly as possible for eligible people with acute STEMI (National Institute for Health and Care Excellence, 2020a).

57. Primary PCI is the preferred coronary reperfusion strategy if the person's presentation is within 12 hours of onset of their symptoms and primary PCI can be delivered within 120 minutes of the time when fibrinolysis could have been given. Evidence from randomised clinical trials shows that if the delay to treatment is similar, primary PCI is superior to fibrinolysis in reducing death, subsequent non-fatal myocardial infarction and stroke (Huynh et al., 2009, Keeley et al., 2003). Compared with fibrinolysis, primary PCI reduced the risk of death at six weeks by at least a quarter, reduced the risk of stroke by a third, and at one year reduced the risk of death by a quarter and subsequent heart attack by half as well as reducing the risk of subsequent non-fatal heart attack and stroke by about a quarter (Huynh et al., 2009, Keeley et al., 2003).

58. Primary PCI is undertaken in a dedicated catheterisation laboratory, similar to an operating theatre. A consultant cardiologist who specialises in keyhole surgery to heart blood vessels, supported by a specialist team including a radiographer, a physiologist and nurses, inserts a catheter (plastic tube) via the wrist blood vessel to the heart where the blockage causing the heart attack is stretched open with a small balloon and held open by a metal stent. The stent stays in the patient's heart blood vessel forever.

59. Fibrinolysis is a drug that is administered to a patient who is having a heart attack via an infusion so long as there are no contra-indications. The drug is given in an area of the hospital where the patients can be closely monitored, such as the coronary care unit or the emergency department.

60. For NSTEMI, urgent but not emergency treatment (reperfusion) to open up the blocked artery supplying the heart is associated with better clinical outcomes, including fewer subsequent heart attacks. For NSTEMI clinical guidelines recommend that the timing of opening up (revascularisation) the partially blocked artery is determined by clinical risk of future adverse cardiovascular events (Byrne et al., 2023).

61. The Global Registry of Acute Cardiac Events risk score is a decision support tool recommended in national and international guidelines for the risk stratification of people with suspected NSTEMI (National Institute for Health and Care Excellence, 2020a). The National Institute for Health and Clinical Excellence mini-Global Registry of Acute Coronary Events and adjusted mini-GRACE risk scores were studied using data for 137,084 patients discharged from hospitals in England and Wales with a diagnosis of acute myocardial infarction between 2003 and 2009 (Simms et al., 2012). The scores demonstrated good performance across a range of statistical indices, but performed less well in higher risk subgroups or people.

62. The National Institute for Health and Care Excellence recommends that people with NSTEMI (National Institute for Health and Care Excellence, 2020a):

    - receive coronary angiography with follow-on PCI immediately if their clinical condition is unstable;
    - are considered for receipt of coronary angiography with follow-on PCI within 72 hours of first admission to hospital if they are at intermediate or higher risk of adverse cardiovascular events (according to the Global Registry of Acute Cardiac Events risk score); and
    - are considered for receipt of coronary angiography with follow-on PCI if they are initially assessed (according to the Global Registry of Acute Cardiac Events risk score) to be at low risk of adverse cardiovascular events and subsequently experience ischaemia or it is demonstrated by ischaemic testing.

63. A meta-analysis of randomised clinical trials found that in all-comers with NSTEMI or unstable angina an early invasive strategy does not reduce all-cause mortality, acute myocardial infarction, admission for heart failure, repeat re-vascularisation, or increase major bleeding or stroke when compared with a delayed invasive strategy, and that the risk of recurrent ischaemia and length of stay are reduced with an early invasive strategy (Kite et al., 2022).

64. The National Institute for Health and Care Excellence recommends that people with unstable angina are considered for receipt of coronary angiography with follow-on PCI if they are initially assessed (according to the Global Registry of Acute Cardiac Events risk score) to be at low risk of adverse cardiovascular events and subsequently experience ischaemia or it is demonstrated by ischaemic testing (National Institute for Health and Care Excellence, 2020a).

65. Some younger people with low Global Registry of Acute Cardiac Events risk scores may be at high risk of adverse cardiovascular outcomes and may benefit from early coronary angiography and follow-on PCI as necessary (National Institute for Health and Care Excellence, 2020a).

66. Recently, the use of the Global Registry of Acute Cardiac Events risk score in suspected cases of NSTEMI or unstable angina in the UK was not shown in a randomised clinical trial to be effective at reducing adverse cardiovascular events or improving the use of treatments in hospital (Gale et al., 2023).

67. In the UK the preferred treatment strategy for STEMI is primary PCI (National Institute for Health and Care Excellence, 2020a). The UK has a network of primary PCI capable hospitals that receive people with a diagnosis of STEMI within 12 hours of symptom onset. In 2019/2020, there were 68 hospitals in England, Wales, Scotland and Northern Ireland that were the destination for paramedic crews to bring patients from the community directly for primary PCI (British Cardiovascular Intervention Society, 2020). Of these, 58 hospitals offered this service all hours of every day of the year. Four hospitals linked to form hybrid services, so that one or other hospital was available all hours of every day of the year, and six of them linked so that one centre provided daytime emergency activity, but another took over at night.

68. After primary PCI the patient is treated on the coronary care unit and cardiology ward. A coronary care unit is a specialist area of the hospitals that provides high dependency cardiac care for patients who are more acutely unwell with cardiac conditions. It has cardiac monitoring facilities and is staffed by highly skilled cardiac nurses and doctors who deliver individualised plans of care for patients. Typically, there are two patients per nurse, and the unit is coordinated by a senior nurse (Sister, Deputy Sister or Charge Nurse) at all times (British Cardiovascular Society, 2011). A cardiology ward is for less acutely ill cardiac patients. There is the ability to monitor patients, and the ward is staffed by nurses who are skilled in cardiac monitoring, treatment and cardiac conditions. Here, the nursing to patient ratio is often more than one to six.

69. Patients who are transferred past their local hospital to the primary PCI capable hospital will be transferred back to their local hospital after about six hours following the operation. In 2019/2020, the median length of hospital stay for STEMI in England, Wales, Scotland and Northern Ireland combined was 2.64 days (British Cardiovascular Intervention Society, 2022).

70. Following the diagnosis of STEMI, an ambulance will take the individual to the nearest primary PCI capable centre. Should a person with STEMI self-present to hospital or have STEMI whilst in hospital and be within 12 hours of onset of their symptoms they will be transferred to a primary PCI centre for receipt of primary PCI.

71. Cases of suspected NSTEMI and unstable angina will be admitted to their local hospital. When in hospital the diagnosis will be confirmed, or refuted, the patient's risk of future adverse cardiovascular events estimated and they will receive coronary angiography with follow-on PCI if appropriate. This will occur at a hospital capable of providing coronary angiography with follow-on PCI, and in some circumstances this will require the transfer of that patient to a capable centre. In 2019/2020, in England, Wales, Scotland and Northern Ireland the median length of hospital stay for NSTEMI was seven days (Weston et al., 2022).

72. In 2019/2020, there were 98 NHS hospitals in England (n=85), Wales (n=4), Scotland (n=6) and Northern Ireland (n=3) that were the capable of undertaking PCI, and 713 PCI operators (consultant cardiologist who specialises in keyhole surgery to heart blood vessels) in England, Wales, Scotland and Northern Ireland (British Cardiovascular Intervention Society, 2020).

73. In the UK, historically, the nationwide service for the emergency treatment of primary PCI for STEMI has been effective at saving lives.

    73.1. Using data from the United Kingdom PCI registry, it was found that for 88,188 primary PCI cases between 2005 and 2013 that were matched to mortality data for the UK population, their crude five-year relative survival was 87.1%, and 94.7% for patients under the age of 55 years (Brogan et al., 2019).

    73.2. An analysis of 208,358 patients admitted to hospital with STEMI in England and Wales between 2003 and 2010 found a significant decline in in-hospital mortality for adults of all ages (Gale et al., 2012).

    73.3. An analysis of 240,090 patients admitted to hospital with STEMI in England and Wales between 2003 and 2010 found a significant improvement in survival at 6 months for those who received reperfusion therapy (Gale et al., 2014). Temporal improvements were described across all ages of people with STEMI who received reperfusion therapy, with greater effects evident in the elderly (Alabas et al., 2014).

    73.4. In England and Wales, the improvements in survival for STEMI between 2004 and 2013 were significantly explained by the uptake of primary PCI and increased use of antiplatelet drugs (P2Y12 inhibitors) like Ticagrelor, Prasugrel and Clopidogrel at six months, and primary PCI at one year (Dondo et al., 2020).

    73.5. In England and Wales, there is little evidence to support an association between the time of day and in-hospital mortality for STEMI, and reported variation in in-hospital mortality may be explained by the differences between hospitals in how unwell patients are, and the use of treatments (Wu et al., 2019).

74. Following symptoms of a heart attack an individual, their family, their carer or a bystander will call the emergency medical services (via the 999 official emergency telephone number in the UK). It is advised that people don't take themselves to hospital. Before the Covid-19 pandemic, about 4.5% of people who received primary PCI for STEMI self-presented to hospital (National Cardiac Audit Programme, 2023, data from England, Wales and NI), though this proportion fell during the first two waves in 2020 and 2021, and had increased to about 8% by March 2022. After calling 999 a call handler will take essential details about the person's condition and location. The information is then passed to an emergency medical dispatcher who uses a triage system to decide which staff and vehicle to dispatch. Cases of chest pain are termed Category 2 (serious conditions that require rapid assessment and or urgent transport). Sometimes a heart attack is complicated by a cardiac arrest, whereby the person has collapsed and the heart has or is about to stop, and are termed Category 1 (signalling an immediate response to

a life-threatening condition). Category 1 and Category 2 calls have a paramedic in attendance with an ambulance; typically, two people attend, though sometimes a rapid response single responder may also arrive by car. In some circumstances, for example in geographically remote places in the UK, a medical team including a doctor and paramedic may be dispatched by helicopter. Sometimes a community responder (a member of the public trained to provide life-saving treatment in the local communities) may be the first person to arrive while the ambulance is on the way.

74.1. A study of 26,325 people admitted to hospital in Scotland with acute myocardial infarction between 2015 and 2017 found that 47.0% of patients called the ambulance services first, 23.3% attended the Emergency Department directly, and 18.7% called NHS telephone triage, and 10.1% had a direct inpatient admission (from a General Practitioner) (Hodgins et al., 2022).

75. If necessary, the ambulance crew will provide life-saving treatment in the locality or in the ambulance whilst on route to the hospital. If the person is in cardiac arrest the ambulance will go to the nearest hospital.

76. In cases of suspected heart attack, the paramedic crew will perform a 12 lead electrocardiogram on the person and offer them aspirin.

77. Upon arrival at hospital with a suspected heart attack, and if it is not a STEMI as determined by the 12 lead electrocardiogram (which, ordinarily, will follow the primary PCI treatment pathway), the person will be assessed by a doctor in the Accident and Emergency department. As a minimum, the person will have their medical history taken, receive a physical examination, receive a 12 lead electrocardiogram and have a blood test.

78. If a suspected heart attack is excluded the person will follow a different clinical pathway. If the diagnosis remains suspected heart attack or it is acute coronary syndrome (other than STEMI within 12 hours of symptom onset) the person will be admitted into hospital under the cardiology or general internal medical services, where they will receive further investigations and treatments.

79. In a minority of cases (about 2%) of acute coronary syndrome, a patient will receive emergency coronary artery bypass grafting (open heart) surgery as the principal coronary revascularisation strategy (Ohri et al., 2022). This would be conducted by a consultant cardiothoracic surgeon and accompanying operating theatre team. After the operation the patient spends time in the cardiac intensive care unit where they are nursed one to one under close supervision, with a hospital length of stay of about seven days.

80. Whilst in hospital, patients with acute myocardial infarction will receive a number of initial medications to treat the acute coronary syndrome. This will include (when eligible and clinically appropriate):

- dual antiplatelet therapy (these are blood thinner tablets and are aspirin with another antiplatelet drug such as Ticagrleor, Prasugrel or Clopidogrel); and
- antithrombin therapy (these are blood thinner injections and are fondaparinux or low molecular weight heparin).

81. Whilst in hospital, patients with acute myocardial infarction will receive a number of secondary prevention medications to reduce their risk of a subsequent acute coronary syndrome. These include (when eligible and clinically appropriate):

- angiotensin converting enzyme inhibitors (these are tablets that relax the blood vessels);
- dual antiplatelet therapy (aspirin with another antiplatelet drug such as Ticagrleor, Prasugrel or Clopidogrel);
- beta blockers (these are tablets that slow the heart rate and reduce the force at which blood is pumped around the body);
- aldosterone antagonists in people with heart failure and who have a reduced left ventricular ejection fraction (these are tables that increase the production of urine); and
- statins and or other lipid lowering therapy (these are tablets that decrease the fat in the blood).

82. Whilst in hospital patients with acute myocardial infarction will receive an echocardiogram (an ultrasound scan of the heart) to ascertain the strength of the heart and determine if there is evidence of heart failure. If there is evidence of heart failure with reduced ejection fraction and the left ventricular systolic function is 35% or less, then patients will, in addition to commencing medications for heart failure receive a further echocardiogram after six weeks when, if the heart function has not improved, they will be considered for an implantable cardiac defibrillator (if clinically appropriate) and a cardiac resynchronisation pacemaker if their 12 lead electrocardiogram QRS duration is greater than 150 milliseconds (if clinically appropriate) (National Institute for Health and Care Excellence, 2014a). This is because patients with ischaemic heart disease and who have a severely impaired left ventricle are at high risk of sudden cardiac death, which may be prevented with an implantable cardiac defibrillator (National Institute for Health and Care Excellence, 2014a). The use of a cardiac resynchronisation therapy pacemaker reduces heart failure adverse outcomes (National Institute for Health and Care Excellence, 2014a).

83. Whilst in hospital patients with low risk NSTEMI, unstable angina or those who have been managed conservatively and who have not had coronary angiography will, in addition to having an echocardiogram, be considered for ischaemia testing before discharge from hospital (National Institute for Health and Care Excellence, 2020a).

84. In the UK, care for NSTEMI received on a cardiac ward and by a cardiology specialist is associated with better clinical outcomes than care received on a general medical ward from non-cardiologist clinicians (Moledina et al., 2022b, Moledina et al., 2022a).

85. Whilst in hospital patients with acute myocardial infarction and or those who have received coronary revascularisation should receive cardiac rehabilitation. Typically, this will extend for 12 weeks after discharge from hospital and include a programme of exercises and information sessions addressing physical activity, health education, cardiovascular risk management and psychological support. Cardiac rehabilitation has been associated with a reduction in the risk of acute myocardial infarction and improvements in health related quality of life, functional capacity, psychological health, adherence to treatment, control of risk factors for cardiovascular disease, and return to work (Taylor et al., 2022).

    85.1 A study of 4,570 people admitted with acute myocardial infarction to hospitals in England between 2011 and 2013 found that cardiac rehabilitation was associated with temporal improvements in their quality of life estimated using EuroQol 5-Dimension 3-Level Questionnaire at up to 12 months following hospitalisation, with

such changes further improving in people who were physically active (Hurdus et al., 2020).

86. Following acute myocardial infarction patients will be informed about the importance of smoking cessation, weight management, regular physical activity, their alcohol consumption, and changing their diet (National Institute for Health and Care Excellence, 2020a).

87. A study of 9,566 people admitted with acute myocardial infarction to 77 hospitals in England between 2011 and 2015 found that for the majority of them their quality of life measured using the EuroQol 5-Dimension 3-Level Questionnaire improved. However, it was worse and more likely to decline among women, those with NSTEMI and those with long-term health conditions (Munyombwe et al., 2021).

88. Following acute myocardial infarction, the patient should be reviewed in an outpatient clinic at between six and 12 weeks following discharge from hospital. If the person received PCI this clinic may be delivered by a healthcare professional other than a doctor.

89. Following acute myocardial infarction a patient will remain at elevated risk of further cardiovascular events, typically death, heart failure, further acute coronary syndrome and stroke. This risk is, however, reduced by timely delivery of optimal medical care and intervention, and ongoing specialist and primary care follow up.

    89.1 A study of 145 million hospital admissions from the UK showed that following acute myocardial infarction, there is an increased risk of subsequent hospitalisation with several diseases including chronic ischaemic heart disease, pneumonia and angina when compared with patients initially admitted with other diseases (Hayward et al., 2023). If admitted again with cardiovascular disease, there is also an increased risk of death.

90. In the UK in 2019, the age-standardised death rate per 100,000 people for coronary heart disease was 98, which is the lowest it is has been recorded since analysis in 1975; (British Heart Foundation) and it was 95 per 100,000 people in England, 109 per 100,000 people in Wales, 100 per 100,000 people in Northern Ireland, and 124 per 100,000 people in Scotland.

91. Data from a UK population-based cohort of 281,259 STEMI and 422,661 NSTEMI between 2003 and 2013 shows that 17.1% of these patients have diabetes and that this is associated with a 72% and 67% excess risk of death, respectively (Alabas et al., 2016).

92. In the UK, historically, the treatment of NSTEMI has been effective at saving lives.

    92.1 An analysis of 325,299 patients admitted to hospital with NSTEMI in England and Wales between 2003 and 2010 found a significant decline in in-hospital mortality for adults of all ages (Gale et al., 2011).

    92.2 An analysis of 343,376 patients admitted to hospital with NSTEMI in England and Wales between 2003 and 2010 demonstrated temporal improvements in relative survival at 6 months, with greater effects evident in the elderly (Alabas et al., 2014).

    92.3 An analysis of 389,057 patients admitted to hospital with NSTEMI in England and Wales between 2003 and 2013 found a significant improvement in survival at six months and that this was explained by the receipt of an invasive coronary strategy (coronary angiography, PCI and coronary artery bypass grafting surgery) (Hall et al., 2016).

93. Data from England and Wales have shown that the use of optimal guideline directed care for NSTEMI is associated with improved survival, and the magnitude of this effect is greater for people with a higher Global Registry of Acute Cardiac Events risk score (Hall et al., 2018), and less so for some groups of people such as those with heart failure or cerebrovascular disease (Yadegarfar et al., 2020). Conversely, data from the UK show that of 389,057 people admitted with NSTEMI to hospitals in England and Wales between 2003 and 2013 86.9% did not receive one or more guideline directed interventions (Dondo et al., 2017). The most frequently missed were dietary advice followed by smoking cessation advice, P2Y12 inhibitors, and coronary angiography. Missed interventions with the strongest impact on reduced survival were coronary angiography, cardiac rehabilitation, smoking cessation advice, and the prescription of statins.

94. A study of 131 patients admitted to hospitals in the North of Scotland with STEMI between 2014 and 2015 found that compared with people living in central areas people living in remote areas less frequently received optimal reperfusion therapy (primary PCI or fibrinolysis) (65% vs. 41%) (Kamona et al., 2018).

95. Compared with 258,364 White patients, there was no evidence of care disparities among 22,194 Black, Asian, and Minority Ethnic patients admitted with NSTEMI to hospitals in England and Wales between 2010 and 2017 (Moledina et al., 2022c).

96. Delays to the diagnosis of acute coronary syndrome result in a higher risk of experiencing adverse cardiovascular events. The severity and timing of these events is determined by the underlying type of the acute coronary syndrome, the duration of the delay and the delay to receiving which specific aspect of care.

97. Determining an accurate diagnosis of the type of acute coronary syndrome is central to optimal clinical outcomes.

    97.1 A study of 221,635 admissions with STEMI and 342,777 admissions with NSTEMI between 1 April 2004 and 31 March 2013 in all 243 acute hospitals in England and Wales found that those who did not have an initial hospitals diagnosis that corresponded with their final diagnosis less frequently received guideline directed care and had higher mortality rates (Wu et al., 2018).

    97.2 It has been shown that missed opportunities in the receipt of diagnostic and or treatments for acute myocardial infarction are associated with a higher risk of death (Simms et al., 2015). The more missed opportunities the higher the risk of death.

98. The total ischaemic time is a term used to describe the duration of time from the onset of a patient's symptoms to the time of reperfusion (opening) of the infarct related artery (blocked heart blood vessel) (Byrne et al., 2023). The total ischaemic time can be divided into:

    - the time interval from symptom onset to the patient's decision to see medical attention;
    - the time interval from the decision to seek medical attention to first medical contact;
    - the time interval from the first medical contact to hospital arrival; and
    - the time from hospital arrival to reperfusion.

99. It is reported that the patient's decision time is often the main factor responsible for the overall delay. Patient related delays are longer in those of advanced age, who live alone, have a low

intensity of initial symptoms, a history of diabetes, women, the occurrence of symptoms at night, and the involvement of a general practitioner (Shavelle et al., 2014).

100. Delays to the diagnosis of STEMI are associated with a higher risk of death, cardiogenic shock, heart failure, stroke, life threatening arrhythmias and subsequent acute coronary syndrome (Gorenek et al., 2014). Among patients with out-of-hospital cardiac arrest the majority have clinical significant coronary artery disease at coronary angiography, and about 50% have a blocked coronary artery (Spaulding et al., 1997).

101. Delays to the receipt of fibrinolysis for STEMI are associated with increased death, cardiogenic shock, heart failure and stroke (Newby et al., 1996).

102. Delays to the receipt of primary PCI for STEMI are associated with increased death, cardiogenic shock, heart failure, stroke and subsequent acute coronary syndrome.

103. System delays are defined as those delays occurring between the time of contact with the emergency medical service by the patient and the time of reperfusion. This is also known as the call to balloon time for primary PCI for STEMI. This therefore incorporates the call to (hospital) door time and the (hospital) door to balloon time. System delays are associated with an increased risk of death in people with STEMI.

    103.1 For STEMI, there is a linear relationship between the duration of time from the onset of symptoms to coronary reperfusion with primary PCI (De Luca et al., 2003).

    103.2 On average, it is estimated that every 30 minute delay to the receipt of primary PCI from symptom onset increases the patient's risk of dying within 1 year of the myocardial infarction by 7.5% (Giuseppe De Luca et al., 2004).

    103.3 The broad rule of thumb is that every one hour delay results in a 10% increase in death.

104. The impact of delays to the receipt of primary PCI for STEMI on death in hospital are greatest in people with cardiogenic shock without out-of-hospital cardiac arrest, followed by cardiogenic shock with out-of-hospital cardiac arrest, followed by no cardiogenic shock with out-of-hospital cardiac arrest (Scholz et al., 2018). Typically, a patient with acute myocardial infarction who has cardiogenic shock and no cardiac arrest is most likely to be a 'late presenter' to hospital. That is, their heart attack occurred over 12 hours ago and probably within a few days; the heart muscle will have sustained irretrievable damage and the ability of the heart to pump blood effectively around the body is reduced. In such cases primary PCI is much less effective. Typically, patients who present with out-of-hospital cardiac arrest in the context of STEMI are in the process of having a heart attack. In these circumstances primary PCI is much more effective.

105. While routine immediate primary PCI for STEMI is associated with clinical benefit in patients presenting within 12 hours of symptom onset, the value of this strategy in patients with STEMI who present later than 12 hours after symptom onset is uncertain.

    105.1 A small randomised clinical trial and an observational study have each suggested reduced death with the use of primary PCI for STEMI that presents 12 hours to 48 hours after symptoms (Schömig et al., 2005, Bouisset et al., 2021).

    105.2 Nonetheless, in the UK the routine use of primary PCI for STEMI in stable patients that present after 12 hours is not recommended (National Institute for Health and Care Excellence, 2020a).

Metrics used to measure performance

106. There are a number of metrics used to measure the performance of care for acute coronary syndromes. These include the:

- National Institute for Health and Care Excellence sets Standards and Indicators; (National Institute for Health and Care Excellence);
- National Audit of Percutaneous Coronary Intervention Quality Improvement Metrics;
- Myocardial Ischaemia National Audit Project Quality Improvement Metrics; (Weston et al., 2022); and
- European Society of Cardiology Quality Indicators (Aktaa et al., 2022).

107. The National Institute for Health and Care Excellence quality standards apply to England and Wales (National Institute for Health and Care Excellence, 2012f). Decisions on how they apply in Scotland and Northern Ireland are made by the Scottish government and Northern Ireland Executive. The National Institute for Health and Care Excellence indicators may be used by NHS England and the devolved administrations of Northern Ireland and Wales (National Institute for Health and Care Excellence, 2018). The Myocardial Ischaemia National Audit Project Quality Improvement Metrics are intended for use in England, Wales, Scotland and Northern Ireland. The European Society of Cardiology Quality Indicators are intended for use by any organisation in any country, though were developed from European Society of Cardiology Clinical Practice Guidelines for cardiovascular care.

108. The National Institute for Health and Care Excellence sets Quality Standards and Indicators. These can be used by commissioners, service providers, practitioners, partner organisations, charities and service users (National Institute for Health and Care Excellence). They are developed from an evidence base and a standard process, which includes input from advisory committees and public consultation. The Quality Standards set out priority areas for quality improvement and highlight areas with identified variation in current practice. The Indicators measure outcomes that reflect the quality of care and processes linked by evidence to improved outcomes.

109. As part of the National Cardiac Audit Programme, the United Kingdom National Audit of Percutaneous Coronary Intervention has a set of Quality Improvement Metrics (NHS, 2019). These are informed by the literature as well as from the European Society of Cardiology Clinical Practice Guidelines for the management of acute myocardial infarction and the National Institute for Health and Care Excellence Quality Standards and Indicators. The National Audit of Percutaneous Coronary Intervention Domain Group choose the Quality Improvement Metrics, many are developed and a selection of them are detailed in the National Cardiovascular Audit Programme annual report.

110. As part of the National Cardiac Audit Programme, the United Kingdom Myocardial Ischaemia National Audit Project has a set of Quality Improvement Metrics (Weston et al., 2022). Wherever possible these are drawn from the European Society of Cardiology Clinical Practice Guidelines for the management of acute myocardial infarction and the National Institute for Health and Care Excellence Quality Standards and Indicators. The Myocardial Ischaemia National Audit Project Quality Improvement Quality Improvement Metrics were agreed upon by the Myocardial Ischaemia National Audit Project Steering Group.

111. The European Society of Cardiology Quality Indicators are tools for assessing and benchmarking the quality of care with view to its improvement. They are developed by physicians following a standard methodology, and relate to current international Clinical Practice Guidelines (Aktaa et al., 2022).

112. The National Institute for Health and Care Excellence Quality Standards for acute coronary syndrome are:

    112.1 Adults with a suspected acute coronary syndrome are assessed for acute myocardial infarction using the criteria in the universal definition of myocardial infarction. This is because prompt and accurate diagnosis is important to ensure that appropriate treatment and care is offered as soon as possible (National Institute for Health and Care Excellence, 2010). Currently, there is no target.

    112.2 Risk assessment for adults with NSTEMI or unstable angina. This is because assessing and categorising risk of future adverse cardiovascular events by formal risk assessment (for example, using the Global Registry of Acute Cardiac Events risk score) in people who have been diagnosed with NSTEMI or unstable angina is important for determining early management strategies (National Institute for Health and Care Excellence, 2020a). Currently, there is no target.

    112.3 Coronary angiography and PCI within 72 hours for NSTEMI or unstable angina. This is because in people with an intermediate or higher risk of future adverse cardiovascular events, coronary angiography to define the extent and severity of coronary disease, done within 72 hours of admission to hospital, offers advantages over an initial conservative strategy, provided there are no contraindications to angiography (such as active bleeding or comorbidity) (National Institute for Health and Care Excellence, 2020a). Currently, there is no target.

    112.4 Coronary angiography and for adults with NSTEMI or unstable angina who are clinically unstable within 24 hours of becoming clinically unstable. This is because coronary angiography is important to define the extent and severity of coronary disease, and the benefits of an early invasive strategy appear to be greatest in people at higher risk of future adverse cardiovascular events (National Institute for Health and Care Excellence, 2020a). Currently, there is no target.

    112.5 Level of consciousness and eligibility for coronary angiography and primary PCI. This is because people who remain unconscious after a cardiac arrest should not be treated differently from people who are conscious, and undertaking primary PCI, if successful, could stabilise the person's heart and may reduce the risk of further complications (National Institute for Health and Care Excellence, 2020a). Currently, there is no target.

113. The National Institute for Health and Care Excellence Indicators for acute coronary syndrome are:

    113.1 referrals to cardiac rehabilitation within five days of an admission for coronary heart disease with a primary diagnosis of acute myocardial infarction, PCI and coronary artery bypass grafting surgery, and completion of the course of cardiac rehabilitation. These are indicators for Integrated Care Boards because they can influence outcomes relating to this measure by ensuring that cardiac rehabilitation services are available locally to an appropriate capacity and by setting out the role of such services within the overall cardiac pathway which has been commissioned (National

Institute for Health and Care Excellence, 2020c). Currently, there are no targets for referrals or completed courses.

114. In 2021 the National Audit of Percutaneous Coronary Intervention Quality Improvement Metrics as reported in the National Audit of Percutaneous Coronary Intervention Annual Report (National Cardiac Audit Programme, 2021) were:

114.1 Number of PCIs undertaken each year at a PCI capable centre. This is because the treatment of patients needing PCI is complex as it requires the interaction of a number of different team members to optimise care. While there is no clear cut off below which a hospital will be too inexperienced to provide optimal care, recommendations from the British Cardiovascular Intervention Society are that hospitals should perform more than 400 cases a year (Society, 2022). Nevertheless, observational research into the relationship between patient survival outcomes and centre volume using the British Cardiovascular Intervention Society dataset of UK activity has not found that lower volume centres were putting patients at risk (O'Neill et al., 2017, Huynh et al., 2009). The standard is 400 PCI procedures each year at a PCI centre.

114.2 Delays to treatment of STEMI by primary PCI. This is because once STEMI has been recognised, the sooner that primary PCI is performed the more likely it is that significant heart muscle damage can be prevented and the greater are the chances of the patient surviving (McNamara et al., 2006). All cases of STEMI excluding cardiogenic shock and pre-PCI ventilation: call-to-balloon time less than 150 minutes in at least 75% of cases; door-to-balloon time less than 60 minutes in at least 75% of cases;(Ibanez et al., 2018) and call to primary PCI centre's door (which currently has no target set) (National Institute for Health and Care Excellence, 2020a, Society, 2022).

114.3 Time delays from admission to first hospital with symptoms of NSTEMI to time of PCI (if this is required for treatment of NSTEMI). This is because although waiting for longer times before performing coronary angiography +/- revascularisation does not appear to be associated with increased mortality (Kofoed et al., 2018), waiting has a negative impact on NHS resources, exposes the patient to the dangers of being in hospital such as infections, and has a negative impact on patient experience. The standard is over 75% of people with NSTEMI should receive coronary angiography within 72 hours of first admission to hospital; (National Institute for Health and Care Excellence, 2020a).

114.4 Use of radial access for PCI unless there are overriding procedural considerations. This is because radial access is associated with fewer complications than femoral access, and in high risk patients is associated with improved survival (National Institute for Health and Care Excellence, 2020a, Neumann et al., 2019). The standard is over 75% of all cases are performed via the radial route.

114.5 Drug eluting stents as proportion of stented cases in primary PCI. This is because new generation drug eluting stents maintain the benefits of reduced restenosis (a gradual narrowing of the stented segment of the heart blood vessel over time) without increasing the risk of stent thrombosis (a blood clot in the stented segment of the heart blood vessel) (Stettler et al., 2007). This standard is at least 90% of cases of primary PCI for STEMI use drug eluting stents; (National Institute for Health and Care Excellence, 2020a).

114.6 Data completeness for time delays to STEMI treatment. This allows accurate assessment of delays to PCI in acute coronary syndromes and outcomes. The standard is at least 95% completeness in each of the key fields.

114.7 Data completeness for time delays to NSTEMI treatment. This allows accurate assessment of delays to PCI in acute coronary syndromes and outcomes. The standard is at least 95% completeness in each of the key fields.

115. In 2022, the Myocardial Ischaemia National Audit Project Quality Improvement Metrics (Weston et al., 2022) were:

115.1 Door-To-Balloon time for STEMI. This is because shorter door-to-balloon times should be associated with better outcomes following STEMI (National Institute for Health and Care Excellence, 2020a). The standards to be met are a door-to-balloon time equal to or less than 60 minutes, and a more relaxed standard of a door-to-balloon time equal to or less than 90 minutes.

115.2 Call-To-Balloon time for STEMI. This is because shorter call-to-balloon times are associated with better outcomes following STEMI (National Institute for Health and Care Excellence, 2020a). The standards to be met are a call-to-balloon time equal to or less than 120 minutes, and a more relaxed standard of a door-to-balloon time equal to or less than 150 minutes.

115.3 No reperfusion for STEMI. This is because reperfusion of a completely or partially occluded coronary artery is associated with reduced myocardial damage (Ibanez et al., 2018). All patients with STEMI within 12 hours of onset of symptoms should be considered for reperfusion, no specific target rate is set for 'no reperfusion', but the aim is for 0% achievement.

115.4 Echocardiography after STEMI. This is because performance of echocardiography allows assessment of the left ventricular function, targeted treatments of heart failure, and identifies patients who might benefit from an implantable cardiac defibrillator and or cardiac resynchronisation pacemaker (Ibanez et al., 2018). There is no national standard published, but the aim is for 90% achievement.

115.5 Admitted to cardiac ward after NSTEMI. This is because admission to a cardiac ward allows optimum cardiac monitoring and access to highly trained cardiac staff (Roffi et al., 2015, Moledina et al., 2022b). There is no national standard published, but the aim is for 80% achievement.

115.6 Seen by cardiologist following NSTEMI. This is because patients with NSTEMI admitted under a cardiologist within 24 hours of hospital admission are more likely to receive guideline directed management and have better clinical outcomes (Moledina et al., 2022a). There is no national standard published, but the aim is for 100% achievement.

115.7 Coronary angiogram during admission with NSTEMI. This is because coronary angiography allows confirmation of the diagnosis and is a precursor for coronary interventions such as PCI and coronary artery bypass grafting surgery (National Institute for Health and Care Excellence, 2014c). There is no national standard published, but the aim is for 100% given that the denominator excludes those judged to be ineligible for angiography.

115.8 Proportion of patients undergoing angiography within 72 hours of admission to hospital with NSTEMI (National Institute for Health and Care Excellence, 2014d). This is because coronary angiography leads to early revascularisation with better outcomes in high risk patients and shorter hospital stays. All cases of NSTEMI should receive coronary angiography within 72 hours of admission to hospital unless angiography is deemed inappropriate; the aim is for 100% achievement.

115.9 Percentage of patients discharged on all secondary prevention drugs for which they are eligible following either STEMI or NSTEMI (National Institute for Health and Care Excellence, 2020a). This is because these medicines have been shown to reduce the likelihood of subsequent coronary events in those who have had acute myocardial infarction. There is no specified standard, but the aim is for 90% of relevant patients to receive all secondary prevention drugs for which they are eligible at time of discharge from hospital following STEMI and NSTEMI.

115.10 Aldosterone antagonists following STEMI. This is because there are improved outcomes when aldosterone antagonists are given to patients with impaired left ventricular systolic function soon after STEMI (Ibanez et al., 2018). There is no specified standard, but the aim is for 90% of eligible patients to receive an aldosterone antagonist at the time of discharge from hospital following STEMI.

115.11 Referral to cardiac rehabilitation. This is because exercise-based cardiac rehabilitation programmes are associated with fewer cardiac deaths in patients with coronary artery disease. The National Health Service Long Term Plan aspires to 85% of those eligible accessing cardiac rehabilitation (NHS, 2019).

116. The 2020 European Society of Cardiology Quality Indicators for Acute Myocardial Infarction (Schiele et al., 2021) are the:

- presence of written protocols for an organisational network;
- hospital use of a recommended troponin blood test;
- pre-hospital interpretation of a 12-lead electrocardiogram;
- participation in a quality register or quality assessment programme;
- assessment of times to reperfusion for STEMI;
- proportion of patients with STEMI who are perfused within 12 hours of onset of symptoms, irrespective of timing;
- proportion of patients with STEMI who have a wire crossed (the first stage of a PCI procedure) within 60 minutes of the time of diagnosis of STEMI, for patients presenting at a primary PCI hospital. For patients diagnosed at a non-primary PCI hospital or in the out of hospital setting, the proportion of patients with STEMI who have a wire crossed within 90 minutes of the time of diagnosis of STEMI. For patients receiving fibrinolysis, the recommended time between diagnosis of STEMI and initiation of fibrinolysis is less than 10 minutes;
- proportion of patients with NSTEMI who receive coronary angiography within 24 hours of admission to hospital;
- use of radial access if an invasive coronary strategy is adopted;

- duration of time between first medical contact and arterial access for patients with STEMI;
- proportion of patients who have assessment of their left ventricular ejection fraction;
- proportion of patients who have assessment of their low-density lipoprotein-cholesterol concentration;
- proportion of patients who have assessment of their ischaemic risk and bleeding risk using validated;
- proportion of patients who have adequate P2Y12 inhibition;
- proportion of patients who receive parenteral anticoagulation on admission to hospital;
- proportion of patients who receive dual antiplatelet therapy at the time of discharge from hospital;
- proportion of patients who have the intended duration of dual antiplatelet therapy state on the discharge document;
- proportion of patients who receive high intensity statins at the time of discharge from hospital;
- proportion of patients with a left ventricular ejection fraction of 40% or less who receive an angiotensin receptor enzyme inhibitor or angiotensin receptor blocker at the time of discharge from hospital;
- proportion of patients with a left ventricular ejection fraction of 40% or less who receive a beta blocker at the time of discharge from hospital;
- use of a discharge letter;
- systematic evaluation of patients' health related quality of life;
- systematic evaluation of patients' experience;
- use of an opportunity-based composite quality indicator;
- use of an all-or-nothing composite quality indicator; and
- use of risk adjusted 30-day mortality.

117. The 2020 European Society of Cardiology Quality Indicators for Acute Myocardial Infarction are the latest published iteration of quality indicators for acute myocardial infarction from the European Society of Cardiology. Given changes in evidence and new recommendations for clinical practice the 2017 European Society of Cardiology Quality Indicators for Acute Myocardial Infarction were updated to the 2020 European Society of Cardiology Quality Indicators for Acute Myocardial Infarction (Schiele et al., 2021, Schiele et al., 2017). To date, the 2017 European Society of Cardiology Quality Indicators for Acute Myocardial Infarction have been tested in England and Wales using the Myocardial Ischaemic National Audit Project data to see if they may be used for measuring quality of care.

    117.1 Using data from 118,075 patients admitted with acute myocardial infarction to 211 hospitals in England and Wales between 2012 and 2013, it was found that 16 of the

20 published 2017 European Society of Cardiology Quality Indicators for Acute Myocardial Infarction could be calculated using the United Kingdom Myocardial Ischaemic National Audit Project (Bebb et al., 2017). Of these, 11 were inversely associated with 30-day mortality. This shows that the 2017 European Society of Cardiology Quality Indicators for Acute Myocardial Infarction may be used to assess specific aspects of quality of care for acute myocardial infarction in the National Health Service (Schiele et al., 2017).

117.2 A systematic review of nine studies using 11 different cohorts from 31 countries found that it is possible to measure between six and 20 of the 2017 European Society of Cardiology Quality Indicators for Acute Myocardial Infarction in existing registries (Rossello et al., 2021). However, the review stated that there was room for improvement in terms of data availability, feasibility, and levels of attainment for the quality indicators.

118. The National Cardiac Audit Programme holds eleven cardiovascular subspecialty domains as one United Kingdom National Clinical Audit. It is part of the National Institute for Cardiovascular Outcomes Research. It is funded by NHS England and managed through the Arden and GEM Commissioning Support Unit. The programme is open to England, Wales, Scotland and Northern Ireland, but data are predominantly collected from England and Wales (and to a lesser extent Northern Ireland) for the Myocardial Ischaemia National Audit Project. The Programme does not report the analysis of data separately for each of the devolved administrations of the United Kingdom. The programme includes the:

- National Congenital Heart Disease Audit;
- Myocardial Ischaemia National Audit Project;
- National Audit of Percutaneous Coronary Interventions;
- National Adult Cardiac Surgery Audit;
- National Heart Failure Audit;
- National Audit of Cardiac Rhythm Management;
- National Audit of Cardiac Rehabilitation;
- UK Transcatheter Aortic Valve Implantation Registry;
- Percutaneous Mitral Valve Repair Registry;
- Left Atrial Appendage Occlusion Registry; and
- Patent Foramen Ovale Closure Registry.

118.1 Prior to 2022, the National Cardiac Audit Programme audits were under the auspice of Barts Health NHS Trust.

118.2 The National Institute for Cardiovascular Outcomes Research is a partnership of cardiologists, managers and analysts who provide disease specific, project management, technical and analytical support for the National Cardiac Audit Programme audits (NICOR).The partnership does not represent Scotland.

118.3 The Myocardial Ischaemia National Audit Project is a domain within the National Institute for Cardiovascular Outcomes Research that contains information about the

care provided to patients who are admitted with acute coronary syndrome to hospitals in England and Wales (NICOR). The data collected represent the 'patient journey' from a call to the emergency services or their self-presentation at an Emergency Department, through diagnosis and treatment at hospital, to the prescription of preventive medications on discharge.

118.4 The National Audit of Percutaneous Coronary Interventions is a domain within National Institute for Cardiovascular Outcomes Research that contains information about the care provided to patients who receive PCI admitted at hospitals in the UK (NICOR). The data collected are about the structure of PCI provision in the UK, and about the appropriateness, process and outcomes from PCI.

119. The Scottish Cardiac Audit Programme is part of the Scottish National Audit Programme in Public Health Scotland. It was commissioned from 2021. The Scottish Cardiac Audit Programme publishes data relating to cardiac interventions (and not admissions with cardiovascular diseases) undertaken in Scotland including:

- congenital heart disease;
- adult PCI;
- transcatheter aortic valve implantation; and
- adult cardiac surgery.

Annual reports are available only for years 2021/22 and 2022/23 (Public Health Scotland, 2024) In 2019/20 there were 9471 PCI procedures performed on adults in Scotland.

Summary

120. Acute coronary syndromes encompass a spectrum of emergency ischemic heart disease conditions that include STEMI, NSTEMI and unstable angina.

121. People with NSTEMI tend to be older and more comorbid than people with STEMI.

122. Acute coronary syndrome is a common and serious disease, but effective treatments are available. Primary PCI for STEMI offers better clinical outcomes than fibrinolysis, and in the UK there is a national primary PCI service for STEMI.

123. There is strong evidence that the timing of treatment for STEMI is very important for achieving optimal clinical outcomes. The sooner definitive treatment is given the greater the chance that a patient will survive and not have further cardiovascular complications from the heart attack.

124. NSTEMI doesn't have to be treated as urgently as STEMI (except in a few circumstances), but it is still a serious condition. Compared with STEMI, NSTEMI can be harder to recognise by patients as a serious event.

125. There is a well-defined set of treatments and care packages for acute coronary syndrome, including secondary prevention medications, cardiac rehabilitation and outpatient review that can help improve clinical outcomes.

126. There are many indicators of and targets for quality that may be used to assess the provision of clinical care and outcomes for acute coronary syndromes. These targets have been

developed and are recognised by regulators and specialist clinical societies for this purpose. Routine NHS administrative and clinical registry data may be used to assess this performance.

II - Chronic coronary syndromes

127. Chronic coronary syndromes encompass a spectrum of non-emergency suspected or established ischaemic heart disease conditions (Knuuti et al., 2020). This includes patients with:

- suspected coronary artery disease;
- stable anginal symptoms and or breathlessness;
- new onset heart failure or left ventricular dysfunction and suspected coronary artery disease;
- asymptomatic and symptomatic patients with stabilised symptoms at least one year after acute coronary syndrome;
- asymptomatic and symptomatic patients at least one year after initial diagnosis or revascularisation;
- angina and suspected vasospastic or microvascular disease; and
- asymptomatic coronary artery disease detected at screening.

128. The classical chronic (non-emergency) presentation of ischaemic heart disease is with angina. Angina is the most common symptom of ischaemic heart disease.

129. Angina is a symptom. It is described as a pain, constricting feeling or an uncomfortable sensation usually in the chest. Some people feel the pain in their arm, neck, stomach, back or jaw. Other symptoms of angina can include:

- fatigue;
- dizziness;
- sweating;
- feeling sick; and
- breathlessness.

Epidemiology

130. Angina is prevalent within the population of the UK, and its prevalence increases with increasing age.

130.1 The Health Survey for England (2006) reported that 6.5% of adult men and 4.0% of adult women in England currently have ischaemic heart disease (The Information Centre, 2006).

130.2 The prevalence of angina increases with age (Members et al., 2013), and for men and women aged between 65 years and 74 years it was reported to be around 14% and 8%, respectively (The Information Centre, 2006).

130.3 Data from the Clinical Practice Research Datalink in 2012 estimated that 3.05% of men and 1.79% of women in England experience angina, with incidence rising with increasing age in both sexes (Merriel, 2017).

130.4 A study of 4.6 million individuals from the UK between 2006 and 2015 reported that the age- and sex-standardised incidence of coronary artery disease was similar in 2006 (443 per 100 000 person-years) and 2015 [436 per 100 000 person-years; adjusted incidence rate ratio (IRR) 0.98, 95% confidence interval (CI) 0.96-1.00] (Sundaram et al., 2020). During this period, cardiovascular mortality declined by 43% for incident coronary artery disease (adjusted IRR 0.57, 95% CI 0.50-0.64). The improvements in health outcomes are likely to be due to greater use of better treatments for ischaemic heart disease – such as the use of antiplatelet and lipid lowering agents after PCI and heart attack.

130.5 A study of Quality and Outcomes Framework data and NHS records found that the prevalence of ischaemic heart disease remained constant at around 3% in England and 4% in Scotland, Wales and Northern Ireland between 2004/5 and 2014/15 (Bhatnager et al., 2016). Between 1991 and 2014 in England the number of prescriptions for diseases of the circulatory system increased by around 243 million (a proportional 78% increase) (Bhatnager et al., 2016). Between 2005 and 2014, the number of prescriptions for diseases of the circulatory system in Wales increased by around 5.5 million (23%), by 2.3 million (9%) in Scotland, and by 2.5 million (28%) in Northern Ireland (Bhatnager et al., 2016). In 2013 there were more than seven times the number of PCI procedures as compared to 1993 (Bhatnager et al., 2016).

130.6 The plateau in incidence of ischaemic heart disease and the decline in mortality from cardiovascular disease is likely to represent improved identification and treatment of cardiovascular risk factors and improved treatment of chronic and acute cardiovascular disease.

131. Stable angina is the most common type of angina. Less common types of angina are vasospastic angina and microvascular angina.

131.1 Typically, stable angina comes on with exertion and is relieved by rest and with medication. It usually stops after less than five minutes. Patients with stable angina often know what type of exertion will provoke their angina.

131.2 Vasospastic angina is a less common type of angina. It occurs when the coronary artery goes into spasm, therefore limiting the blood supply to the heart.

131.3 Microvascular angina is due to narrowing in the tiny coronary arteries and occurs with exertion.

131.4 Although men and women experience the classic symptoms of angina, women are more likely to also describe the other symptoms of angina, and are more likely to have microvascular and vasospastic angina.

132. Stable angina is due to atheroma. This is described above in the section Ischaemic heart disease (paras 54-6).

133. The risk factors for angina are those for ischaemic heart disease. This is described above in the section Ischaemic heart disease (para 58).

134. As detailed in paragraph 127, chronic coronary syndrome may also present with signs and or symptoms of heart failure. This is because coronary artery disease may limit the supply of blood to the heart, which can become weak. This report does not extend to heart failure due to coronary artery disease.

135. A chronic coronary syndrome may also be identified at screening, with evidence for coronary artery disease. The risk factors for, primary prevention of and screening for coronary artery disease are covered in the section about the prevention of ischaemic heart disease below.

Care pathways and treatments

136. Most frequently, a patient with angina will present to their General Practitioner in the first instance.

137. Angina is a clinical diagnosis. A careful history taken from the patient is the cornerstone to the diagnosis of angina. Angina severity may be graded according to the Canadian Cardiovascular Society score, but this grading system is infrequently used in clinical practice in the UK. A physical examination is undertaken.

138. First line investigations in patients with suspected angina include:

- blood tests (full blood count, urea and electrolytes, lipid profile, Hba1c, thyroid function tests, liver function test, amylase, C-reactive protein or erythrocyte sedimentation rate);
- 12 lead electrocardiogram; and
- chest x-ray.

These investigations are normally undertaken in primary care by the patient's General Practitioner.

139. Following review by a General Practitioner and the baseline investigations, a patient with suspected angina and who is pain free with chest pain more than 72 hours ago and has no complications will be referred to secondary care to see a cardiology specialist healthcare professional at a Rapid Access Chest Pain Clinic (National Institute for Health and Care Excellence). This is for further investigations and treatment, as necessary. At this point in time the General Practitioner may prescribe aspirin and sublingual glyceryl trinitrate until the diagnosis is confirmed, and explore and address issues concerning the patient's cardiovascular risk factors.

- It is estimated that patients with stable angina see their General Practitioner between 0.5 and three times each year for consultations related directly to their angina (National Institute for Health and Care Excellence, Murphy et al., 2006, Stewart et al., 2003).
- It is estimated that 71% of patients with stable angina referred to a cardiologist come from General Practitioners (Scholes and Mindell, 2018).

140. Rapid Access Chest Pain clinics were instigated in 2000 as part of the National Service Framework for Coronary Heart Disease, (Department of Health, 2000) and are established in nearly all acute trusts in England, Wales, Scotland and Northern Ireland. The Rapid Access Chest Pain clinic is a hospital out-patient service that aims to remove the delay in the specialist assessment of patients with recent onset chest pain and to distinguish those people with

angina from those with other causes of chest pain. It aims to deliver this for each patient within two weeks of referral from their General Practitioner.

140.1 At a Rapid Access Chest Pain Clinic a patient with recent onset chest pain will, in addition to a history and an examination, receive any of the following, which will be determined by the patient's probability of having angina, and the facilities available at the hospital that they are attending the Rapid Access Chest Pain Clinic:

- exercise tolerance test;
- CT cardiac angiogram;
- stress echocardiogram;
- myocardial perfusion scan;
- cardiac magnetic resonance imaging scan; and
- invasive coronary angiography.

140.2 An evaluation of 11,782 patients who attended a Rapid Access Chest Pain clinic in one of six centres between 1996 and 2002 in England found that the service effectively identified patients at increased risk, but failed to correctly diagnose all patients, and that there was variation in the use of specialist investigations (Sekhri et al., 2006).

140.3 An evaluation of Rapid Access Chest Pain Clinic service at a single site between 2012 and 2015 which included data for 1634 referrals found that the agreement between the General Practitioner and the Cardiologist in the typicality of angina was poor, with the General Practitioner overestimating the pre-test probability of angina (Batty and Haq, 2016).

140.4 A prospective evaluation of a Rapid Access Chest Pain Clinic in Northern Ireland between 1999 and 2000 found it offered a prompt, safe and cost-effective service (Dougan et al., 2001).

140.5 An evaluation of Rapid Access Chest Pain Clinic services in two Scottish teaching hospitals from 1996 found that it provided an effective tool for the early assessment of patients with possible angina (Byrne et al. 2002).

140.6 Rapid Access Chest Pain Clinic services were conceived and implemented because at the time (circa 2000) there was a critical need for better care and improved clinical outcomes for people at risk of and with ischaemic heart disease. Since then there have been new treatments and operations for ischaemic heart disease and its prevention that have seen substantial improvements in outcomes. Of over 12,000 patients referred to a Rapid Access Chest Pain Clinic at a single centre in London between 2002 and 2011 about 80% of them had a cardiac cause for their chest pain (Debney and Fox, 2012). Nowadays, the diagnostic yield of angina from Rapid Access Chest Pain Clinics is likely to be lower than this. Moreover, a study of 456 patients referred to the Rapid Access Chest Pain Clinic at York Hospital in England in 2007 found that 52% did not have chest pain, suggesting that the clinical service may not be being used effectively (Dumville et al., 2007). In essence, it is likely that Rapid Access Chest Pain Clinic services are an outdated model of care delivery for suspected chronic coronary syndromes.

140.7 By contrast, the evaluation of 1223 patients attending a combined Rapid Access Chest Pain, arrhythmia and Heart Failure Clinic at a single centre in London between 2002 and 2003 found evidence for improved diagnosis and risk stratification of patients at high risk of sudden cardiac death and those without significant cardiac disease at one year follow up (Tenkorang et al., 2006).

141. Once a diagnosis of angina has been confirmed, the patient will be offered advice about angina, lifestyle advice, and advice about reducing their cardiovascular risk (National Institute for Health and Care Excellence). A patient with angina will be prescribed aspirin and a statin to reduce their risk of ischaemic events (secondary prevention), and sublingual glyceryl trinitrate. They will also receive medications to reduce the symptoms of angina, such as beta blockers, calcium channel blockers, isosorbide mononitrate, nicorandil, ivabradine and ranolozine. Patients with co-existing diabetes mellitus, heart failure, asymptomatic left ventricular dysfunction, chronic kidney disease or previous acute myocardial infarction will also be prescribed an angiotensin converting enzyme inhibitor unless this is contraindicated or not tolerated.

142. Optimal drug treatment for angina consists of one or two anti-anginal drugs as necessary plus drugs for secondary prevention of cardiovascular disease (National Institute for Health and Care Excellence, 2011). It is recommended that a third medication is prescribed only when the patient's symptoms are not satisfactorily controlled with two anti-anginal drugs and they are waiting for revascularisation or that revascularisation is not considered appropriate or acceptable.

143. It is recommended that a patient with a new diagnosis of angina is reviewed two to four weeks after starting or changing medications (National Institute for Health and Care Excellence). This is to ascertain their response to the treatment and to adjust the medications to the maximum licensed or tolerated doses. At this review, typically undertaken by the General Practitioner, the patient will also check the patient's blood pressure and heart rate, they will be assessed for signs of heart failure, screened for low mood or depression, and checked for compliance to medications.

144. If a patient with angina is not responding to medications, or they have side effects or complications with medications they will be re-referred to the hospital cardiology outpatient services for evaluation. There they may have their medications changed and receive new investigations which may include invasive coronary angiography.

- Invasive coronary angiography is offered to guide the treatment strategy in patients whose angina is not controlled on optimal drug treatment (National Institute for Health and Care Excellence, 2011).

145. Coronary revascularisation (coronary artery bypass grafting surgery or PCI) is offered to people with stable angina whose symptoms are not satisfactorily controlled with optimal drug treatment (National Institute for Health and Care Excellence, 2011). If revascularisation is deemed appropriate, then the choice or the revascularisation strategy is determined by whether the alternative revascularisation strategy is not appropriate, as well as whether the patient has diabetes, is aged 65 years or over and has anatomically complex three-vessel disease with or without involvement of the left main stem. Such decisions are undertaken in the context of a multi-disciplinary team meeting involving cardiac surgeons and interventional cardiologists.

146. Patients with stable angina who are asymptomatic on optimal drug treatments and who have extensive ischaemia (left main stem or proximal three-vessel disease) identified on

investigation (exercise tolerance test, stress echocardiogram, myocardial perfusion scan, cardiac magnetic resonance imaging, and or CT coronary angiogram) and in whom coronary revascularisation is acceptable and appropriate can be considered for coronary angiography (National Institute for Health and Care Excellence, 2011).

147. Coronary artery bypass grafting surgery is considered for people with stable angina and suitable coronary anatomy whose symptoms are satisfactorily controlled with optimal drug treatment, and in whom coronary angiography indicates left main stem disease or proximal three-vessel disease (National Institute for Health and Care Excellence, 2011).

148. Chronic coronary syndromes are long–term health conditions. Typically, a patient with a chronic coronary syndrome can have long, stable periods. However, chronic coronary syndromes are a progressive disease state. A patient with a chronic coronary syndrome can become unstable and present as an acute coronary syndrome, usually due to an acute atherothrombotic event caused by plaque rupture or erosion (Knuuti et al., 2020).

149. With appropriate lifestyle modification, optimal drug treatments and intervention as appropriate, a patient with a chronic coronary syndrome can have a good prognosis and quality of life.

    149.1 Of 13,619 patients with angina from 3647 centres in 29 countries between 2003 and 2004 and treated according to best judgement and practices of their primary care physicians in the Reduction of Atherothrombosis for Continued Health (REACH) registry, the primary composite endpoint of cardiovascular death, myocardial infarction or stroke occurred in 16.3% at four years (Eisen et al., 2016). At four years that rate of myocardial infarction was 4.8%, stroke 5.4%, death from any cause 12.6%, cardiovascular death 8.4%, heart failure 11.0%, unstable angina 15.2%, cardiovascular hospitalisation 26.9% and coronary revascularisation 11.4%.

    149.2 Of 8,908 outpatients with coronary artery disease, those who reported greater physical limitation as measured using the Seattle Angina Questionnaire, had a higher risk of death at mean follow up of two years, which was 61% higher with moderate limitation, and 2.5-fold higher with the greatest limitation compared with no limitation (Mozaffarian et al., 2003).

Metrics used to measure performance

150. There are a number of metrics used to measure the performance of care for chronic coronary syndromes. These include the:

- National Institute for Health and Care Excellence sets Standards and Indicators (National Institute for Health and Care Excellence);
- National Audit of PCI Quality Improvement Metrics; and
- European Society of Cardiology Quality Indicators (Aktaa et al., 2022).

151. The National Institute for Health and Care Excellence Quality Standards for chronic coronary syndrome are:

- People with features of typical or atypical angina are offered 64-slice (or above) CT coronary angiography (National Institute for Health and Care Excellence, 2012a). Currently, there is no target.

- People with stable angina are offered a short-acting nitrate and either a beta-blocker or calcium-channel blocker as first-line treatment (National Institute for Health and Care Excellence, 2012b). Currently, there is no target.
- People with stable angina are prescribed a short-acting nitrate and one or two anti-anginal drugs as necessary, before revascularisation is considered (National Institute for Health and Care Excellence, 2012c). Currently, there is no target.
- People with stable angina who have had coronary angiography have their treatment options discussed by a multidisciplinary team if there is left main stem disease, anatomically complex three-vessel disease or doubt about the best method of revascularisation (National Institute for Health and Care Excellence, 2012d). Currently, there is no target.
- People with stable angina whose symptoms have not responded to treatment are offered a re-evaluation of their diagnosis and treatment (National Institute for Health and Care Excellence, 2012e). Currently, there is no target.

152. The National Institute for Health and Care Excellence Indicators for chronic coronary syndrome are the:

152.1 Percentage of patients with cardiovascular disease who are currently treated with a lipid lowering therapy (National Institute for Health and Care Excellence, 2022c). Currently, there is no target.

152.2 Percentage of patients with cardiovascular disease in whom the last recorded low density lipoprotein-cholesterol level (measured in the preceding 12 months) is 2.0 mmol per litre or less, or last recorded non- high density lipoprotein-cholesterol cholesterol level (measured in the preceding 12 months) is 2.6 mmol per litre or less, if low density lipoprotein-cholesterol is not recorded (National Institute for Health and Care Excellence, 2023d). Currently, there is no target.

152.3 Percentage of patients with coronary heart disease, stroke or transient ischemic attack, diabetes and/or chronic obstructive pulmonary disease who have influenza immunisation in the preceding 1 August and 31 March (National Institute for Health and Care Excellence, 2015c). Currently, there is no target.

152.4 Percentage of patients registered at the practice aged 65 years and over who have been diagnosed with one or more of the following conditions: coronary heart disease, heart failure, hypertension, diabetes, chronic kidney disease, peripheral artery disease, or stroke/transient ischaemic attach who have had a pulse rhythm assessment in the preceding 12 months (National Institute for Health and Care Excellence, 2017). Currently, there is no target.

152.5 Percentage of patients with one or more of the following conditions: coronary heart disease, atrial fibrillation, chronic heart failure, stroke or transient ischaemic attack, diabetes or dementia who have been screened for hazardous drinking using the FAST or AUDIT-C tool in the preceding two years (National Institute for Health and Care Excellence, 2024). Currently, there is no target.

152.6 Percentage of patients with one or more of the following conditions: coronary heart disease, atrial fibrillation, chronic heart failure, stroke or transient ischaemic attack, diabetes or dementia with a FAST score of 3 or more or AUDIT-C score of 5 or more in the preceding two years who have received brief intervention to help them reduce

their alcohol related risk within three months of the score being recorded (National Institute for Health and Care Excellence, 2019b). Currently, there is no target.

152.7 Percentage of patients aged 79 years or under with coronary heart disease in whom the last blood pressure reading (measured in the preceding 12 months) is less than 135/85 mmHg if using ambulatory or home monitoring, or less than 140/90 mmHg if monitored in clinic (National Institute for Health and Care Excellence, 2022a). Currently, there is no target.

152.8 Percentage of patients aged 80 years or over with coronary heart disease in whom the last blood pressure reading (measured in the preceding 12 months) is less than 145/85 mmHg if using ambulatory or home monitoring, or less than 150/90 mmHg if monitored in clinic (National Institute for Health and Care Excellence, 2022b). Currently, there is no target.

152.9 General Practice establishes and maintains a register of patients with coronary heart disease (National Institute for Health and Care Excellence, 2023b). Currently, there is no target.

152.10 Percentage of patients with coronary heart disease who have had influenza immunisation in the preceding 1st August to 31st March (National Institute for Health and Care Excellence, 2015a). Currently, there is no target.

152.11 Percentage of patients with coronary heart disease with a record in the preceding 12 months that aspirin, an alternative anti-platelet therapy, or an anti-coagulant is being taken (National Institute for Health and Care Excellence, 2015b). Currently, there is no target.

153. The National Institute for Health and Care Excellence Quality Outcomes Framework Indicators for chronic coronary syndrome are the:

153.1 General Practice establishes and maintains a register of patients with coronary heart disease (National Institute for Health and Care Excellence, 2023e). In 2023 there was no payment stage.

153.2 Percentage of patients with coronary heart disease with a record in the preceding 12 months that aspirin, an alternative anti-platelet therapy, or an anti-coagulant is being taken (National Institute for Health and Care Excellence, 2023e). In 2023 the payment stage was 56% to 96%.

153.3 Percentage of patients aged 79 years or under with coronary heart disease in whom the last blood pressure reading (measured in the preceding 12 months) is 140/90 mmHg or less (National Institute for Health and Care Excellence, 2023e). In 2023 the payment stage was 40% to 77%.

153.4 Percentage of patients aged 80 years and over with coronary heart disease in whom the last blood pressure reading (measured in the preceding 12 months) is 150/90 mmHg or less (National Institute for Health and Care Excellence, 2023e). In 2023 the payment stage was 46% to 86%.

153.5 Percentage of patients with any or any combination of the following conditions: coronary heart disease, peripheral artery disease, stroke or transient ischaemic attack, hypertension, diabetes, chronic obstructive pulmonary disease, chronic kidney disease, asthma, schizophrenia, bipolar affective disorder or other psychoses

whose notes record smoking status in the preceding 12 months (National Institute for Health and Care Excellence, 2023e). In 2023 the payment stage was 50% to 90%; and

153.6 Percentage of patients with any or any combination of the following conditions: coronary heart disease, peripheral artery disease, stroke or transient ischaemic attack, hypertension, diabetes, chronic obstructive pulmonary disease, chronic kidney disease, asthma, schizophrenia, bipolar affective disorder or other psychoses who are recorded as current smokers who have a record of an offer of support and treatment within the preceding 12 months (National Institute for Health and Care Excellence, 2023e). In 2023 the payment stage was 56% to 96%.

154. The payment stage means the threshold at which a General Practice will be remunerated for clinical activity (NHS England and NHS Improvement, 2022). In 2022/23 the size of the Quality Outcomes Framework stayed the same at 635 points; the value of a Quality Outcomes Framework point was £207.56.

155. In 2021, the additional National Audit of PCI Quality Improvement Metric as reported in the National Audit of PCI Annual Report (National Cardiac Audit Programme, 2021) that is solely relevant to chronic coronary syndromes is the:

- proportion of patients treated by PCI for stable symptoms who are treated as a day case. The standard is over 75% of cases of PCI for stable symptoms should be delivered as days cases.

Other Quality Improvement Metrics for chronic coronary syndrome are provided in the publicly available British Cardiovascular Society Coronary and Structural Audit (Society, 2022).

156. Presently, there is no two week target (or metric) for the duration of time between referral from a General Practitioner to being seen at a Rapid Access Chest Pain clinic.

Summary

157. Chronic coronary syndromes encompass a spectrum of non-emergency suspected or established ischaemic heart disease conditions.

158. The classical chronic presentation of ischaemic heart disease is with angina.

159. Angina is common in the UK and its occurrence increases with increasing age. It is a common reason why patients see their General Practitioner.

160. Although there is an increased risk of death with chronic coronary syndrome this is small. Angina is more typically associated with symptoms and therefore reduced quality of life.

161. Medications and coronary revascularisation are used to reduce the symptoms of angina. There are clinical guidelines about how to treat chronic coronary syndromes.

162. There are many indicators of and targets for quality that many be used to assess the provision of clinical care and outcomes for chronic coronary syndromes. These targets have been developed and are recognised by regulators and specialist clinical societies for this purpose. Routine NHS administrative, primary care and clinical registry data may be used to assess this performance.

III - Prevention of ischaemic heart disease

163. In the NHS there are clinical services to identify risk factors for ischaemic heart disease that can be controlled and can be considered modifiable (high blood pressure, high blood fat, diabetes, smoking, unhealthy diet, obese and overweight, low levels of exercise). These services are similar across the devolved nations.

164. In England the mechanism for the identification and improvement of ischaemic heart disease risk factors is via the NHS Health Check, which is a cardiovascular risk assessment programme undertaken in primary care. People aged 40 to 74 years and who do not have a pre-existing health condition are invited to a NHS Health Check by their General Practitioner of local council every five years (NHS, 2023). The NHS Health Check includes an assessment of:

- cardiovascular risk;
- alcohol consumption;
- physical activity;
- cholesterol level;
- body mass index;
- dementia in those aged 65 years to 74 years; and
- screening for diabetes mellitus and chronic kidney disease in those at increased risk of developing these conditions.

165. Currently, the UK National Screening Committee does not recommend screening for vascular disease (UK National Screening Committee, 2007).

165.1 An analysis of 9,694,979 individuals aged 40 to 74 years offered a NHS Health Check in England between 2012 and 2017 found that 52% took up the offer (Patel et al., 2020).

165.2 In 2022/23, 38.9% of people took up a NHS Health Check invite per year, and 5.6% of the total eligible population were offered and NHS Health Check (Office for Health Improvement & Disparities, 2024d).

166. In Scotland the Keep Well programme used to invite individuals aged between 40 and 64 years living in areas of high deprivation to attend a health check. The checks included screening for cardiovascular disease and its main risk factors, such as high blood pressure, cholesterol, smoking, and unhealthy diet (Public Health Scotland, 2023b).

167. Across Great Britain, ischaemic heart disease risk factors are detected in primary care using mechanisms such as the:

- Quality of Outcomes Framework (QOF) in England; (NHS England, 2023)
- Quality Assurance and Improvement Framework (QAIF) in Wales; (Welsh Government, 2019) and
- Transitional Quality Arrangements (TQA) Framework in Scotland (Scottish Government, 2017).

168. QRISK3 is a prediction algorithm for 10-year risk of cardiovascular disease (Hippisley-Cox et al., 2017).

    168.1 The National Institute for Health and Care Excellence recommends that a person's 10-year cardiovascular risk should be assessed using the QRISK assessment tool every five years (apart from people who already have cardiovascular disease or are at high risk of developing it, or people aged 85 years or over (National Institute for Health and Care Excellence, 2023c).

    168.2 Generally speaking, adults aged 40 years and over with an elevated QRISK3 score of more than 10% (which may be embedded within primary care electronic health records and uses multiple variables [including blood fat levels, age, body mass index and other comorbidities] to predict the risk of a person experiencing a stroke or heart attack in the next 10 years), or with an elevated lifetime risk of ischaemic heart disease (that is, the presence of one or more risk factors [high blood pressure, high blood fat, smoking, obesity, family history in a first degree relative of premature ischaemic heart disease]) should be offered a cardioprotective diet (reduction of saturated fat intake), advice to do aerobic and muscle-strengthening activities, keep drinking alcohol at a low level, smoking cessation, and should be offered high-intensity statin treatment (National Institute for Health and Care Excellence, 2023c).

169. In Scotland, the cardiovascular risk prediction tool is called the ASSIGN score, which is endorsed by the Scottish Intelligence Guidelines Network and Scottish Government Health Directive (Assign Score, 2014).

170. It should be noted that many risk factors for cardiovascular disease do not occur in isolation. Risk factors for cardiovascular disease often co-exist in clusters for an individual, e.g. high blood pressure, high blood fat and diabetes (Williams et al., 2018).

Blood pressure

171. Hypertension is common in the UK population, and is a modifiable risk factor for ischaemic heart disease (Lay-Flurrie et al., 2020).

    171.1 According to the Quality and outcomes Framework, in 2022/2023 the prevalence of hypertension in England across all ages was 14.4% (Office for Health Improvement and Disparities, 2023b).

    171.2 According to the CVDPREVENT report of over 15 million people in England, the pre-pandemic (pre-March 2020) baseline prevalence of hypertension in adults was 16.4%, with no difference in prevalence rates between men and women) (CVDPREVENT, 2020). The prevalence was 58.0% in people aged over 80 years. After age adjustment hypertension prevalence was 3.4% higher in the most deprived quintile in England compared to the least deprived quintile.

    171.3 According to the Quality Assurance and Improvement Framework (QAIF) disease registers in 2021/22 the prevalence of hypertension in Wales was 15.7% (StatsWales, 2023).

    171.4 According to the Scottish Health Survey 2019 in 2018/19 the prevalence of hypertension in adults in Scotland was 29% (Scottish Government, 2020b).

    171.5 According to the General Practice Intelligence Platform in 2023 the prevalence of hypertension in Northern Ireland was 14.1% (Information Analysis Directorate, 2023).

172. Blood pressure is measured using a blood pressure cuff, either with an automated device or with concurrent auscultation of the brachial (arm) artery. It is reported as systolic blood pressure (blood pressure during contraction of the heart) over diastolic blood pressure (blood pressure during relation of the heart) in millimetres of mercury e.g. 130 / 70 mmHg.

    172.1 The National Institute of Health and Care Excellence recommends that high blood pressure is diagnosed in clinic if a blood pressure is greater than 140/90mmHg on at least two measurements (National Institute for Health and Care Excellence, 2019a). If the measurement is between 140/90mmHg and 180/120mmHg then ambulatory blood pressure monitoring or (if not suitable or tolerated) home blood pressure monitoring should be offered to confirm the diagnosis (if average value is 135/85mmHg).

    172.2 The National Institute of Health and Care Excellence recommends a formal estimation of cardiovascular risk should be offered for patients with high blood pressure (National Institute for Health and Care Excellence, 2019a). This is conducted using the QRISK3 tool.

    172.3 The National Institute of Health and Care Excellence recommends that all patients with high blood pressure should be offered testing for the presence of protein in the urine by sending a urine sample for estimation of the albumin: creatinine ratio, and testing for blood in the urine (haematuria), blood tests for diabetes, kidney function, and blood fats, examination of the back of the eye to look for changes of high blood pressure-related eye disease, and a 12-lead electrocardiograph to look for electrical evidence of abnormalities of the heart (National Institute for Health and Care Excellence, 2019a).

    172.4 There are different stages of blood pressure to reflect the severity of abnormality in blood pressure reading from what is considered a healthy level (National Institute for Health and Care Excellence, 2019a).

173. The National Institute of Health and Care Excellence recommends that lifestyle advice should be offered to all people with high blood pressure, and continued to be offered periodically (National Institute for Health and Care Excellence, 2019a). This includes advice on healthy diet, regular exercise, avoidance of excess alcohol consumption, discouragement of excess caffeine consumption, keeping of dietary sodium intake low, and cessation of smoking.

174. After lifestyle therapy, the National Institute of Health and Care Excellence recommends that patients aged under 80 years with stage 1 high blood pressure (up to 160mmHg when measured in clinic) should be offered medications to reduce their blood pressure if there is evidence of damage to body organs (heart, brain, kidneys, eyes), they are known to have heart disease or kidney disease or diabetes, or they have a QRISK score of 10% or higher (National Institute for Health and Care Excellence, 2019a). Patients aged under 60 years can also be offered medications to reduce their blood pressure even if their QRISK score is less than 10% because they have a higher lifetime probability of developing cardiovascular disease (National Institute for Health and Care Excellence, 2019a).

175. The National Institute of Health and Care Excellence recommends to control blood pressure measured in clinic to below 140/90 mmHg (or below 150/90 mmHg if the patient is aged 80 years or over) (National Institute for Health and Care Excellence, 2019a). For those who are monitored using ambulatory or home blood pressure monitoring the targets are 135/85 mmHg for those aged under 80 years and 145/85 mmHg for those aged 80 years or over.

176. For high blood pressure, medications include, on their own or in combination, angiotensin converting enzyme inhibitors, angiotensin II receptor antagonists, calcium channel blockers, thiazide-like diuretics, and in some cases, spironolactone and alpha-blockers or beta-blockers (National Institute for Health and Care Excellence, 2019a).

177. It is aimed that patients with high blood pressure should have an annual review to monitor their blood pressure, and discuss lifestyle, symptoms and medication (National Institute for Health and Care Excellence, 2019a).

    177.1 Data from the Office for Health Improvement and Disparities suggests that, of patients with hypertension, 79.0% have had a blood pressure check in the last 12 months, 65.7% of patients aged less than 80 years have reached a target blood pressure of equal to or lower than 140/90 mmHg, and 79.4% of patients aged 80 years or over have reached target blood pressure of equal to or lower than 150/90 mmHg (Office for Health Improvement and Disparities, 2023b).

    177.2 According to the CVDPREVENT report of over 15 million people in England, the pre-pandemic (pre-March 2020) for those aged 18 years to 79 years and had a diagnosis of hypertension, 67.5% were treated to the NICE guideline target of equal to or less than 140/90 mmHg (in whom the last blood pressure reading was within the preceding 12 months (CVDPREVENT, 2020). For those aged 80 years or over, 81.6% were treated to target.

    177.3 According to the 2024 British Heart Foundation Factsheet, high blood pressure is the leading modifiable risk factor for heart and circulatory diseases in Wales, that around 700,000 adults in Wales have high blood pressure, and around 520,000 people in Wales are on their GP's hypertension register, suggesting that as many as 180,000 could be undiagnosed (British Heart Foundation Cymru, 2024).

    177.4 According to the 2024 British Heart Foundation Factsheet, high blood pressure is the leading modifiable risk factor for heart and circulatory diseases in Scotland, that around 1,300,000 adults in Scotland have high blood pressure, and around 790,000 people in Scotland are on their GP's hypertension register, suggesting that as many as 500,000 could be undiagnosed (British Heart Foundation, 2024e).

    177.5 According to the 2024 British Heart Foundation Factsheet, high blood pressure is the leading modifiable risk factor for heart and circulatory diseases in Northern Ireland, that around 400,000 adults in Northern Ireland have high blood pressure, and around 290,000 people in Northern Ireland are on their GP's hypertension register, suggesting that as many as 110,000 could be undiagnosed (British Heart Foundation Northern Ireland, 2024).

Cholesterol

178. Evidence confirms that the key initiating event in narrowing of coronary arteries is the retention of low-density lipoprotein cholesterol and other cholesterol-rich lipoproteins (proteins and fat combined) within the wall of the artery (Mach et al., 2020). High blood fat levels are common in the UK population, and are a modifiable risk factor for ischaemic heart disease (Morgan et al., 2022).

    178.1 According to the CVDPREVENT report of over 15 million people in England, the pre-pandemic (pre-March 2020) baseline prevalence of high cholesterol was not

available because prevalence indicators for high cholesterol were not a recorded condition in the Quality Outcomes Framework (CVDPREVENT, 2020).

178.2 Randomised clinical trials show that reduction in low density lipoprotein cholesterol using medications reduces the risk of ischaemic heart disease, heart attacks, and strokes (Visseren et al., 2022).

178.3 Total cholesterol is an important predictor of myocardial infarction. However, non-high density lipoprotein cholesterol - the difference between total and high density lipoprotein cholesterol - is a powerful risk factor (National Institute for Health and Care Excellence, 2023a). Accordingly, non-high density lipoprotein cholesterol has replaced low-density lipoprotein cholesterol as the primary target for reducing cardiovascular risk with lipid-modifying treatment.

178.4 A raised triglyceride level is a risk factor for cardiovascular disease and is independent of the risk associated with total cholesterol (National Institute for Health and Care Excellence, 2023a).

179. Decisions on treatment to reduce blood fat depend on the assessment of the patient's cardiovascular risk, and is recommended on an ongoing basis from the age of 40 years and over (National Institute for Health and Care Excellence, 2023a).

179.1 The QRISK3 tool is recommended to estimate cardiovascular risk for people aged between 25 years and 84 years with diabetes or without known cardiovascular disease (National Institute for Health and Care Excellence, 2023c).

179.2 Risk is accepted to be high in those with type I diabetes, those with chronic kidney disease, and those with familial hypercholesterolaemia (an inherited disorder associated with very high levels of low density lipoprotein-cholesterol) (National Institute for Health and Care Excellence, 2023c).

179.3 People over the age of 85 years are considered to be at increased risk of ischaemic heart disease because of age alone (National Institute for Health and Care Excellence, 2023c).

180. The National Institute of Health and Care Excellence recommends to measure both total cholesterol and high density lipoprotein cholesterol to achieve the best estimate of cardiovascular disease risk (National Institute for Health and Care Excellence, 2023c).

181. Before prescribing a statin for primary prevention of ischaemic heart disease it is recommended to try to optimise lifestyle and modify of other risk factors (National Institute for Health and Care Excellence, 2023c).

181.1 The aim of treatment with statins is to achieve a greater than 40% reduction in non-high density lipoprotein cholesterol levels (National Institute for Health and Care Excellence, 2023c).

181.2 According to National Institute of Health and Care Excellence guidelines, for primary prevention of ischaemic heart disease, statin treatment (atorvastatin 20 mg daily) should be offered to people aged under 85 years if their estimated 10-year risk of developing cardiovascular disease using the QRISK3 assessment tool is 10% or more (National Institute for Health and Care Excellence, 2023c).

181.3 For patients with type 1 diabetes, they can be offered treatment with statins if they are either aged 40 years or over, or have been diabetic for 10 years or more, or have

established nephropathy (kidney disease), or have other risk factors for ischaemic heart disease (National Institute for Health and Care Excellence, 2023c).

181.4 It is also recommended to offer statin treatment to people with chronic kidney disease or familial hypercholesterolaemia (National Institute for Health and Care Excellence, 2023c).

182. The National Institute of Health and Care Excellence guidelines recommend to measure the full lipid profile at two to three months after starting or changing lipid-lowering treatment. Patients on lipid-lowering medication should be offered an annual review and annual full lipid profile to inform these discussions (National Institute for Health and Care Excellence, 2023c).

183. Data from the Office for Health Improvement and Disparities demonstrates that in 2021, 71.6% of patients with diabetes aged over 40 years in England were treated with a statin (Office for Health Improvement and Disparities, 2023a).

184. Data from the Office for Health Improvement and Disparities demonstrates that, in 2018/2019, 81.8% of patients with type 1 diabetes in England received a cholesterol check, 92.8% of patients with type 2 diabetes received a cholesterol check, 73.1% of patients with type 1 diabetes achieved a cholesterol value of less than 5 mmol/L, and 78.4% of patients with type 2 diabetes achieved a cholesterol value of less than 5 mmol/L (Office for Health Improvement and Disparities, 2024c).

185. Data from all 8,142 standard NHS general practices in England up to March 2019 demonstrated that 45% of patients prescribed a statin had not reached the recommended 40% reduction in low density lipoprotein-cholesterol (Curtis et al., 2020).

Diabetes

186. Diabetes mellitus is prevalent in the UK population, and is a modifiable risk factor for ischaemic heart disease (Whicher et al., 2020).

186.1 Broadly speaking, diabetes mellitus is divided into two main types (Diabetes UK, 2024). Type 2 diabetes is the most common type. It is high blood sugar levels due to your body not making enough of a hormone called insulin, or, what it does make not working properly - known as insulin resistance. Anyone can develop type 2 diabetes, but it mostly affects people over the age of 25 and more so if there is a family history of type 2 diabetes. Type 1 diabetes is when blood sugar levels are too high because the body cannot make a hormone called insulin. This is less common, the exact cause is unknown, and is often diagnosed in childhood.

186.2 Data from the Office for Health Improvement and Disparities shows that the prevalence of diabetes in people aged 17 years and over in 2021/2022 was 7.3% (Office for Health Improvement and Disparities, 2024a).

186.3 According to the 2024 British Heart Foundation Factsheet, over 210,000 adults in Wales have been diagnosed with diabetes, around 90% of those diagnosed are living with type 2 diabetes and 10% have either type 1 or rarer types, and it is estimated that thousands of people across Northern Ireland are likely to have undiagnosed type 2 diabetes (British Heart Foundation Cymru, 2024).

186.4 According to the 2024 British Heart Foundation Factsheet, over 330,000 adults in Scotland have been diagnosed with diabetes, around 90% of those diagnosed are living with type 2 diabetes and 10% have either type 1 or rarer types, and it is

estimated that prevalence rates for diabetes in the most deprived areas of Scotland are nearly twice as high as those in the least deprived (British Heart Foundation, 2024e).

186.5 According to the 2024 British Heart Foundation Factsheet, over 110,000 adults in Northern Ireland have been diagnosed with diabetes, around 90% of those diagnosed are living with type 2 diabetes and 10% have either type 1 or rarer types, and it is estimated that thousands of people across Northern Ireland are likely to have undiagnosed type 2 diabetes (British Heart Foundation Northern Ireland, 2024).

186.6 People with type 2 diabetes are at a two- to four-fold higher risk of ischaemic heart disease (Marx et al., 2023).

187. The National Institute of Health and Care Excellence guidelines recommend that all patients with type 2 diabetes should be advised to follow a healthy lifestyle (National Institute for Health and Care Excellence, 2015d). This includes:

- being active;
- losing weight if the patient is overweight (by 5% to 10% initially);
- getting enough exercise;
- having a healthy diet (eating carbohydrates from fruit, vegetables, whole grains, and pulses, eating low fat dairy products and oily fish; and limiting intake of saturated fats and trans fatty acids);
- not smoking; and
- controlling alcohol intake.

188. The National Institute of Health and Care Excellence guidelines recommends that the target HbA1c (a measure of the amount of glucose in the blood over a long period of time) is 48 mmol/mol for those who control their diabetes with lifestyle (National Institute for Health and Care Excellence, 2015d).

188.1 For those who use glucose-lowering medications, the National Institute of Health and Care Excellence recommends a HbA1c target of 53mmol/mol (National Institute for Health and Care Excellence, 2015d).

188.2 It is recommended to measure HbA1c levels every three to six months until HbA1c is stable on unchanging therapy, and every six months once the HBA1c level and blood glucose lowering therapy are stable (National Institute for Health and Care Excellence, 2015d).

189. The first line medication for the treatment of diabetes is metformin. For those who are unable to tolerate metformin other medications include a DPP-4 inhibitor, pioglitazone, a sulphonylurea, or an SGLT2 inhibitor (National Institute for Health and Care Excellence, 2015d).

190. For patients with type I diabetes who are aged under 80 years it is recommended to control blood pressure to less than 140/90 mmHg if the urine albumin to creatinine ratio is less than 70 mg/mmol (protein in urine) and to less than 130/80 mmHg if the urine albumin to creatinine ratio is 70 mg/mmol or above. For those aged 80 years and over with type 1 diabetes the blood

pressure target is less than 150/90 mmHg (National Institute for Health and Care Excellence, 2019a).

190.1 Data from the Office for Health Improvement and Disparities demonstrates that in 2020/21, of patients with type 2 diabetes, 31.5% achieved a HBA1c <48 mmol/mol, and 66.7% achieved a blood pressure of equal to or less than 140/90 mmHg (Office for Health Improvement and Disparities, 2024a).

Smoking

191. Smoking is prevalent in the UK population and is a modifiable risk factor for ischaemic heart disease, which presents earlier in smokers than non-smokers (Visseren et al., 2022).

191.1 According to data from the Office for Health Improvement and Disparities in 2020 in England 14.3% of people were active (regular or occasional) smokers, and in 2021 the prevalence of regular smokers was 3% (Office for Health Improvement and Disparities, 2024b).

191.2 According to the 2024 British Heart Foundation Factsheet, at least 320,000 (13%) of adults in Wales smoke cigarettes and over 1,000 Welsh deaths from heart and circulatory diseases can be attributed to smoking each year (British Heart Foundation Cymru, 2024).

191.3 According to the 2024 British Heart Foundation Factsheet, at least 670,000 (15%) of adults in Scotland smoke cigarettes and over 2,000 Scottish deaths from heart and circulatory diseases can be attributed to smoking each year (British Heart Foundation, 2024e).

191.4 According to the 2024 British Heart Foundation Factsheet, at least 210,000 (14%) of adults in Northern Ireland smoke cigarettes and over 2,300 Northern Irish deaths from heart and circulatory diseases can be attributed to smoking each year (British Heart Foundation Northern Ireland, 2024).

192. The National Institute of Health and Care Excellence recommends asking people at every opportunity if they smoke or have smoked (National Institute for Health and Care Excellence, 2021).

192.1 If the patient smokes the National Institute of Health and Care Excellence recommends advising them to stop smoking and to inform them of stop smoking support, and nicotine containing products for general sale (National Institute for Health and Care Excellence, 2021).

192.2 Medications and behavioural support can be offered to people who are willing to stop smoking.

193. Data from the Office for Health Improvement and Disparities demonstrates that in 2020/21 91.9% of smokers aged 15 years and over were offered support or treatment to stop smoking. According to the same data sources, the pre-pandemic (2019/2020) rate was 89.7% (Office for Health Improvement and Disparities, 2024b).

Diet and physical activity

194. Unhealthy diets are common in the UK population, and are a modifiable risk factor for ischaemic heart disease (Gao et al., 2021).

194.1 The Public Health England National Diet and Nutrition Survey found that in 2016-2019, saturated fatty acids (saturated fat) intake exceeded the government recommendation of no more than 10% of total energy in all age groups to whom the recommendation applied (Public Health England, 2020). Mean intake was 12.3% for adults aged 19 to 64 years and 13.3% for adults aged 65 years and over. The Survey also found that fibre intake was below the government recommendations for all age groups.

195. The National Institute of Health and Care Excellence recommends giving advice on healthy eating as part of lifestyle changes.

195.1 Specifically for a cardioprotective diet the National Institute of Health and Care Excellence recommends to advise a diet in which total fat intake is 30% or less of total energy intake, saturated fats are 7% or less, or total energy intake, and, where possible, saturated fats are replaced by non-unsaturated (e.g. olive oil) and polyunsaturated fats (National Institute for Health and Care Excellence, 2023a).

196. Overweight and obesity are prevalent in the UK population and are modifiable risk factors for ischaemic heart disease (Keaver et al., 2020).

196.1 The Health Survey for England 2021 estimates that a quarter of adults in England are obese and a further third of adults in England are overweight but not obese (NHS Digital, 2021a).

196.2 According to the 2024 British Heart Foundation Factsheet, at least 26% of adults in Wales have obesity, 35% of adults in Wales are defined as being overweight, and around one in five heart and circulatory disease deaths in Wales are associated with a high body-mass index (British Heart Foundation Cymru, 2024).

196.3 According to the 2024 British Heart Foundation Factsheet, at least 29% of adults in Scotland have obesity, 38% of adults in Scotland are defined as being overweight, and around one in five heart and circulatory disease deaths in Scotland are associated with a high body-mass index (British Heart Foundation, 2024e).

196.4 According to the 2024 British Heart Foundation Factsheet, at least 27% of adults in Northern Ireland have obesity, 38% of adults in Northern Ireland are defined as being overweight, and around one in six heart and circulatory disease deaths in Northern Ireland are associated with a high body-mass index (British Heart Foundation Northern Ireland, 2024).

197. Lifestyle therapy to improve eating behaviour and physical activity is recommended in all overweight and obese individuals and can be administered through behavioural interventions. There are also mediation and surgical treatments for obesity (National Institute for Health and Care Excellence, 2014b).

198. Data from the Office for Health Improvement and Disparities shows that, in 2020/21, 72.8% of patients with type 2 diabetes and 67.5% with type 1 diabetes had their body mass index recorded. There are no data provided before this date (Office for Health Improvement and Disparities, 2024a).

199. For low levels of exercise (physical activity) the National Institute of Health and Care Excellence recommends aerobic and muscle-strengthening activities in line with the UK Chief Medical Officers' physical activity guidelines (National Institute for Health and Care Excellence, 2023a).

Secondary prevention

200. Secondary prevention aims to prevent complications or reduce impact, and to prevent further cardiovascular events in patients with ischaemic heart disease (Visseren et al., 2022).

200.1 Secondary prevention includes cardiac rehabilitation, addressing relevant lifestyle risk-factors, and drug treatment (Visseren et al., 2022).

200.2 Lifestyle changes that can reduce the risk of having further heart attack or other cardiovascular events following a heart attack include smoking cessation, a healthy diet, aiming to be moderately physically active for at least 150 minutes per week, losing weight if overweight or obese, keeping alcohol consumption within recommended limits (Visseren et al., 2022).

200.3 The National Institute for Health and Care Excellence recommends that all people who have had an acute coronary syndrome should be given advice about, and offered, a cardiac rehabilitation programme with an exercise component (National Institute for Health and Care Excellence, 2020b). This should start as soon as possible, and should normally be initiated in hospital before discharge.

200.4 After an acute coronary syndrome, the patient should be prescribed (provided there are no contraindications) an angiotensin converting enzyme inhibitor, a beta-blocker, a statin and dual antiplatelet therapy to reduce the risk of a further acute coronary syndrome (National Institute for Health and Care Excellence, 2020a).

200.5 The National Institute for Health and Care Excellence recommends for secondary prevention of ischaemic heart disease that a high-intensity statin treatment (atorvastatin 80 mg daily) should be prescribed. If a 40% reduction in non-high density lipoprotein-cholesterol is not achieved on the highest dose statin then ezetimibe can be co-administered (National Institute for Health and Care Excellence, 2020b).

200.6 The National Institute for Health and Care Excellence recommends to consider offering icosapent ethyl for people at high risk of cardiovascular events and raised fasting triglycerides (1.7 mmol/L or above) who are already taking a statin (National Institute for Health and Care Excellence, 2020b, Excellence, 2023).

200.7 The National Institute for Health and Care Excellence recommends to consider inclisiran as an option for treating primary hypercholesterolaemia or mixed dyslipidaemia as an adjunct for secondary prevention if low density lipoprotein-cholesterol concentrations are persistently ≥2.6 mmol/l, despite maximum tolerated lipid-lowering therapy (maximum tolerated statins with or without other lipid-lowering therapies or, other lipid-lowering therapies when statins are not tolerated or are contraindicated) (National Institute for Health and Care Excellence, 2020b, Excellence, 2023).

200.8 Secondary care treatment options may include a protein convertase subtilisin/kexin type 9 (PCSK9) inhibitor (alirocumab or evolocumab), alone or in combination with a statin and/or other lipid-lowering drugs for people with primary non-familial hypercholesterolaemia or mixed dyslipidaemia for secondary prevention if low density lipoprotein-cholesterol level is persistently ≥4.0 mmol/L and they are considered high risk, or low density lipoprotein-cholesterol level is persistently ≥3.5

mmol/L and they are considered very high risk (National Institute for Health and Care Excellence, 2020b, Excellence, 2023).

200.9 For patients with diabetes SGLT2 inhibitors are recommended for secondary prevention in those with known ischaemic heart disease (National Institute for Health and Care Excellence, 2015d).

201. Data from the Office for Health Improvement and Disparities demonstrates that, in 2022/23, 83.6% of patients with diabetes and a history of cardiovascular disease were treated with a statin (Office for Health Improvement and Disparities, 2024a).

Summary

202. The prevalence of risk factors for ischaemic heart disease is high in the UK.

203. The National Institute for Health and Care Excellence provides comprehensive recommendations about the treatment of risk factors for ischaemic heart disease in the UK.

The impact of the Covid-19 pandemic on ischaemic heart disease

Preface

204. This section provides evidence from the published literature and expert opinion about the impact of the Covid-19 pandemic on ischaemic heart disease. This is described for each of acute coronary syndromes, chronic coronary syndromes and the prevention of ischaemic heart disease.

205. For acute coronary syndrome, details are provided about the numbers of admissions to hospital and the numbers of deaths.

206. The pandemic substantially disrupted access to and caused delays to primary and secondary care, prevention, diagnosis, treatments, and follow-up healthcare for people with ischaemic heart disease.

207. There is a difference in the breadth and the depth of published information available for acute coronary syndromes compared with the more limited published information available for chronic coronary syndromes and the prevention of ischaemic heart disease.

208. There is more published information available for England compared with the devolved nations.

209. The majority of information about the impact of the Covid-19 pandemic on acute coronary syndromes was grounded in routinely collected structured clinical and administrative data for England with analyses undertaken by academic institutions. At the time, there was no formal, 'tried and tested' system or dedicated organisation in place to specifically undertake the rapid assimilation, linkage and curation of data, and its timely analysis and reporting. Moreover, the analyses of national clinical registry data undertaken by 'volunteers' cessed when access to data was terminated. Access to national administrative data was for the purpose of research, undertaken through the British Heart Foundation Data Science Centre and also delivered on a 'voluntary' basis.

210. Publications of the analysis of data for cardiovascular deaths and to a lesser extent admissions with acute coronary syndrome relate to the first wave of the pandemic.

I - Acute coronary syndrome

Admissions

211. A pivotal study that provides evidence for the impact of the Covid-19 pandemic on admissions to hospital with acute coronary syndrome in England was co-authored by Gale and published in The Lancet on 4th July 2020 (Mafham et al., 2020).

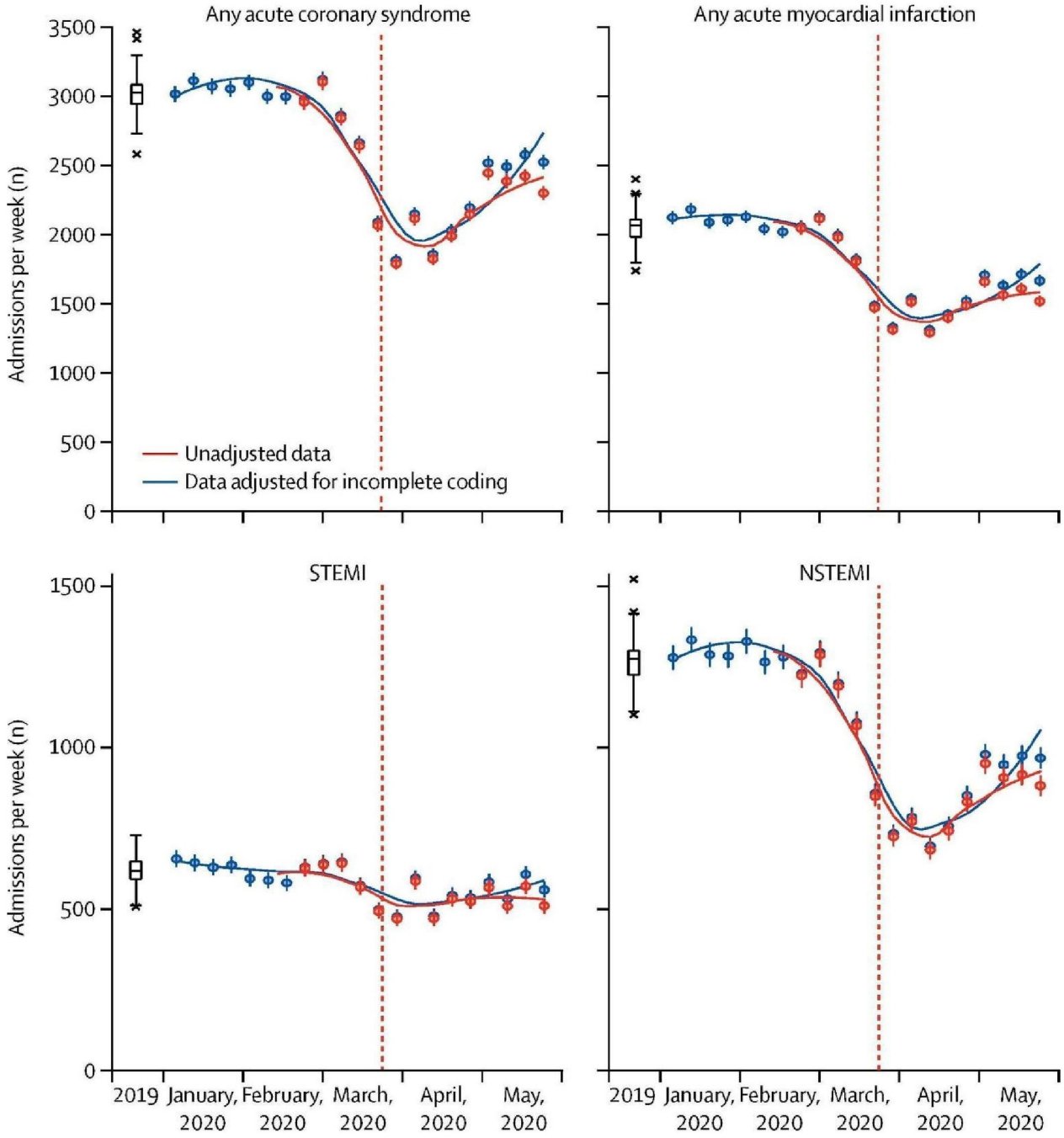
    211.1. The study used data from the Secondary Uses Service Admitted Patient Care database of England. The Secondary Uses Service Admitted Patient Care database of NHS Digital is an administrative database that is designed to provide anonymised patient-based data for purposes such as healthcare planning, commissioning of clinical services, public health, clinical audit and governance, benchmarking, performance improvement, medical research and national policy development. NHS

England has responsibility for delivering the Secondary Uses Service to users such as Commissioners and Providers of NHS funded care. The Secondary Uses Service Admitted Patient Care database was used because it is updated more rapidly than is the Hospital Episodes Statistics (HES) administrative database.

211.2. For the study, all episodes of care for patients admitted with acute coronary syndrome, defined using International Classification of Diseases 10th revision codes, to 147 acute NHS hospital trusts in England from Jan 1, 2019, to May 24, 2020, were identified in the Secondary Uses Service Admitted Patient Care database. Admissions were classified as STEMI, NSTEMI, myocardial infarction of unknown type, or other acute coronary syndromes (including unstable angina). Revascularisation procedures undertaken during these admissions (invasive coronary angiography without PCI, PCI and coronary artery bypass grafting surgery were identified. The numbers of weekly admissions and procedures undertaken were calculated.

211.3. The study found that between January 2020 and May 2020 there had been about 8,000 fewer admissions with acute coronary syndromes than would have been expected under normal circumstances. This included about 5,000 fewer admissions for acute myocardial infarction (Figure 1) (Mafham et al., 2020).

Figure 1. Weekly admissions to acute NHS hospital trusts in England with an acute coronary syndrome, by type (Mafham et al., 2020). The date of the UK Covid-19 lockdown (March 23, 2020) is shown with a vertical dotted line.



211.4. For weekly admissions in 2019, boxplots show the median and interquartile range, with whiskers extending (up to) 1·5 times the interquartile range above the upper quartile and below the lower quartile, with any weekly counts beyond those ranges indicated by x. For 2020, a locally estimated scatterplot smoothing spline is fitted through the weekly reported counts, with datapoints and standard errors plotted. The date of the UK Covid-19 lockdown (March 23, 2020) is shown with a vertical dotted line.

211.5. This represented a proportional 40% decline in admissions for acute coronary syndromes (Mafham et al., 2020).

211.6. This decline was partly reversed during April 2020 and May 2020, such that by the last week of May 2020, there were 2522 admissions, representing a proportional 16% reduction from baseline (Mafham et al., 2020).

211.7. By the end of March 2020, the median hospital length of stay for patients admitted with acute coronary syndrome fell from four days in 2019 to three days (Mafham et al., 2020).

211.8. The study shows that the proportion of women admitted with acute coronary syndrome declined from a 2019 baseline proportion of 37% to 35% in April 2020. The proportion of men admitted with acute coronary syndrome increased from a 2019 baseline proportion of 63% to 66% in May 2020 (Mafham et al., 2020).

211.9. Of those admitted with acute coronary syndrome, the proportion of people aged less than 50 years, 50 to 59 years, 60 to 69 years, and 70 to 79 years was unchanged in each of the months from January 2020 to May 2020 compared with 2019 (Table 1) (Mafham et al., 2020). This suggests that for these ages, the patient response to the pandemic was similar to pre-pandemic. However, the proportion of people aged 80 years and over admitted with acute coronary syndrome declined in these months from a 2019 baseline proportion of 30% to 27% in May 2020. This suggests that the elderly were less frequently admitted to hospital with acute coronary syndrome; this effect was most noticeable in May 2020.

Table 1. Proportion of people admitted with acute coronary syndrome by age group for 2019 and May 2020 (Mafham et al., 2020).

Age group	**Monthly average for 2019 (n=13,075)**	**Monthly average for May 2020 (n=9756)**
Less than 50 years	7%	8%
50 to 59 years	16%	18%
60 to 69 years	21%	22%
70 to 79 years	26%	25%
80 years and over	30%	27%

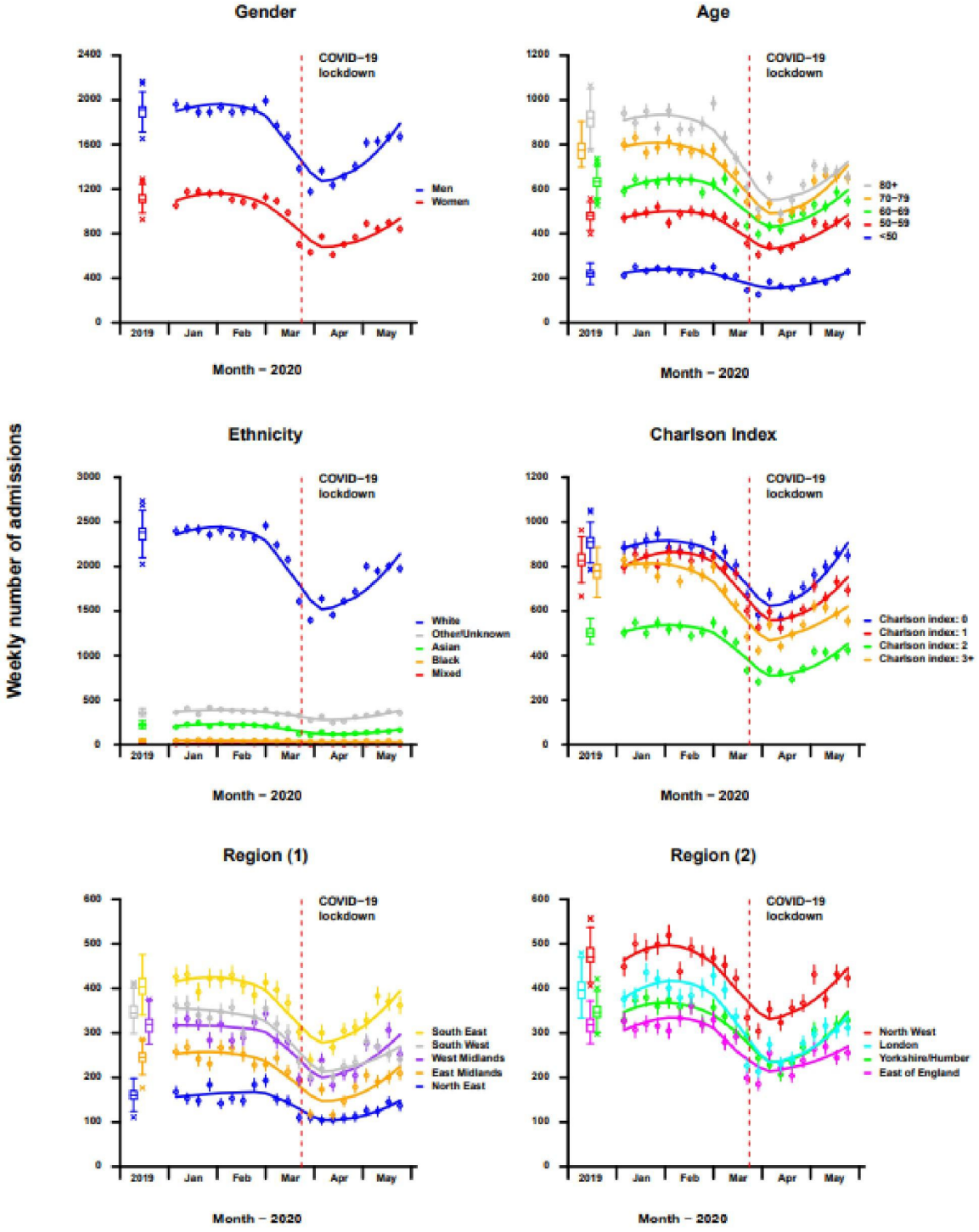
211.10. For people aged 80 years and over there was a 44% reduction in admissions with acute coronary syndrome in the week of 23rd-30th March 2020 compared with the 2019 weekly average; this is the age group with the greatest decline in this period (Figure 2) (Mafham et al., 2020).

211.11. The proportion of Asian and Black ethnicity people admitted with acute coronary syndrome declined from a 2019 baseline proportion of 7% to 6%, and 2% to 1%, respectively in May 2020 (Figure 2) (Mafham et al., 2020). The proportion of White people admitted with acute coronary syndrome did not differ from a 2019 baseline proportion of 79% to 78% in May 2020. The proportion of other or unknown ethnic group people admitted with acute coronary syndrome increased from a 2019 baseline proportion of 12% to 15% in May 2020. For people of mixed ethnicity there was a 69% reduction in admissions with acute coronary syndrome in the week of 23rd-30th March 2020 compared with the 2019 weekly average; this is the ethnic group with the greatest decline in this period (Mafham et al., 2020).

211.12. According to regions in England, the proportion of people admitted with acute coronary syndrome remained roughly similar from the 2019 baseline proportion to May 2020 (Figure 2) (Mafham et al., 2020). For people living in the East Midlands, there was a 52% reduction in admissions with acute coronary syndrome in the week of 23rd-30th March 2020 compared with the 2019 weekly average; this is the English region with the greatest decline in this period (Mafham et al., 2020).

211.13. There was a slightly greater decline in the proportion of people admitted with acute coronary syndrome who were more comorbid (according to the Charlson Comorbidity Index) than who were less comorbid (Figure 2) (Mafham et al., 2020). Comorbidity is a condition whereby a person has more than one illness or disease at the same time, but where the one 'index' condition is the focus of attention and the other illnesses are viewed in relation to this (Harrison et al., 2021). It is associated with worse health outcomes and more complex clinical management (Valderas et al., 2009). The Charlson Comorbidity Index is a widely used scoring system for comorbidities; the higher the score the more the comorbidities, and the higher the predicted mortality rate (Roffman et al., 2016). For those with a Charlson Comorbidity Index of three or higher (most comorbid) there was a decline from a 2019 baseline proportion of 26% to 23% in May 2020. Whereas for those with a Charlson Comorbidity Index of zero (least comorbid) there was a proportional increase from a 2019 baseline proportion of 30% to 33% in May 2020.

Figure 2. Weekly number of admissions with an acute coronary syndrome, by age, sex, Charlson index, ethnicity and region. The date of the UK Covid-19 lockdown (March 23, 2020) is shown with a vertical dotted line.



211.14. Taken together the evidence described in this section on the impact on admissions suggests that women, the elderly, Asian and mixed ethnicity people, those with comorbidities and those living in the East Midlands were less frequently admitted to hospital in England with acute coronary syndrome. For the comparisons between the weekly average in 2019 and May 2020, these were relatively small absolute

changes in the proportions of people by the categories. However, when studied by numbers of admissions to hospital and for the week of the 23rd March 2020 to the 30th March 2020 compared with the weekly average in 2019, then the relative decreases (percentage declines) are much larger. The reductions in hospitalisations for these groups of people signal a differential in the impact of the Covid19 pandemic on healthcare access for specific groups of the population in England. It is possible that these groups of people:

- preferred not to attend hospital;
- were following advice to isolate and/or shield;
- wished to protect the NHS for use by others with Covid-19;
- died from Covid-19 before attending hospital; and/or
- were unable to attend hospital.

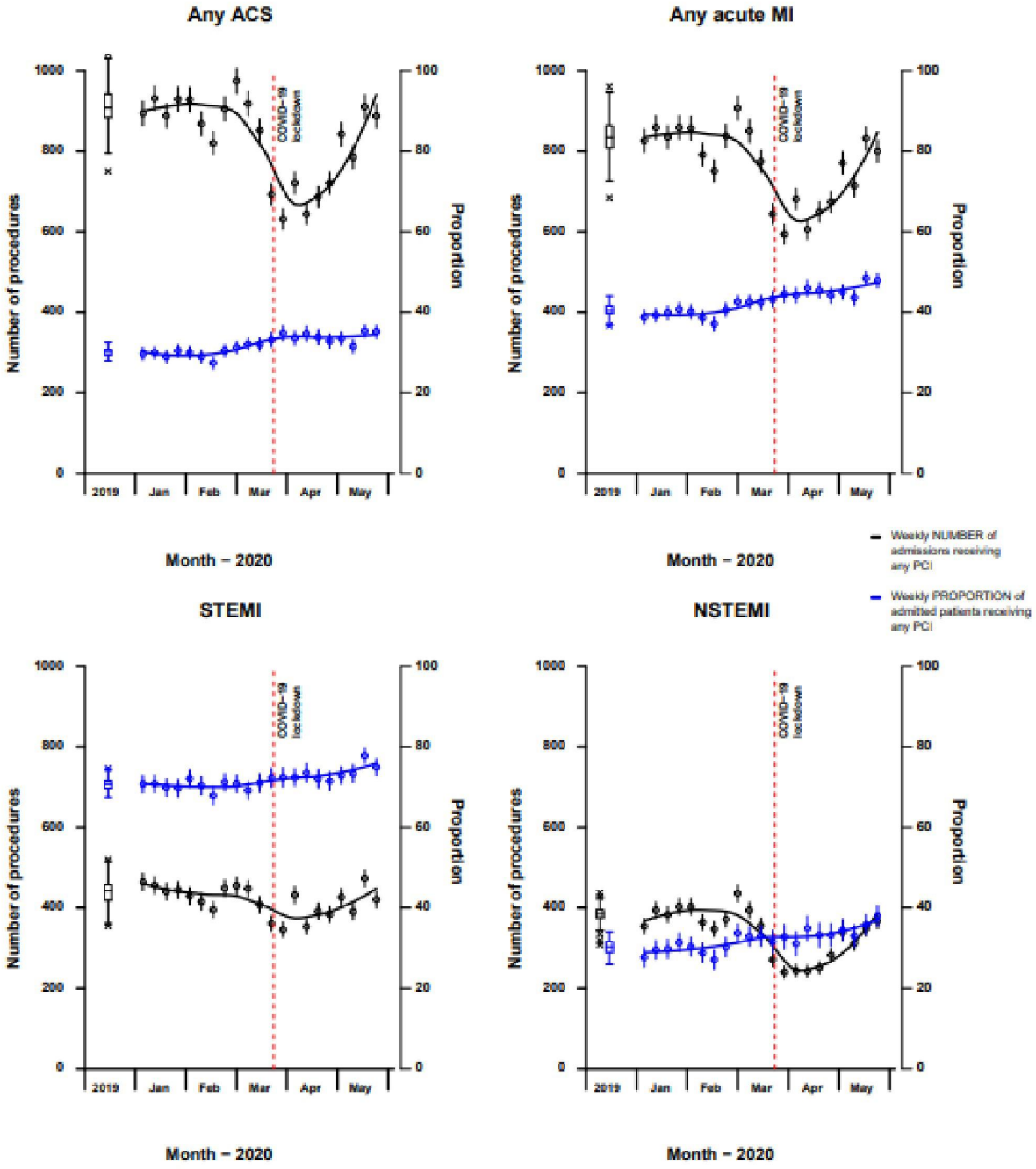
It is possible that the response by the public was associated with public messaging.

211.15. The number of people admitted with acute coronary syndrome who received invasive coronary angiography without PCI declined from 429 procedures per week in 2019 to 172 procedures per week by the end of March 2020, representing a proportional 60% decline in activity (Mafham et al., 2020).

211.16. Compared with the weekly average for 2019, the proportion of people admitted with acute coronary syndrome who received PCI declined overall by a proportional 31%, PCI on the day of admission to hospital reduced by a proportional 16%, and PCI after the day of admission to hospital reduced by a proportional 47% (Mafham et al., 2020).

211.17. However, from February 2020 until May 2020 (the end of the data analysis) the proportion of people admitted with acute coronary syndrome who also received PCI increased (Figure 3) (Mafham et al., 2020).

Figure 3. Weekly numbers and weekly proportions of admissions with an acute coronary syndrome that received any percutaneous coronary intervention (Mafham et al., 2020). The date of the UK Covid-19 lockdown (March 23, 2020) is shown with a vertical dotted line.



211.18. This suggests that although there was a decline in the numbers of admissions with acute coronary syndrome and therefore the number of PCI procedures, there was a preference towards undertaking PCI as close as possible to the date of admission to hospital. The likely rationale for this change was to decrease the exposure of the patient and treating healthcare professionals, and other patients already in hospital to Covid-19, and to ensure that there were as many unoccupied hospital beds available for any surge of patients with Covid-19. Mafham et al., 2020). It also

suggests that the throughput of patients with acute coronary syndrome in the NHS may be accelerated if the ratio of staff/infrastructure/resources to patients is high.

211.19. The proportion of people admitted with acute coronary syndrome who received coronary artery bypass grafting surgery declined from 93 operations per week in 2019 to 19 operations per week by the end of March 2020, representing a proportional 80% decline in activity (Mafham et al., 2020).

211.20. The likely reason was that patients infected with Covid-19 who required intensive care support were occupying beds to which patients who would under normal circumstances be transferred after coronary artery bypass grafting surgery. (Mafham et al., 2020).

211.21. For acute myocardial infarction (STEMI and NSTEMI) here was a reduction in the weekly number of admissions from a 2019 baseline rate of 2,061 admissions per week to 1,335 admissions per week at the end of March 2020 (Mafham et al., 2020). This represents a proportional 35% decline in admissions for acute coronary syndrome.

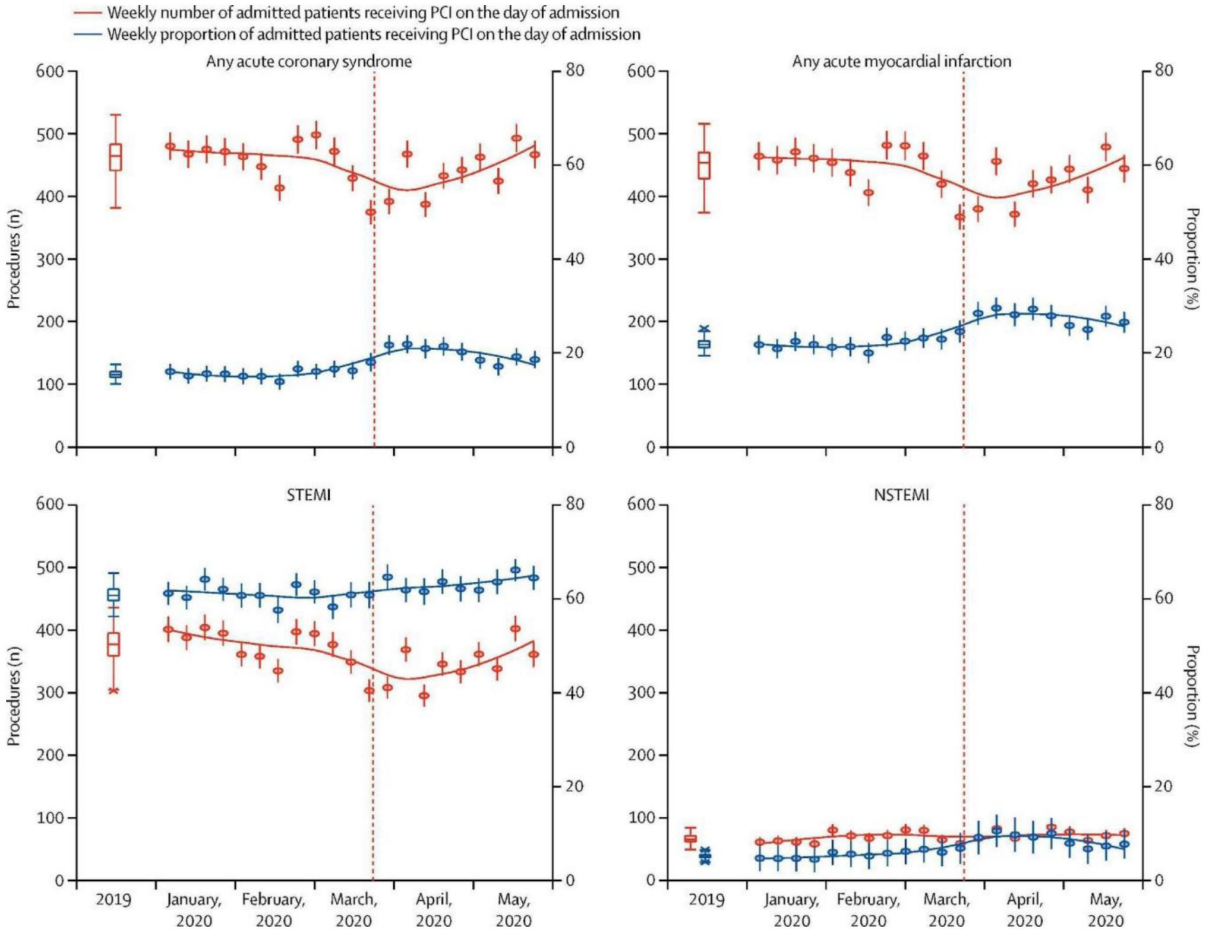
211.22. The number of people admitted with acute myocardial infarction who received invasive coronary angiography without PCI declined from 306 procedures per week in 2019 to 139 procedures per week by the end of March 2020, representing a proportional 55% decline in activity (Mafham et al., 2020). For this group, PCI declined overall by 29%, PCI on the day of admission to hospital declined by 16%, and PCI after the day of admission to hospital declined by 45%.

211.23. This suggests that there was a preference towards undertaking PCI as close as possible to the date of admission to hospital. The likely rationale was to decrease exposure of the patient and treating healthcare professionals, and other patients already in hospital to Covid-19, and to ensure that there were as many unoccupied hospital beds available for any surge of patients with Covid-19 (Mafham et al., 2020).

211.24. For STEMI, there was a reduction in the weekly number of admissions from a 2019 baseline rate of 621 admissions per week to 477 admissions per week at the end of March 2020 (Mafham et al., 2020). This represents a proportional 23% decline in admissions for STEMI (Figure 4).

211.25. For people admitted with STEMI, compared with the weekly average in 2019 at the end of March 2020, PCI procedures had declined by 21%, with PCI on the day of admission to hospital declining by 18%, and PCI after the day of admission to hospital declining by 43% (Figure 4). Invasive coronary angiography without PCI declined a proportional 31% (Mafham et al., 2020).

Figure 4. Weekly admissions to acute NHS hospital trusts in England with an acute coronary syndrome receiving PCI on the day of admission (Mafham et al., 2020). The date of the UK Covid-19 lockdown (March 23, 2020) is shown with a vertical dotted line.



211.26. This suggests that there was a preference towards undertaking PCI as close as possible to the date of admission to hospital. The likely rationale was to decrease exposure of the patient and treating healthcare professionals, and other patients already in hospital to Covid-19, and to ensure that there were as many unoccupied hospital beds available for any surge of patients with Covid-19 (Mafham et al., 2020).

211.27. Between April 2020 and May 2020, there was an increase in admissions with STEMI. However, during this period the weekly number of admissions was a proportional 10% lower than the 2019 baseline (Mafham et al., 2020). This suggests that there was a partial recovery in STEMI activity.

211.28. For NSTEMI, there was a reduction in the weekly number of admissions from a 2019 baseline rate of 1,267 admissions per week to 733 admissions per week at the end of March 2020 (Mafham et al., 2020). This represents a proportional 42% decline in admissions for NSTEMI (Figure 4).

211.29. For people admitted with NSTEMI, compared with the weekly average in 2019 at the end of March 2020, PCI procedures had declined by 37%, with PCI on the day of admission to hospital increasing by 1%, and PCI after the day of admission to

hospital declining by 46%. Invasive coronary angiography without PCI declined by a proportional 60% (Figure 4) (Mafham et al., 2020).

211.30. This suggests that there was a preference towards undertaking PCI as close as possible to the date of admission to hospital with a substantial fall in the proportion of cases of invasive coronary angiography without PCI, and a small increase in the proportion of people receiving same day PCI. Historically, in the NHS the time to receipt of PCI for NSTEMI could range from about three days to 11 days – that is, a patient would stay in hospital until there was availability for PCI at PCI-capable hospital. The likely rationale was to treat as effectively and efficiently as possible the coronary artery disease that was the underlying cause of the NSTEMI, rather than deferring to a later date or to only tablet-based treatments. Normal clinical practice was modified to decrease exposure of the patient and treating healthcare professionals, and other patients already in hospital to Covid-19, and to ensure that there were as many unoccupied hospital beds available for any surge of patients with Covid-19. In addition, it is likely that the patient flow was more efficient, when normally patients with NSTEMI would have to wait for available staff and services to enable an invasive coronary strategy.

211.31. Between April 2020 and May 2020, there was an increase in admissions with NSTEMI. However, during this period, the weekly number of admissions was a proportional 24% lower than the 2019 baseline (Mafham et al., 2020). This suggests that there was a partial recovery in NSTEMI activity, but less than that for STEMI.

211.32. At the end of March 2020, the median length of hospital stays for patients admitted with acute coronary syndrome decreased from four days (interquartile range two to 9 days) in 2019 to three days (interquartile range one to five days). For STEMI, the reduction in median stay was from three days (interquartile range two to six days) to two days (interquartile range two to four days) and for NSTEMI it was from five days (interquartile range three to 11 days) to three days (interquartile range two to six days). The length of stay remained lower during April and May 2020 (Mafham et al., 2020). These findings support the notion that NHS clinical services for the management of acute coronary syndrome were streamlined for the efficient treatment and turnaround of patients.

212. Data from Public Health Scotland reports a 15.8% proportional decline in admissions with heart attack compared with the 2018-2019 average, with the nadir reported in June 2020 (Public Health Scotland, 2023a).

213. A separate study that provides independent and aligning evidence for the impact of the Covid-19 pandemic on admissions to hospital with acute coronary syndrome in England was led by Gale and published in the European Heart Journal Quality of Care and Clinical Outcomes on 30th July 2020 (Wu et al., 2021b).

213.1. The study used data from the Myocardial Ischaemia National Audit Project. The Myocardial Ischaemia National Audit Project is a clinically designed national registry of admissions with acute coronary syndrome to NHS hospitals in England, Wales, and Northern Ireland (Wilkinson et al., 2020). It collects data spanning about 130 data fields covering the course of patient care, from the moment the patient calls for professional help through to hospital discharge and cardiac rehabilitation. Data are entered by clinicians and clerical staff within NHS hospitals, and pseudonymized records are uploaded centrally to the National Institute for Cardiovascular Outcomes Research for annual reporting.

213.2. The work required the rapid assimilation, access, curation, cleaning and analysis of individual participant clinical data collected at NHS hospitals. The work was endorsed by the Chief Scientific Advisor to the Government of the UK to provide health data intelligence to the Scientific Advisory Group for Emergencies. The Secretary of State for Health and Social Care has issued NHS Digital with a Notice under Regulation 3(4) of the NHS (Control of Patient Information Regulations) 2002 (COPI) to require NHS Digital to share confidential patient information with organisations entitled to process this under COPI for Covid-19 purposes. For this rapid NHS evaluation, health data linkage was enabled under Covid-19 public health NHS England Directions 2020, conferred by Section 254 of the Health and Social Care Act 2012. During the Covid-19 pandemic, Myocardial Ischaemia National Audit Project data were obtained through weekly live feeding into NHS Digital server.

213.3. The study analysed 50,689 patients aged 18 years or over admitted with acute myocardial infarction to 99 hospitals in England between 1st January 2019 and 22nd May 2020 (17,246 STEMI and 33,443 NSTEMI) (Wu et al., 2021b).

213.4. Analysis of the data found that the nadir (lowest point) in admissions occurred on 19th April 2020. The study defined a pre-pandemic phase from 1st January 2019 to 22nd March 2020, a decline phase from 23rd March (first UK lockdown) to the nadir in admissions, and a recovery phase from 20th April 2020 to 22nd May 2020) (Wu et al., 2021b).

213.5. For admissions with STEMI, there was a 28.6% decrease to a nadir on 19th April 2020 representing a decline in the median daily number of admissions from 35 to 25 (Wu et al., 2021b). This is consistent with and greater than the proportional decline reported using HES data as published in The Lancet (Mafham et al., 2020).

213.6. For admissions with NSTEMI, there was a 49.3% decrease to a nadir on 19th April 2020 representing a decline in the median daily number of admissions from 69 to 35 (Wu et al., 2021b). This is consistent with and greater than the proportional decline reported using as published in The Lancet (Mafham et al., 2020).

213.7. Compared with the pre-pandemic phase during the decline phase patients hospitalised with acute myocardial infarction were younger (66.9 vs. 68.7 years), more frequently male (69.6% vs. 67.9%), and less frequently had diabetes (24.5% vs. 28.1%) and cerebrovascular disease (7.1% vs. 8.6%) (Wu et al., 2021b). This is consistent with the findings from the HES data analysis as published in The Lancet (Mafham et al., 2020).

213.8. Compared with the pre-pandemic phase, during the decline phase patients hospitalised with acute myocardial infarction less frequently self-presented to hospital without making use of the Emergency Ambulance Service (20.6% vs 11.4%) and less frequently had pulmonary oedema (4.4% vs 2.5%) (Wu et al., 2021b).

213.9. Compared with the pre-pandemic phase, during the decline phase patients hospitalised with acute myocardial infarction had similar rates of pre-hospital cardiac arrest (3.8% vs 4.1%) and cardiogenic shock (1.6% vs 1.5%) (Wu et al., 2021b).

213.10. Compared with the pre-pandemic phase, during the decline phase for patients hospitalised with acute myocardial infarction the median duration in symptom onset to call-for-help (79.0 minute vs 76.5 minutes) and median duration in call-for-help to

hospital arrival times (79.0 minute vs 80.0 minutes) for those arriving by ambulance remained stable (Wu et al., 2021b).

213.11. Compared with the pre pandemic phase, during the decline phase for patients hospitalised with acute myocardial infarction the proportion of patients with planned follow-up by a cardiologist (85.4% vs 87.1%), receiving inpatient echocardiography (77.3% vs 76.6%) and, referred for cardiac rehabilitation (89.3% vs 89.7%) remained very high, as did the prescription of secondary prevention pharmacotherapies at the time of discharge from hospital (all equal to or greater than 95%) (Wu et al., 2021b).

213.12. Compared with the pre-pandemic phase, during the decline phase for patients hospitalised with acute myocardial infarction the median length of hospital stays decreased from four days to two days in the decline phase. For STEMI the median length of hospital stays changed from three days in the pre-pandemic phase to two days in the decline phase, For NSTEMI the median length of hospital stays changed from five days to two days in the decline phase (Wu et al., 2021b). These findings from clinical registry data are consistent with those reported using the Secondary Uses Service Admitted Patient Care database and published in The Lancet (Mafham et al., 2020). This supports the notion that NHS clinical services for the management of acute coronary syndrome were streamlined for the efficient treatment and turnaround of patients with acute coronary syndrome.

213.13. For admissions with STEMI to England their profiles, care and outcomes were similar to STEMI admitted before the first lockdown (Wu et al., 2021b). This supports the notion that the symptoms of STEMI are intrusive and noticeable, and that patients with STEMI did not preferentially seek (or not seek) help according to their age and comorbid status.

213.14. For admissions with STEMI in England, the use of primary PCI was very high throughout the study period and only a small proportion of patients admitted with STEMI received thrombolysis (0.3%) (Wu et al., 2021b). This supports the notion that the national primary PCI service in the UK was ring-fenced and prioritised such that patients in the greatest need could be treated with evidence-based life-saving treatments without delay.

213.15. Compared with the pre-pandemic phase, patients hospitalised with NSTEMI following lockdown were younger (70.2 vs. 68.5 years) and less frequently had diabetes mellitus (31.5% vs. 26.7% and pulmonary oedema (4.7% vs. 2.2%) (Wu et al., 2021b). Pulmonary oedema is a condition in which too much fluid accumulates in the lungs, interfering with a person's ability to breathe normally – it can be life threatening and does not resolve without medical intervention.

213.16. This suggests that less comorbid, younger and less unwell cases of NSTEMI presented to hospital, and therefore older, more comorbid and more unwell cases of NSTEMI did not attend NHS hospitals. Also, that NSTEMI with large areas of myocardial ischaemia ('big heart attacks' that typically would be associated with pulmonary oedema if not treated) may have died in the community.

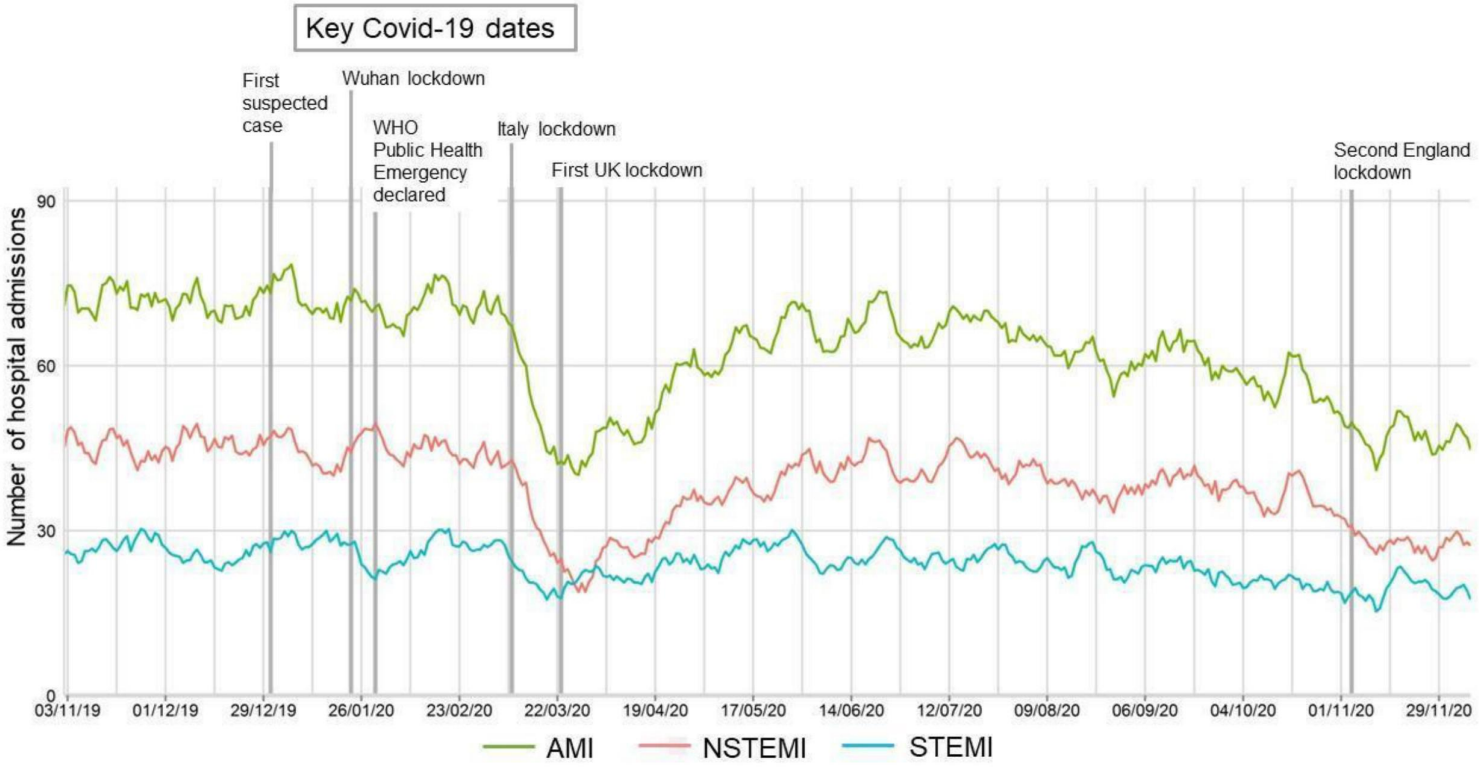
213.17. In the decline phase, there was a 3% reduction in the proportion of NSTEMI who received an invasive coronary strategy, and there were less inter-hospital transfers for such an approach. However, for those who received an invasive strategy, the median time to invasive coronary angiography was reduced from 64 hours to 26 hours to 38 hours over the three sequential phases (Wu et al., 2021b). This affirms

the evidence for the modification of NHS services for acute coronary syndromes such that patients were, where possible, treated at their local hospital and with the minimal use of transfers between hospitals. This was to reduce the spread of Covid-19 to protect patients and healthcare professionals, and to ensure that there was bed capacity.

214. In a separate piece of work, and following on from the data assimilation and analysis of the Myocardial Ischaemia National Audit Project data, Gale and team at the University of Leeds led a prospective (as near live as possible) analysis and data visualisation of Myocardial Ischaemia National Audit Project data from 66 NHS hospitals in England that had complete uploaded data (University of Leeds, 2024).

    214.1 Updated times series plots of activity for acute myocardial infarction (STEMI and NSTEMI) were displayed on a dedicated and publicly available website developed and housed by the University of Leeds (University of Leeds, 2024). According to data access bestowed to the clinical and analytics team at the University of Leeds, the analyses were extended with available data for as long as possible, until 8th December 2020. The last website update for the analyses was published on the 11th February 2021. This therefore enabled an appraisal of the effect of the Covid-19 pandemic on admission with acute myocardial infarction before, during and after the first UK lockdown and included data visualisation of activity during the second lockdown in England (Figure 5).

Figure 5. Times series of daily hospitalisations of acute myocardial infarction between 3rd November 2019 and 8th December 2020, by STEMI and NSTEMI (updated 11th Feb 2021). Data from 66 NHS hospitals in England with complete uploaded data up until 8th December 2020. Lines represent a seven-day simple moving average (indicating the mean number of daily admissions for that day and the preceding six days), adjusted for seasonality. Key dates including the first suspected case (31st December 2019), Wuhan lockdown (23rd January 2020), World Health Organisation declaration of a public health emergency of international concern (30th January 2020), Italy lockdown (10th March 2020), first UK lockdown (23rd March 2020) and second England lockdown (5th November 2020) are shown with a bold vertical line. AMI: acute myocardial infarction; STEMI: ST-elevation myocardial infarction; NSTEMI: non-ST elevation myocardial infarction (University of Leeds, 2024).



214.2 This was enabled as a result of the Secretary of State for Health and Social Care issuing NHS Digital with a Notice under Regulation 3(4) of the NHS (Control of Patient Information Regulations) 2002 (COPI) to require NHS Digital to share confidential patient information with organisations entitled to process this under COPI for Covid-19 purposes. For the rapid NHS evaluation using Myocardial Ischaemia National Audit Project, health data linkage was enabled under Covid-19 public health NHS England Directions 2020, conferred by Section 254 of the Health and Social Care Act 2012. During the Covid-19 pandemic, Myocardial Ischaemia National Audit Project data were obtained through weekly live feeds into the NHS Digital server.

214.3 The data visualisation shows that the impact of the Covid-19 pandemic was much greater for admissions with NSTEMI than STEMI (University of Leeds, 2024).

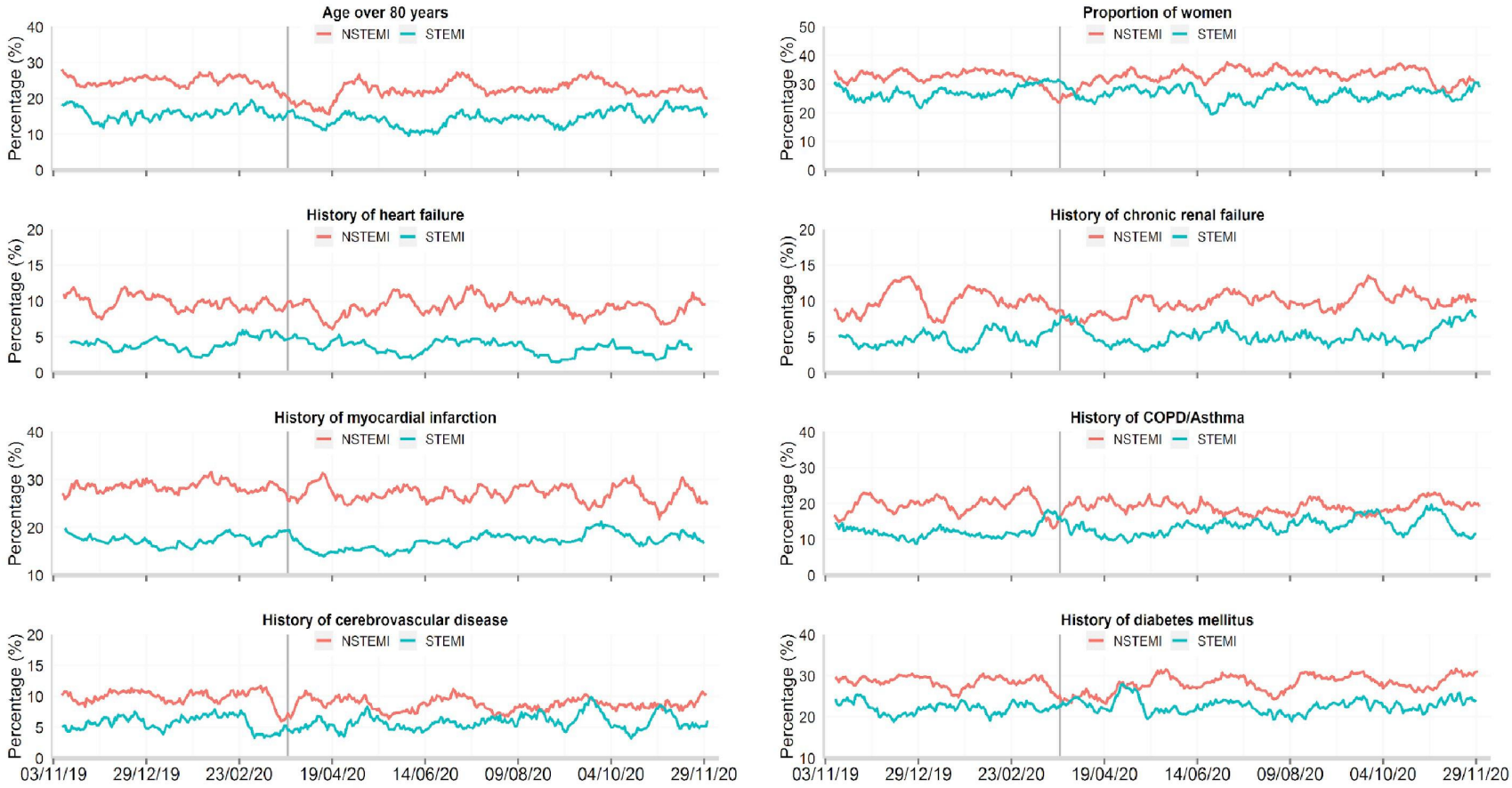
214.4 The data visualisation also shows that the impact of the Covid-19 pandemic whilst continuing to be greater for admissions with NSTEMI than STEMI at around the time of the second lockdown in England, the impact of the second UK was less and the difference in effects on admission between STEMI and NSTEMI was much less than that for the first UK lockdown (University of Leeds, 2024).

214.5 The data visualisation demonstrates a peak in admissions with acute myocardial infarction occurring towards the end of June 2020 (University of Leeds, 2024).

214.6 There was a gradual decline in admissions with acute myocardial infarction from about the end of June 2020 to the date of the second lockdown in England occurring on 5th November 2020, when qualitatively the angle of the decline became steeper, and probably reached the second nadir in mid-November 2020 (University of Leeds, 2024). The second phase of reduced admissions with acute myocardial infarction in England continued until the end of the available access to data on the 8th December 2020. It is therefore not possible to comment about how long the second decline in admissions with acute myocardial infarction extended or the slope and dynamics of the second recovery.

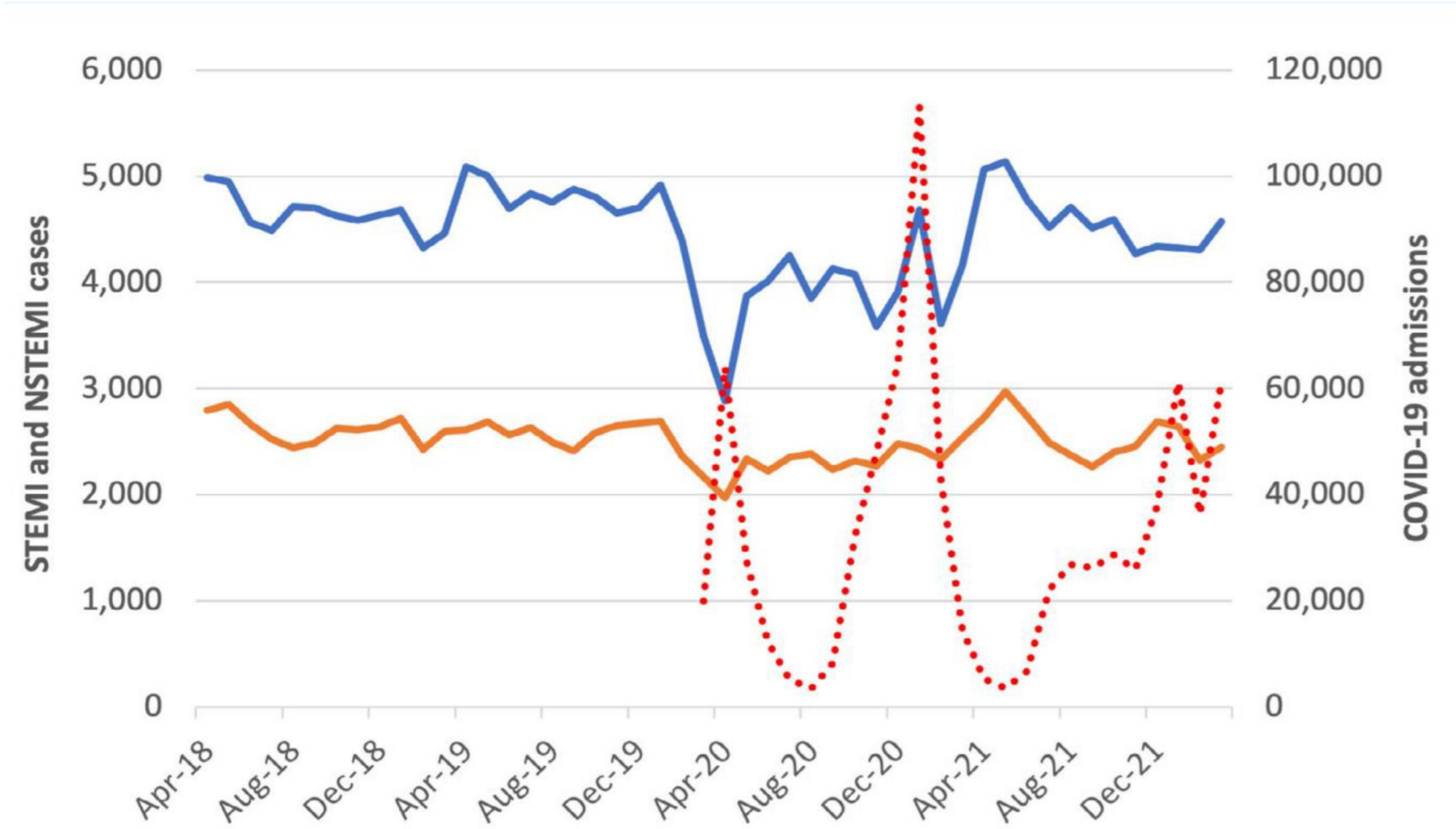
214.7 Qualitatively, it appears that for NSTEMI each of women, people aged 80 years and over, history of previous myocardial infarction, stroke (cerebrovascular disease), chronic renal failure, chronic obstructive pulmonary disease and asthma, and diabetes mellitus less frequently attended hospital at around the time of the first UK lockdown (Figure 6) (University of Leeds, 2024). Differences by patient characteristics at the time of the second lockdown in England are less discernible and therefore less reliable for interpretation. For STEMI, the effects according to patient characteristics are less obvious. These findings support the notion that women, the elderly and the comorbid were less likely to seek help for NSTEMI and that baseline characteristics were less influential for people with STEMI.

Figure 6. Time series plot of daily hospitalisations with acute myocardial infarction between 3rd November 2019 and 8th December 2020 for baseline patient characteristics, by STEMI and NSTEMI (updated 11th Feb 2021). Data from 66 National Health Service hospitals in England with complete uploaded data up until 8th December 2020. Lines represent the proportions of a 7-day simple moving average (indicating the mean number of daily admissions for that day and the preceding 6 days) for each demographic / co-morbidity characteristic, adjusted for seasonality. The date of the UK Covid-19 lockdown (March 23, 2020) is shown with a vertical line. STEMI: ST-elevation myocardial infarction; NSTEMI: non-ST elevation myocardial infarction (University of Leeds, 2024).



215. A data visualisation from the Myocardial Ischaemia National Audit Project and the National Audit of Percutaneous Coronary Intervention 2023 Summary Report shows the reciprocal relationship between admissions from Covid-19 and admissions from STEMI and NSTEMI in England, Wales and Northern Ireland combined at around the time of the first UK lockdown (Figure 7) (NICOR 2023). As noted in other analyses, the impact of the Covid-19 pandemic on admissions was greater for NSTEMI than for STEM. Also, the impact of the second lockdown in England was not as great as that of the first UK lockdown in terms of the decline in admissions with STEMI and NSTEMI, and this was despite a much greater surge in admissions with Covid-19 at the time of the second UK lockdown. Qualitatively, the number of admissions with STEMI and NSTEMI appears to return to the baseline (pre Covid-19 era) rate at about the end of July 2022; suggesting that there was a period of about six months during which admission to hospitals in the UK were below that expected and witnessed in earlier years.

Figure 7: Monthly admission with STEMI and NSTEMI in England, Wales and Northern Ireland combined compared with Covid-19 admissions, 2019/20 to 2021/22. Solid lines represent data from the Myocardial Ischaemia National Audit Project; Orange is STEMI, blue is NSTEMI. The dotted line represents Covid-19 admission data from the UK Health Services Authority (NICOR 2023).



216. Scotland did not go into lockdown at the time of England's second lockdown. On 29th October 2020 the Scottish Government set out its Covid-19 Strategic Framework which detailed the Protection Levels Framework that was implemented on 2nd November 2020 (Scottish Government, 2020a). The framework placed different levels of restriction in different geographic areas of Scotland according to:

- the number of positive cases per hundred thousand people over the most recent week;
- the percentage of positive tests;
- the forecast for new cases in the weeks ahead; and
- the capacity both of local hospitals and intensive care facilities.

217. According to data from Public Health Scotland, in the week ending 20th December 2020 there was a 2.6% proportional decline in admissions with heart attack compared with the 2018-2019 average in Scotland (Public Health Scotland, 2023a).

218. As part of the British Heart Foundation Data Science Centre's CVD-COVID-UK/COVID-IMPACT research programme, (Wood et al., 2021) an analysis of administrative records data for England, Scotland and Wales undertaken. The study population included all individuals admitted to hospital in England, Scotland or Wales with a primary diagnosis of acute coronary syndrome, heart failure, stroke/transient ischaemic attack, peripheral arterial disease, aortic aneurysm and venous thromboembolism between 1st January 2016 and 31st December 2021- the study period covers four years before the Covid-19 pandemic for comparison with the first two years of the Covid-19 pandemic (Wright et al., 2023). The cohort comprised a total of 1,973,104 and 970,374 admissions and 1,616,550 and 635,187 procedures in 2016–19 and 2020–21, respectively (Figures 8 and 9).

    218.1 In 2020, admissions for all cardiovascular diseases in England, Wales and Scotland combined countries were lower than expected (6% proportional decrease in England, 6% proportional decrease in Scotland and 7% proportional decrease in Wales) (Wright et al., 2023).

    218.2 In 2021, admissions in England were 4% higher than expected, but in Scotland and Wales, numbers were similar to 2016–19 (Wright et al., 2023).

    218.3 In 2020, there were 14,506 (4% proportional decrease) fewer emergency admissions than expected for all cardiovascular diseases in England, Wales and Scotland combined, and the proportional reduction was similar in all three countries (Wright et al., 2023).

    218.4 There was an 8% proportional decrease in admissions with acute coronary syndrome in England, and about a 5% proportional decrease in admissions with acute coronary syndrome in each of Scotland and Wales (Figures 7 and 8) (Wright et al., 2023). However, the confidence interval around the point estimate (percentage decrease) is wider for each of Scotland and Wales suggesting uncertainty in the precision of the estimate.

Figure 8. Monthly emergency hospital admissions for acute coronary syndrome as primary diagnosis admissions between pre-pandemic (2016–19) and 2020 for England, Scotland and Wales (Adapted from Wright et al., 2023).

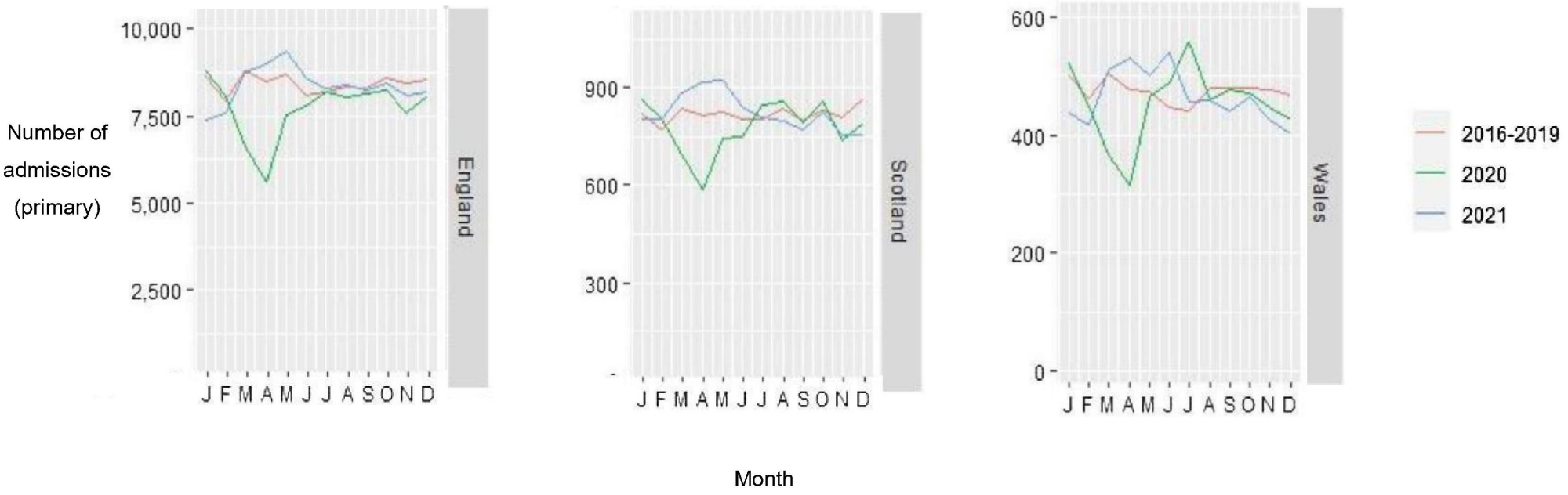
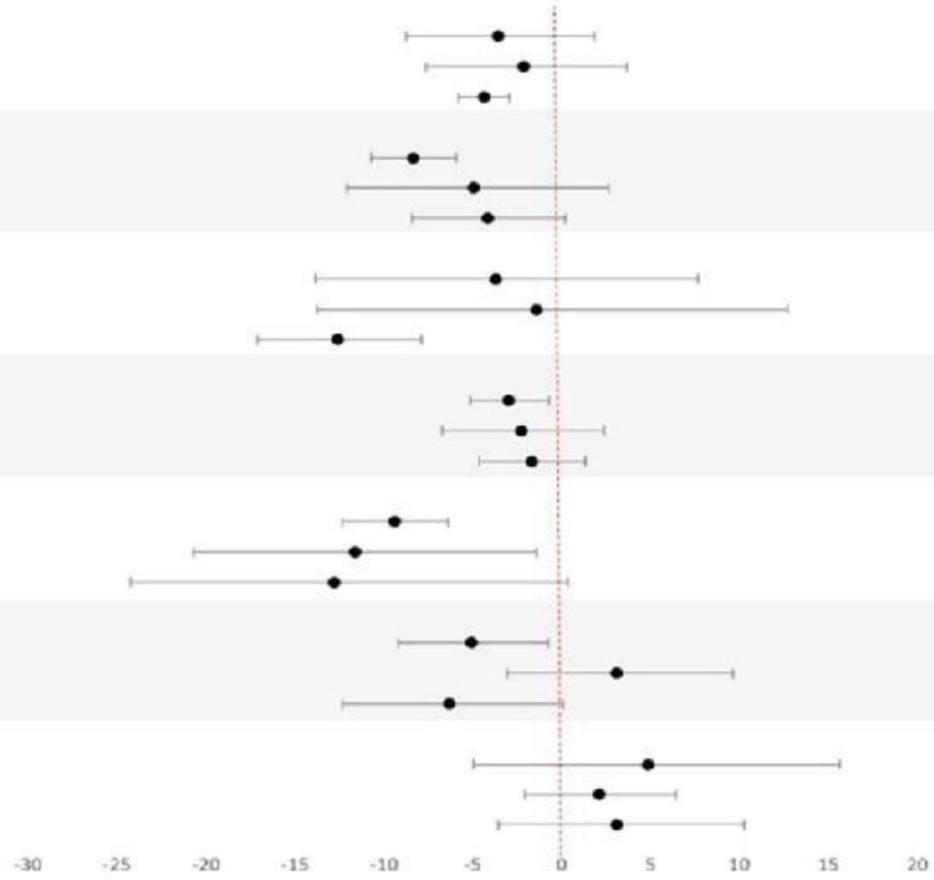


Figure 9. Annual counts and percentage change in emergency admissions between pre-pandemic (2016–19) and 2020 for England, Scotland and Wales (Wright et al., 2023).

Condition	Mean No. 2016/19	Total No. 2020	Difference 2016/19 to 2020	% change (95% CI) 2016/19 to 2020
Emergency admissions				
All conditions				
England	364636	351766	-12870	-4 (-9,2)
Scotland	34521	33801	-720	-2 (-8,4)
Wales	21233	20317	-916	-4 (-6,-3)
ACS				
England	101186	92790	-8396	-8 (-11,-6)
Scotland	9807	9324	-483	-5 (-12,3)
Wales	5689	5454	-235	-4 (-8,0)
HF				
England	80997	78042	-2955	-4 (-14,8)
Scotland	5919	5837	-82	-1 (-14,13)
Wales	4464	3903	-561	-13 (-17,-8)
Stroke/TIA				
England	106461	103371	-3090	-3 (-5,-1)
Scotland	11843	11583	-260	-2 (-7,2)
Wales	6574	6466	-108	-2 (-5,1)
AA				
England	4800	4351	-449	-9 (-12,-6)
Scotland	449	397	-52	-12 (-21,-1)
Wales	273	238	-35	-13 (-24,0)
PAD				
England	14773	14032	-741	-5 (-9,-1)
Scotland	1750	1805	55	3 (-3,10)
Wales	1164	1091	-73	-6 (-12,0)
VTE				
England	56419	59180	2761	5 (-5,16)
Scotland	4753	4855	102	2 (-2,6)
Wales	3069	3165	96	3 (-4,10)



219. To date, the literature expresses the decline in admissions with acute coronary syndrome in the UK as proportional to that expected for that time of year. There are no publications that provide details of the potential numbers of people who did not present to NHS hospitals with acute coronary syndrome during the Covid-19 pandemic. Therefore, the author of this report worked with Professor Jianhua Wu, biostatistician, to prepare estimates using information from the publication by Gale and Wu that used Myocardial Ischaemia National Audit Project data rapidly reported by 42 hospitals in England (Wu et al., 2021b). The work is unpublished and was only undertaken for this report. For this it was assumed that:

- The average daily number of admissions with acute myocardial infarction was constant in pre-pandemic period; and
- The total annual number of admissions with acute myocardial infarction in the UK is approximately 100,000 (British Heart Foundation, 2024c).
- The reduction in admissions with acute myocardial infarction was derived by subtracting from the daily number of admissions with acute myocardial infarction in pre-pandemic period the total daily number of admissions with acute myocardial infarction estimated from the literature [(Wu et al., 2021b).
- The proportional reduction in the number of admissions with acute myocardial infarction was derived by dividing the reduction admissions with acute myocardial infarction by the total number of admissions with acute myocardial infarction in the pre-pandemic period.
- The number of admissions with acute myocardial infarction was derived from the area under curve in figure 1 of the publication (Wu et al., 2021b). This represents the 99 rapid reporting NHS hospitals in England that were used to avoid data reporting lag bias during COVID period.
- For the first dip in admissions with acute myocardial infarction, the time period used was 1st March 2020 to 17th May 2020 (the date of first mass testing in the UK).

The analysis found that:

219.1 For the 42 rapid reporting hospitals, the average daily number of admissions with acute myocardial infarction was 45 patients, corresponding to a total of 3,510 patients. The area under curve for figure 1 of the publication (Wu et al., 2021b) between 1st March 2020 to 17th May 2020 was 2,704. This equates to 786 fewer admissions with acute myocardial infarction during this period across the 42 NHS hospitals in England. The proportional decline in admissions with acute myocardial infarction reduction was (3,510-2,704)/3,510 = 23.0%. Extrapolating the reduction rate to the whole of the UK, would represent (100,000 admissions*78 days/365 days)*0.23 = 4,915 fewer admissions with acute myocardial infarction.

219.2 For the full analytic period of 248 days, the time period used was 1st March 2020 to 2nd Nov 2020 (shortly before the second lockdown in England on 5th November). The area under the curve in figure 1 between 1st March 2020 to 2nd Nov 2020 was 9,632 patients. In the absence of the pandemic there should have been a total of 248 days*45 patients = 11,160 patients. Therefore, 1528 fewer admissions, corresponding to a 13.7% reduction in admissions with acute myocardial infarction during the period. Extrapolating this to the whole UK, there would be (100,000

admissions*248 days/365 days)*0.137 = 9,303 fewer admissions with acute myocardial infarction during the period.

219.3 Using admission estimates from the Mafham et al 2020 publication Figure 1 (top right panel blue curve) (Mafham et al., 2020), it may be estimated that there were a total of 5,150 fewer admissions with acute myocardial infarction in England between 1st March 2020 and 17th May 2020.

220. A study of 34,127 patients who received PCI for STEMI in England between January 2017 and April 2020 as recorded in the National Audit of PCI Analysis and co-authored by Gale found a proportional 43% decline in the number of procedures in April 2020 compared with the average monthly procedures between 2017 and 2019 (Kwok et al., 2020b).

220.1 The study also reported an increase in the median time from symptom to hospital after the date of the first UK lockdown (150 minutes vs. 135 minutes) and an increase in the median door-to-balloon time after the lockdown (48 minutes vs. 37 minutes). The increase in duration of time from onset of symptoms to arrival at hospital represents patient delays to calling for help and ambulance response times. Each of these could have contributed to the longer duration - with people being hesitant about calling an already 'busy service', or having concerns about their admission to hospital and being exposed to Covid-19, as well as delays by the emergency services because of other emergency call activity, and the time needed for donning of personal protective equipment and the assessment of the patient.

221. According to Public Health Scotland in the week ending on the 12th April 2020 there was a 34.2% proportional decline in the coronary angiography, and in the week ending on the 19th April 2020 there was a 24.8% proportional decline in PCI in Scotland compared with the 2018-2019 average (Public Health Scotland, 2023a).

222. As part of the British Heart Foundation Data Science Centre's CVD-COVID-UK/COVID-IMPACT research programme,(Wood et al., 2021) an analysis of administrative records data for England, Scotland and Wales undertaken. The study population included all individuals admitted to hospital in England, Scotland or Wales with a primary diagnosis of acute coronary syndrome, heart failure, stroke/transient ischaemic attack, peripheral arterial disease, aortic aneurysm and venous thromboembolism between 1st January 2016 and 31st December 2021- the study period covers four years before the Covid-19 pandemic for comparison with the first two years of the Covid-19 pandemic (Wright et al., 2023). The cohort comprised a total of 1,973,104 and 970,374 admissions and 1,616,550 and 635,187 procedures in 2016–19 and 2020–21, respectively.

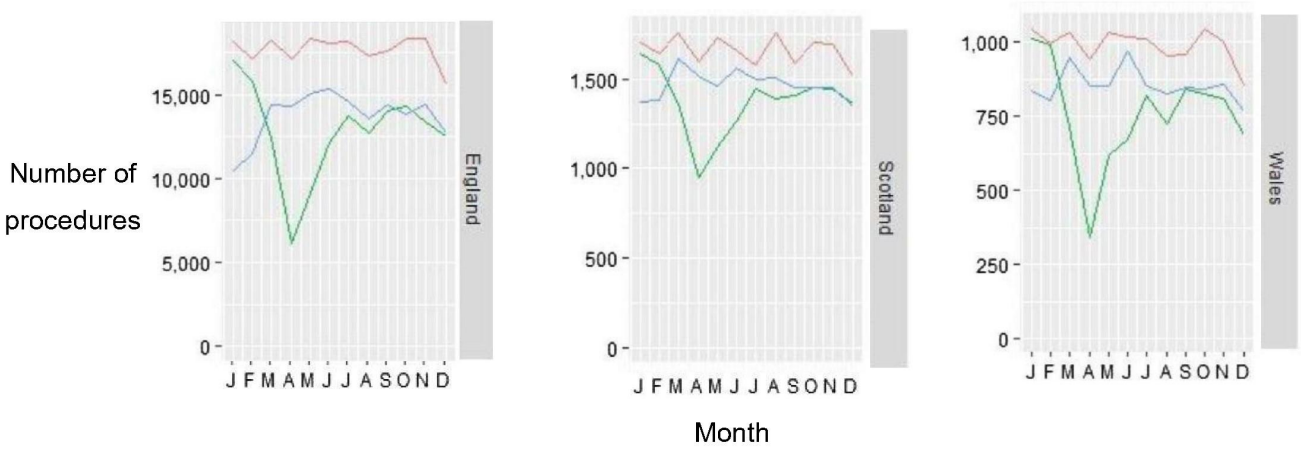
222.1 In 2020, there were 96,554 (24% proportional decrease) fewer total procedures for the six cardiovascular diseases studied subtypes combined in England, Wales and Scotland compared with the expected number in 2016–19 (Wright et al., 2023).

222.2 In 2020, admissions for all cardiovascular disease procedures were lower than expected and varied by country (25% proportional decrease in England, 16% proportional decrease in Scotland, 23% proportional decrease in Wales) (Figure 10) (Wright et al., 2023).

222.3 Percutaneous coronary intervention demonstrated a 17% proportional decrease in Scotland and a 27% proportional decreased in England (Wright et al., 2023).

222.4 Coronary artery bypass grafting surgery demonstrated a 23% proportional decreased in Scotland and a 44% proportional decrease in Wales (Wright et al., 2023).

Figure 10. Monthly total procedures for acute coronary syndrome between pre-pandemic (2016–19) and 2020 for England, Scotland and Wales (Adapted from Wright et al., 2023).



223. A study of 126,491 patients who received PCI procedures at 44 hospitals in England between January 2017 and April 2020 as recorded in the National Audit of PCI register between January 2017 and April 2020 and co-authored by Gale found that after March 23, 2020 there was a 49% fall in the number of PCI procedures (Kwok et al., 2020a).

223.1 There was a proportional decline of 45% in PCI procedures for NSTEMI.

223.2 There was a proportional decline of 33% in PCI procedures for STEMI.

223.3 Patients who received PCI after the first lockdown were slightly younger (64.5 versus 65.5 years) and less frequently had diabetes (20.4% versus 24.6%), hypertension (52.0% versus 56.8%), previous myocardial infarction (23.5% versus 26.7%), previous PCI (24.3% versus 28.3%), or previous coronary artery bypass grafting surgery (4.6% versus 7.2%) compared with before the lockdown. This suggests that both younger and less comorbid patients were admitted with STEMI and NSTEMI or that there was a clinical preference for PCI for patients with STEMI and NSTEMI who had these characteristics (and that elderly and comorbid patients were less likely to receive PCI). The later argument is less plausible because other data sources (as detailed above) reported that the decline in admissions was greater among the elderly and those with comorbidities.

224. A separate study, co-authored by Gale, analysed 374,899 major cardiac and cardiothoracic inpatient and outpatient procedures performed in people aged 18 years and over in England between 1st January and 31st May for each of the years 2018, 2019, and 2020 as recorded in HES (Mohamed et al., 2021a).

224.1 Hospital Episode Statistics is a data warehouse containing details of all Admitted Patient Care, Outpatient Attendances and Urgent and Emergency Care Activities in England (NHS Digital, 2024). It is an administrative database that provides data for the purpose of healthcare analysis to the NHS, government, the National Institute for Health and Care Excellence, and researchers. The HES data are created from data

submitted to NHS England as part of the Commissioning Data Sets which is managed by the Secondary Use Service.

224.2 The study found a deficit of 4,501 major cardiac and cardiothoracic inpatient and outpatient procedures during the March 2020 to May 2020 period compared to the monthly averages for March to May in 2018 to 2019 (Mohamed et al., 2021a).

224.3 Between March 2020 and May 2020 compared with the 2018–2019 average for these months, cardiac catheterisation (invasive coronary angiography, PCI) and cardiac device implantations (pacemakers) were the most affected in terms of the total deficit in numbers (n = 19 637 and n = 10 453) (Mohamed et al., 2021a). Compared with the corresponding months in 2018 and 2019, in 2020 the proportional decrease in cardiac catheterisation in England was -6.5% in January, -7.3% in February, -34.3% in March, -73.1% in April, and -62.8% in May. Compared with the corresponding months in 2018 and 2019, in 2020 the proportional decrease in PCI in England was -0.9% in January, -0.9% in February, -20.6% in March, -41.2% in April, and -36.0% in May. Compared with the corresponding months in 2018 and 2019, in 2020 there was also a proportional decrease in coronary artery bypass grafting surgery in England of -9.1% in January, -4.0% in February, -43.6% in March, -82.4% in April, and -78.0% in May (Mohamed et al., 2021a).

224.4 Compared with the corresponding months in 2018 and 2019, in 2020 for cardiac catheterisation the mean ages were similar, the proportion of men similar, but there were proportionally fewer people who were Asian or Black (Mohamed et al., 2021a) For PCI the mean ages were also similar, the proportion of men similar, and there were proportionally fewer people who were Asian (Mohamed et al., 2021a). For coronary artery bypass grafting surgery the mean ages were similar, the proportion of men higher, and there were proportionally fewer people who were Asian (Mohamed et al., 2021a).

224.5 Compared with the corresponding months in 2018 and 2019, in 2020 for each of cardiac catheterisation (1.6% vs. 2.1%) and PCI (2.0% vs. 3.6%) there was a proportional increase in ventricular fibrillation or ventricular tachycardia (life threatening heart rhythm disturbances that require immediate treatments) (Mohamed et al., 2021a). This suggests that patients admitted to hospital with acute coronary syndrome and who had an invasive coronary procedure between March 2020 and May 2020 were more frequently critically unwell and in need of emergency care. This aligns with the notion that patients who did attend hospital were in the later stages of acute coronary syndrome or that the called for help occurred when they were in a 'life or death' situation.

225. An assessment of the quality of acute myocardial infarction care in England and Wales according to the 2020 European Society of Cardiology Association for Acute Cardiovascular Care quality indicators for acute myocardial infarction was led by Gale and undertaken using data from the Myocardial Ischaemia National Audit Project and National Audit of PCI registry between 1st January 2017 and 27th May 2020 (Aktaa et al., 2021). The study included 236,743 patients from 186 hospitals of which there were 10,749 admissions with acute myocardial infarction after 23rd March 2020.

225.1 Compared with before the first lockdown there was an improvement in the attainment of 10 (62.5%) of the 16 measured quality indicators. For example, there was an increase in hospital use of high-sensitivity cardiac troponins (the heart attack blood test) for NSTEMI, in performance of invasive coronary angiography within 24 hours

for NSTEMI, in use of radial access for invasive coronary procedures, and in the measurement of serum cholesterol during hospitalisation. There was also a slight increase in the attainment of a composite quality indicator (which assesses a range of processes of acute coronary syndrome care in one element). There was a modest reduction in the attainment of five quality indicators, with the greatest decrease being for the evaluation of left ventricular ejection fraction. This suggests that there was good overall adherence to guidelines-recommended therapies, accelerated in-hospital care for patients admitted with acute myocardial infarction to NHS hospitals in England and Wales during the Covid-19 pandemic. However, this was at the expense of less frequently performing an assessment of the power of the heart after heart attack to check for heart failure (typically with echocardiography – an ultrasound scan of the heart). This additional investigation could have incurred greater risk of exposure to Covid-19 for the patient and healthcare professional, and delayed an otherwise expedient discharge from hospital.

226. A multisource national healthcare records study of 73,746 Black Asian and Minority Ethnic group patients hospitalised with acute myocardial infarction in England between 1 February 2020 to 27 May 2020 and compared with patients admitted with acute myocardial infarction in England during the same period in the previous three consecutive years found a proportional increase in Black Asian and Minority Ethnic group patients from 10.1% to 16.7% during the pandemic (Rashid et al., 2021a). Black Asian and Minority Ethnic group patients admitted during the pandemic study period were younger, more frequently male and more likely to present with STEMI. Black Asian and Minority Ethnic group patients hospitalised with acute myocardial infarction had higher in-hospital (OR 1.68, 95% CI 1.27 to 2.28) and seven day mortality (OR 1.81 95% CI 1.31 to 2.19) during the pandemic study period compared with the non-pandemic study period.

227. Of a total of 12,958 patients hospitalised with acute coronary syndrome in England between 1st March 2020 and 31st May 2020, 517 (4.0%) were Covid-19-positive. Those who were Covid-19-positive were more likely to present with NSTEMI (Rashid et al., 2021b). Patients admitted with acute coronary syndrome and who were Covid-19-positive were generally older, of Black Asian and Minority ethnicity, more comorbid and had unfavourable presenting clinical characteristics such as elevated cardiac troponin, pulmonary oedema, cardiogenic shock and poor left ventricular systolic function compared with patients admitted with acute coronary syndrome and who were not Covid-19-positive. Patients admitted with acute coronary syndrome and who were Covid-19-positive were less likely to receive an invasive coronary angiography (67.7% vs 81.0%), PCI (PCI) (30.2% vs 53.9%) and dual antiplatelet medication (76.3% vs 88.0%). After adjusting for baseline differences, patients admitted with acute coronary syndrome and who were Covid-19-positive had higher in-hospital (adjusted odds ratio (aOR): 3.27; 95% confidence interval (CI): 2.41-4.42) and 30-day mortality (aOR: 6.53; 95% CI: 5.1-8.36) compared to patients with the non-COVID-19 ACS.

228. According to the 2019/20 BCIS audit report in 2019/20 there were 1593 PCIs for ventilated emergencies (British Cardiovascular Intervention Society, 2020).

229. According to the 2021/22 BCIS audit report, in 2018/19 10% of all cases with PCI were for out of hospital cardiac arrest. The proportion was 8.9% in 2019/20 and 8.33% in 2020/21 (British Cardiovascular Intervention Society, 2020). The report also states that in 2018/19 2% of all PCIs received pre-PCI ventilation, and that in 2019/20 the proportion was about 1.7%, and about 1.8% in 2020/21 (British Cardiovascular Intervention Society, 2022). For the year 2019/20 the use of inotropes for left ventricular support for PCI decline slightly, and did not follow the consistent upward trajectory seen over between 2008 and 2021/22 (British

Cardiovascular Intervention Society, 2022). In 2019/20 the use of extraction atherectomy for primary PCI reach a nadir with only 14.3% of cases of primary PCI using this technique. The technique had been on the decline since 2012, but increased to 15.3% in 2020/21 and 16.9% in 2021/22 (British Cardiovascular Intervention Society, 2022).

230. According to the 2021/22 BCIS audit report, following the first UK lockdown the proportion of NSTEMI who waited less than 72 hours in England, Wales was 82.8% at peak in April 2020 and 68.3% at peak in December 2020 (British Cardiovascular Intervention Society, 2020). Between 2018 and 2020 the proportion of NSTEMI who waited less than 72 hours in England, Wales was about 55%.

231. There is no robust reason to argue that the effects of the pandemic were largely different from those described in the scientific publications and public reports for that of England and Wales (and Northern Ireland). However, it is acknowledged that there is less detailed information about the impact of the Covid-19 pandemic on admissions, procedures and deaths for the devolved administrative nations compared with that for England. Equally, it is acknowledged that each of the devolved administrative nations has different demographics, and healthcare system infrastructure and policies.

Explanation(s) for change in numbers of admissions with acute coronary syndrome

232. The times series analyses show that the decline in admissions with acute coronary syndromes to hospital in England commenced in early March 2020, and possibly at the end of February 2020 (Mafham et al., 2020; Wu et al., 2021b; University of Leeds, 2024).

233. The paper led by Gale and the subsequent times series analyses of Myocardial Ischaemia National Audit Project data from 66 hospitals in England for admissions with acute myocardial infarction enables an understanding of the sequence of events and admissions activity for STEMI and NSTEMI (Wu et al., 2021b; University of Leeds, 2024). These include:

- the first suspect case of Covid-19 in the UK (31st December 2019);
- the Wuhan lockdown (23rd January 2020);
- the World Health Organisation declaration of a public health emergency (30th January 2020);
- the Italy lockdown (10th March 2020); and
- the first UK lockdown (23rd March 2020).

234. Other key dates are:

- the UK media reporting Covid-19 in China and northern Italy (mid-February 2020); and
- the first reported UK death from Covid-19 (5th March 2020).

235. From the time series plots it is apparent that the onset of the decline in admissions with acute myocardial infarction occurred after (University of Leeds, 2024):

- the first suspect case of Covid-19 in the UK (31st December 2019);
- the Wuhan lockdown (23rd January 2020);

- the World Health Organisation declaration of a public health emergency (30th January 2020);
- the UK media reporting Covid-19 in China and northern Italy (mid-February 2020); and
- possibly just after or at the time of the first reported UK death from Covid-19 (5th March 2020).

236. The first UK death from Covid-19 was reported by the government on 5th March 2020, (Department of Health and Social care, 2020) and in the media on 6th March 2020 (The Guardian, 2020).

237. The first UK lockdown was initiated on 23rd March 2020, some 18 days after the first reported UK death from Covid-19, and after the onset of the decline in admissions with acute myocardial infarction.

238. Qualitatively, it is apparent from the date stamps on the time series plot of admissions activity that the onset of the decline in admissions with acute myocardial infarction in England occurred just after or at the time of the first reported UK death from Covid-19 (5th March 2020) and at about time of the Italy lockdown on 10th March 2020 (see Figure 5) (University of Leeds, 2024).

239. The paper by Mafham and colleagues found that the nadir in admissions with acute coronary syndrome in England was in early April 2020 (Mafham et al., 2020). Specific analysis of data from the Myocardial Ischaemia National Audit Project led by Gale found that the nadir in admissions to hospitals in England occurred on 19th April 2020 (Wu et al., 2021b).

240. Given the widespread reduction in admissions with acute coronary syndrome across England, Wales, Scotland and Northern Ireland, and people of different ages, sexes and ethnic groups, it is plausible that the causative factor(s) was common to all of these entities.

241. With this information to hand, it is therefore not unreasonable to suggest that the decline in admissions with acute myocardial infarction in England were associated with a number of factors that may have been accentuated by public messaging of the cases, deaths and hospital situations occurring as a result of the Covid-19 pandemic as it unfolded abroad and in the UK. These factors include, the public:

    - preferred not to attend hospital;
    - were following advice to isolate and/or shield;
    - wished to protect the NHS for use by others with Covid-19;
    - died from Covid-19 before attending hospital; and/or
    - were unable to attend hospital.

    Indeed, media broadcasting (which will have reached the vast majority of adults in the UK) may have ensured a maladaptive public response to seeking emergency treatment or symptoms of a heart attack. Qualitatively, the angle of the decline in admissions with acute myocardial infarction was less steep and approaching the nadir at date of the first UK lockdown suggesting that the onset of the first UK lockdown was much less likely to have been a causative factor in the decline in admissions with acute myocardial infarction.

242. The sequencing of events in England, Wales, Scotland and Northern Ireland is consistent with a report based on United States data that indicated that the reduction in acute myocardial infarction admissions preceded the United States shelter-in-place order by about two weeks (Solomon et al., 2020).

243. Theories about decreased air pollution, decreased 'work stress' and decreased physical activity being responsible for the reduction in heart attacks and therefore admission to hospital are unlikely to be substantiated. This is because the decline in admissions with acute coronary syndrome preceded the first UK lockdown (Wright, 2020, New York Times, 2020). Whilst there is some evidence for a time sensitive relationship between air pollution, emotional stress and heart attack, this is not conclusive. A time stratified case crossover study linking data from the Myocardial Ischaemia National Audit Project of 79,288 admissions with acute myocardial infarction in England and Wales between 2003 and 2006 found that high levels of PM(10) and No(2), which are typically markers of traffic related pollution were associated with transiently increased risk of myocardial infarction one to six hours after exposure (Bhaskaran et al., 2011). However, in a larger study of over 400,000 hospitalised acute myocardial infarction events in England and Wales from the Myocardial Ischaemia National Audit Project database, over two million cardiovascular disease emergency hospital admissions and over 600,000 cardiovascular deaths no clear evidence was found for the pollution effects on STEMI (Milojevic et al., 2014). Moreover, the next section in this report about deaths provides evidence to support the notion that there were deaths from cardiovascular disease that occurred in the community at a higher rate than expect during the Covid-19 pandemic – it is widely accepted that delays to seeking and receiving care for a heart attack are associated with major adverse clinical outcomes.

244. Another possible theory about the decline in admission with acute myocardial infarction us that there was an underreporting of cases because staff were undertaking other clinical activities in hospitals, there were delays to data processing of the submitted clinical and administrative data to NHS Digital, and there was imperfect recording of the data field for these datasets. It is highly likely that the decline in admissions and procedures was due to a reduction in clinical cases being admitted to hospital rather than delayed submissions and processing of the data. This is because:

- multiple different data sources have each demonstrated consistent findings in reduced admissions with acute myocardial infarction;
- the different data sources used different approaches to data collection;
- later, retrospective, analyses (annual public reporting) have been consistent with early analyses;
- first-hand information from cardiovascular healthcare professionals who were working during the Covid19 pandemic witnessed a decline in admissions for acute coronary syndromes; and
- For the Myocardial Ischaemia National Audit Project, regular notifications were actioned by the British Cardiovascular Society and British Cardiovascular Intervention Society to its members, and from the National Institute for Cardiovascular Outcomes Research to each hospitals' Myocardial Ischaemia National Audit Project audit clerk emphasising the importance of inputting and submitting contemporary data. A survey of each acute NHS hospitals' Myocardial Ischaemia National Audit Project data coding as well as tracking of submission status was undertaken, and from this, 99 'rapid-reporting' hospitals who provided weekly uploads of Myocardial Ischaemia

National Audit Project data were identified and used as primary analysis, as reported in the papers above by Gale and colleagues.

245. In early April 2020 there were internet-based publicity campaigns by the British Heart Foundation and the British Cardiovascular Society, (British Heart Foundation, 2024a) and by NHS England in May 2020 advising people who had symptoms of a heart attack to attend hospital (NHS England, 2020). Others also undertook public awareness messaging about the symptoms of heart attack (University of Leeds, 2024).

246. Following the nadir in admissions with acute coronary syndrome in England there was an increase in admissions although not to pre-pandemic rates, such that in the last week of May 2020 there was a proportional 16% decline in admissions with acute coronary syndrome compared with the 2019 baseline weekly average (Mafham et al., 2020, Wu et al., 2021b).

247. The data visualisation by Gale demonstrates a peak in admissions with acute myocardial infarction occurring towards the end of June 2020 (University of Leeds, 2024). This suggests that the public messaging is likely to have been effective. However, there was a latent effect and therefore other factors were at play such as a greater confidence in the NHS to be able to cope with the increase in cases of Covid-19, and the partial return of some routine clinical services.

248. There was a gradual decline in admissions with acute myocardial infarction from about the end of June 2020 to about one week after the date of the second UK lockdown occurring on 5th November 2020, when qualitatively the angle of the decline became steeper, and probably reached the second nadir in mid-November 2020 (University of Leeds, 2024).

249. The data visualisation also shows that at around the time of the second UK lockdown the impact of the second UK lockdown on admissions with acute myocardial infarction was less and the difference in effects on admissions for STEMI and NSTEMI was much less than that for the first UK lockdown (University of Leeds, 2024). It is possible therefore that publicity campaigns by the British Heart Foundation and the British Cardiovascular Society in early April, 2020, (British Heart Foundation, 2024a) and NHS England in May 2020 as well as messaging by others in the ensuing months, (NHS England, 2020) in which people with heart attack symptoms were encouraged to attend hospital, could have helped to allay fears of attending hospital when a heart attack was suspected. It is highly likely that there was also much greater confidence in the NHS to be able to cope with the increase in cases of Covid-19.

250. Qualitatively, the nadir in admissions with acute myocardial infarction in England occurred slightly later after the second lockdown in England than they did for the first lockdown (University of Leeds, 2024). This suggests that the impact of the onset of lockdowns may have had differential effects, which were minimal in the first decline. The onset of the second decline is difficult to discern, because there was a gradual decline in admissions with acute myocardial infarction from July 2020, with it becoming steeper at about the end of October 2020.

251. The second phase of reduced admissions with acute myocardial infarction in England continued until the end of the available access by Gale and colleagues to Myocardial Ischaemia National Audit Project data on the 8th December 2020. It is therefore not possible to comment in detail about how long the second decline in admissions with acute myocardial infarction extended or the slope and dynamics of the second recovery.

252. A data visualisation from the Myocardial Ischaemia National Audit Project and the National Audit of Percutaneous Coronary Intervention 2023 Summary Report suggest that the second

decline recovered in about February 2021, with a third decline occurring in about April, with recovery in about July 2021 (NICOR, 2023a).

253. The proportional decline in admissions with NSTEMI was greater than the proportional decline in admissions with STEMI. For the first decline, the reduction was estimated at 43% to 49% for NSTEMI and 23% to 29% for STEMI depending upon whether the data source for England was administrative clinical for (Mafham et al., 2020; Wu et al., 2021b). The greater impact on people with NSTEMI (not seeking help) was likely to be because STEMI is associated with more severe symptoms than NSTEMI, and therefore the threshold for going to hospitals despite the risk of being exposed to Covid-19 would be lower. Whereas, on balance, people with NSTEMI would have had a higher threshold for hospitalisation and opted to stay at home and or misinterpreted their symptoms as non-cardiac. In addition, people with NSTEMI are typically older and more comorbid and may have had greater hesitancy about seeking help. This age-STEMI/NSTEMI effect is evident in the Myocardial Ischaemia National Audit Project and the National Audit of Percutaneous Coronary Intervention 2023 Summary Report (NICOR 2023). It shows that people aged 75 years and over and admitted with NTEMI had a greater decline in admissions than all other ages of people with NSTEMI and all ages of people with STEMI.

Deaths

254. A study led by the author (Gale) of this report analysed deaths with cardiovascular disease listed on the medical certificate of cause of death, either as the immediate cause or a contributory cause of death. Historical trends of cardiovascular deaths in England and Wales between January 2014 and June 2020 were analysed, and the trends from earlier years were used to estimate how many deaths would have been expected from 1st February 2020 to 30th June 2020 had the pandemic not occurred and previous trends continued. Administrative codes that were appended to the death certificates were used to identify whether a death was "related" to COVID-19, that is, where Covid-19 is recorded in parts Ib or Ic (part of the chain of events leading to death) but cardiovascular disease was the immediate cause in Ia. Examples of this might be where someone was infected with Covid-19, but they had a fatal pulmonary embolus (blood clot in the lungs) or a heart attack that the clinician completing the certificate believes was caused by the infection, rather than dying solely due to respiratory failure. In this case, Covid-19 is the underlying cause of death even though it was not the immediate cause. Acute cardiovascular deaths defined as "related" to Covid-19 could also include those the completing clinician believes are less closely causal, in part II of the death certificate, where they "contribute" to the death but are not in the direct chain of events (Wu et al., 2021c). There is inevitably a subjective element of clinical judgement about whether Covid-19 was a direct underlying cause, or merely a contributory cause, which is why these categories are combined for this study.

    254.1 After 2nd March 2020, there were 28,969 acute cardiovascular deaths of which 5.1% related to Covid-19 (7.9% suspected; 92.1% confirmed) (Wu et al., 2021c).

    254.2 There was an excess acute cardiovascular mortality of 2,085 deaths (proportional increase of 8% compared with the expected historical average in the same time period of the year) (Figure 11) (Wu et al., 2021c).

    254.3 Qualitatively, the excess acute cardiovascular mortality began in late March 2020 and peaked in early April 2020 (Figure 11) (Wu et al., 2021c).

    254.4 While hospital remained the most frequent place of acute cardiovascular death, there were proportionally fewer deaths in hospital (53.4% vs 63.0% of all acute

cardiovascular deaths) and more at home (30.9% vs 23.5%), and in care homes (15.7% vs 13.5%) compared with the non-Covid-19 period (Figure 11) (Wu et al., 2021c).

254.5 Acute cardiovascular deaths in the community accounted for nearly half of all acute cardiovascular deaths in the period 1st February 2020 to 30th June 2020 (Wu et al., 2021c).

254.6 Acute cardiovascular deaths at the persons' home had the greatest excess acute cardiovascular deaths (2,279 deaths, proportional increase of 35%), followed by acute cardiovascular deaths at care homes and hospices (1,095 deaths, proportional increase of 32%) and acute cardiovascular deaths in hospital (50 deaths, no proportional increase) (Figure 11) (Wu et al., 2021c).

254.7 The number of excess acute cardiovascular deaths were higher among men than women (1182 vs 948; a proportional increase of 8% vs 7%) and were highest in the age category 18 years to 49 years (176, a proportional increase of 17%) (Wu et al., 2021c).

254.8 The most frequent cause of acute cardiovascular death during this period was stroke (10,318, 35.6%), followed by acute coronary syndrome (7,098, 24.5%), heart failure (6,770, 23.4%), pulmonary embolism (a blood clot in the lungs) (2,689, 9.3%) and cardiac arrest (1,328, 4.6%) (Wu et al., 2021c).

254.9 Deep vein thrombosis (a blood clot in the leg) demonstrated the greatest increase in excess acute cardiovascular death (20, a proportional increase of 23%), followed by pulmonary embolism (437, a proportional increase of 19%) and cardiogenic shock (54, a proportional increase of 14%) (Wu et al., 2021c).

254.10 Compared with acute cardiovascular deaths prior to 2nd March 2020, acute cardiovascular deaths that were also related to Covid-19 on the medical certificate of cause of death were more likely to occur in hospital (81.1% vs 63.0%), much less at home (7.1% vs 23.5%) and remained of similar proportions to non-Covid-19-related acute cardiovascular deaths in care homes (13.5% vs 11.8%) (Wu et al., 2021c).

254.11 The rate of Covid-19-related excess acute cardiovascular deaths was higher in hospitals than in care homes (a proportional increase of 7% vs +5%) and less at home (a proportional increase of 2%) (Wu et al., 2021c).

254.12 Covid-19-related excess acute cardiovascular deaths occurred in similar proportions for men and women (a proportional increase of 6% vs 5%), and the rate of excess Covid-19-related acute cardiovascular deaths was comparable across different age groups (Wu et al., 2021c).

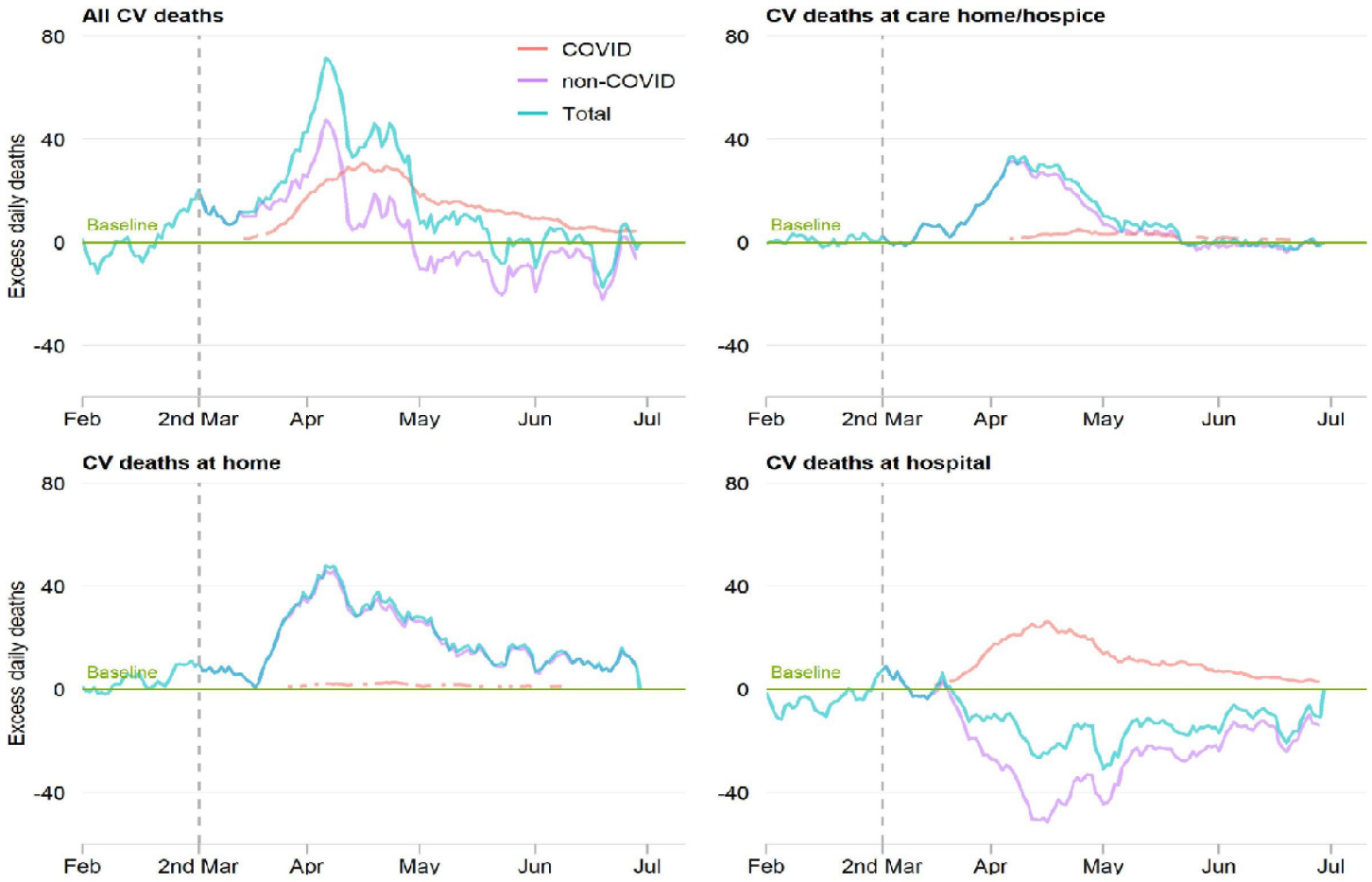
254.13 The greatest proportional increase of Covid-19-related excess acute cardiovascular death was due to pulmonary embolism (251, a proportional increase of 11%) followed by stroke (562, a proportional increase of 6%), acute coronary syndrome (318, a proportional increase of 5%), cardiac arrest (93, a proportional increase of 6%) and heart failure (273, a proportional increase of 4%) (Wu et al., 2021c).

254.14 The most frequent causes of excess acute cardiovascular death in care homes and hospices were stroke (715, a proportional increase of 39%) and heart failure (227, a proportional increase of 25%), which compared with acute coronary syndrome (768, a proportional increase of 41%) and heart failure (734, a proportional increase of

33%) at home, and pulmonary embolism (155, a proportional increase of 13%) and cardiogenic shock (55, a proportional increase of 15%) in hospital (Wu et al., 2021c).

254.15 For stroke, acute coronary syndrome, heart failure and cardiac arrest, the numbers of deaths in hospital were lower than the historical baseline (Wu et al., 2021c).

Figure 11. Monthly time series of acute cardiovascular deaths, by place of death (Wu et al., 2021c). The number of daily cardiovascular deaths is presented using a 7-day simple moving average (indicating the mean number of daily cardiovascular deaths for that day and the preceding 6 days) from 1st February 2020 up to and including 30th June 2020, adjusted for seasonality. The number of non-Covid-19 excess cardiovascular deaths each day from 1st February 2020 were subtracted from the expected daily death estimated using Farrington surveillance algorithm in the same time period. The green line is a zero historical baseline. The red line represents daily Covid-19 cardiovascular death from 2nd March to 30th June 2020; the purple line represents excess daily non-Covid-19 cardiovascular deaths from 2nd March to 30th June 2020 and the blue line represents the total excess daily cardiovascular deaths from 1st February to 30th June 2020.



255. Data collected by the National Records Scotland found similar trends in excess deaths from heart disease and stroke (National Records of Scotland, 2013).

255.1 There was an excess in deaths from heart disease and stroke across all locations in Scotland from March 2020 to May 2020.

255.2 There was an excess in deaths from heart disease and stroke across in homes and non-institutions in Scotland from early March 2020 to mid-September 2020.

255.3 There was a decline in deaths from heart disease and stroke across hospitals in Scotland from March 2020 to May 2020.

255.4 According to Public Health Scotland data, in September 2020 there was a 20.4% proportional increase in deaths from acute myocardial infarction in Scotland compared with the 2015-2019 average (Public Health Scotland, 2023a). The proportional increase was 30.5% for men and 6.2% for women.

256. A separate study, co-authored by Gale, analysed mortality data based on any of the 10th revision of the International Statistical Classification of Diseases and Related Health Problems codes corresponding to the immediate cause of death and contributed causes (as stated on the medical certificate of cause of death) The study included deaths in England and Wales between 2015 and 2020, and was organised in two categories: direct or indirect, whereby direct deaths were where the underlying cause of death was attributed to Covid-19 plus respiratory deaths. Deaths were also analysed by groups of diseases, one of which was deaths from cardiovascular and diabetes.

256.1 The study found that between 7th March 2020 to 2nd October 2020 (the first 30 weeks of the pandemic period) there were 62,321 excess deaths in England and Wales (Kontopantelis et al., 2021).

256.2 There was an increase in cardiovascular and diabetes deaths, with an estimated 6,887 excess deaths in England and Wales, with similar numbers for males and females.

256.3 The highest number of excess cardiovascular and diabetes deaths occurred in the 85 years and over age group (1,907), followed by the 45 years to 65 years (1,379) and 75 years to 84 years (1,359) age groups.

256.4 There was no socioeconomic gradient evident for the excess cardiovascular and diabetes deaths, which contrasted with excess deaths from all causes which were higher in more deprived areas.

256.5 There were fewer than expected cardiovascular and diabetes deaths in hospitals (−3,082), and more in private homes (6,667) and care homes (2,736).

256.6 Nationally, most of the excess deaths due to cardiovascular disease and diabetes occurred during the first half of the first wave of the pandemic (April 2020 to mid-May 2020), with a second, smaller increase from mid-July 2020 to August 2020.

257. Another study, co-authored by Gale, of the national mortality registers in England and Wales was undertaken using data from 27th December 2014 until 25th December 2020, covering 3,265,937 deaths (Kontopantelis et al., 2022). Deaths were analysed by groups of diseases, one of which was deaths from cardiovascular and diabetes.

257.1 It found that between 7th March 2020 and 25th December 2020, there were an estimated 65,941 (95% CI: 47,542 to 84,340) excess year of life lost in England and Wales due to cardiovascular and diabetes deaths, reflecting a 6% (95% CI: 4% to 7%) increase compared to the equivalent time period in 2019 (Kontopantelis et al., 2022).

257.2 The number of years of life lost attributable to cardiovascular and diabetes deaths was over three times greater for men than women (50,877; 95% CI: 43,841 to 57,913 versus 15,064; 95% CI: 2,610 to 27,519) (Kontopantelis et al., 2022).

257.3 The number of years of life lost attributable to cardiovascular and diabetes deaths was over three times greater for men than women (50,877; 95% CI: 43,841 to 57,913 versus 15,064; 95% CI: 2,610 to 27,519) (Kontopantelis et al., 2022).

257.4 There was an overall socioeconomic gradient evident in these excess years of life lost attributable to cardiovascular and diabetes deaths; 11,927 (95% CI: 8,994 to 14,950) and 22,776 (95% CI: 18,788 to 26,764) excess years of life were estimated in the least and most deprived areas, respectively (Kontopantelis et al., 2022).

257.5 In England and Wales, most of the excess years of life lost due to cardiovascular disease and diabetes occurred during the first half of the first wave of the pandemic (April 2020 to mid-May 2020), but observed years of life lost exceeded predictions until the end of 2020 (Kontopantelis et al., 2022).

257.6 There were 75 (95% CI: 31 to 119) excess years of life lost per 100,000 of the population, ranging from 13 (95% CI: −25 to 55) per 100,000 in the East of England to 163 (95% CI: 112 to 213) per 100,000 in the West Midlands. Rates ranged from 23 (95% CI: −20 to 65) per 100,000 in the second least deprived to 144 (95% CI: 97 to 191) per 100,000 in the most deprived quintile (Kontopantelis et al., 2022).

258. An analysis, co-authored by Gale, of 144,279 death certificates in England and Wales between 1st March 2020 and 12th May 2020, and organised in two categories: direct or indirect, whereby direct deaths were where the underlying cause of death was attributed to Covid-19 plus respiratory deaths, found the rate of reported underlying chronic conditions was generally higher in Covid-19 deaths than non-Covid-19 deaths, with the most prevalent reported conditions being hypertension (Covid-19 vs non-Covid-19: 19.0% and 11.2%) (Mohamed et al., 2020). The rates of pre-existing ischaemic heart disease were similar in Covid-19 (11.4%) and non- Covid-19 (12%) deaths.

259. An analysis, co-authored by Gale, of adults (aged 18 years and over) who received PCI between 1st January 2017 and 10th May 2020 in England and as recorded in the British Cardiovascular Intervention Society registry (the national clinical register of PCI) found that the rates of death at 30 days increased from 2.5% in February 2020 to 3.2% in March 2020, due to higher rates of post-discharge mortality, with 59.6% of 30-day deaths due to cardiac causes (Mohamed et al., 2021c).

260. An analysis, led by Gale, of 3,451,538 death certificates in England and Wales between 1st January 2014, and 30th June 2020 reported that after the first Covid-19 death on 2nd March 2020 to 30th June 2020, there was an excess mortality of 57,860 (a proportional increase of 35%) compared with the expected daily deaths estimated by the Farrington surveillance algorithm for daily historical data between 2014 and 2020 (Wu et al., 2021a). The estimated excess deaths due to cardiac disease in this period were 2,225 deaths. which including 1,050 related to Covid-19, was a proportional increase of 9%. Between 2nd March 2020 and 30th

June 2020 there were 2,485 excess deaths at home due to cardiac disease, very few of which involved Covid-19. During this period, there were 1,211 excess deaths in care homes due to cardiac disease. During this period there were 1,398 fewer deaths in hospital due to cardiac disease than expected.

261. According to the 2021/22 British Cardiovascular Intervention Society audit report, in-hospital mortality rates following primary PCI in England Wales, Scotland and Northern Ireland combined were 5.4% in 2018/19 and 5.5% in 2019/20 and 5.5% in 2020/21 (British Cardiovascular Intervention Society, 2022).

262. By means of a Notice under Regulation 3(4) of the NHS (Control of Patient Information Regulations) 2002 issued by the Secretary of State for Health and Social Care required NHS Digital to share confidential patient information with organisations entitled to process this for Covid-19 purposes, an analysis of data from the Myocardial Ischaemia National Audit Project, led by Gale, was deterministically linked the clinical registry data to Civil Registration Deaths Data received up to 21st June 2020.

    262.1 This showed that unadjusted all-cause mortality for before and during the first decline in admissions with acute myocardial infarction were comparable for seven-day mortality (4.4% vs 4.7%) and 30-day mortality (7.0% vs 7.6%) were comparable (Wu et al., 2021b).

    262.2 For admissions with STEMI in England crude all-cause mortality at 30 days decreased from 10.2% pre-lockdown to 7.7% in the decline phase and increased to 8.3% in the recovery phase (Wu et al., 2021b).

    262.3 For patients hospitalised with NSTEMI crude all-cause mortality at 30 days increased from 5.4% pre-lockdown to 7.5% in the decline phase and decreased to 5.0% in the recovery phase (Wu et al., 2021b).

263. A study, co-authored by Gale, of 34,127 patients who received PCI for STEMI in England between January 2017 and April 2020 as recorded in the National Audit of PCI reported that the in-hospital mortality rate was 4.8% before the lockdown and it was 3.5% after the lockdown. Following adjustment for baseline characteristics, no differences were observed for in-hospital death and major adverse cardiovascular events (Kwok et al., 2020b).

264. A study, co-authored by Gale, analysed 374,899 major cardiac and cardiothoracic inpatient and outpatient procedures performed in people aged 18 years and over in England between 1st January and 31st May for each of the years 2018, 2019, and 2020 as recorded in Hospital Episode Statistics (Mohamed et al., 2021a).

    264.1 Compared with the corresponding months in 2018 and 2019, in 2020 there was an increase in the rates of death at 30 days following cardiac catheterisation in England from 1.1% to 1.6% (Mohamed et al., 2021a).

    264.2 Compared with the corresponding months in 2018 and 2019, in 2020 the rates of death at 30 days following PCI in England were similar 2.7% to 2.8% (Mohamed et al., 2021a).

    264.3 Compared with the corresponding months in 2018 and 2019, in 2020 the rates of death at 30 days following coronary artery bypass grafting surgery in England were similar 1.1% to 1.8% (Mohamed et al., 2021a).

265. The Scottish Cardiac Audit Programme was commissioned from 2021 and as such there is no report of deaths during the pandemic period (Public Health Scotland, 2024).

Explanation(s) for excess cardiovascular deaths

266. In effect, there is evidence from national administrative records of death certificates in England and Wales for an excess of cardiovascular deaths during the pandemic period, and for a 'displacement of the place of death'. That is, during the Covid-19 pandemic there were more deaths from acute cardiovascular causes than expected, and while hospital remained the most frequent place of acute cardiovascular death there were proportionally fewer deaths in hospital and more deaths at home and in care homes compared with during non-Covid-19.

267. While stroke and acute coronary syndromes accounted for the vast majority of acute cardiovascular deaths, the number of deaths in hospital due to these conditions fell below that expected for the time of year and it increased in the community, and particularly in people's homes.

268. This signifies that the public either did not seek help for suspected heart attack or were not referred to hospital for suspected heart attack during the pandemic. Given that acute myocardial infarction is frequently an intrusive and symptomatic condition, the vast majority of people with a heart attack call the emergency services and attend hospitals using the ambulance services. In 2021/2022 the proportion of people with a heart attack admitted directly to a heart attack centre in England, Wales and Northern Ireland was 81% (British Cardiovascular Intervention Society, 2023). Analysis of the Myocardial Ischaemia National Audit Project data for England led by Gale found that the proportion of people admitted with acute myocardial infarction who self-presented to hospital before the first UK lockdown was 20.6%, and it was 11.4% between 23rd March 2020 and 19th April 2020 (Wu et al., 2021b). That is, during the Covid-19 pandemic proportionally more people with heart attacks used the ambulances services. Analysis of national clinical registry and national administrative datasets for England as detailed in the section above about admissions to hospital describe the decline in admissions with acute myocardial infarction. Analysis of the Myocardial Ischaemia National Audit Project data for England led by Gale, and detailed in the section above about admissions to hospital, also describes the higher rates of people admitted with acute myocardial infarction who also had a life-threatening heart rhythm disorder (likely as a consequence of delays to seeking help) (Wu et al., 2021b). The temporality of the times series plots of decline in admissions with acute myocardial infarction and excess acute cardiovascular deaths tally. That is, the excess in acute cardiovascular deaths began in late March 2020 and peaked in early April 2020, and the onset of the decline in admission with acute myocardial infarction began in early March 2020 and the nadir was on 19th April 2020 (Wu et al., 2021b). This suggests that people with heart attacks more often stayed in the community (less frequently attended hospital) and more often died in the community (as a result of not receiving time-dependent heart attack treatments).

269. The time series plots for acute cardiovascular deaths show that the excess in acute cardiovascular deaths began in late March 2020 and peaked in early April 2020 (Wu et al., 2021c). This suggests that information in the media and government directives at the time including the onset of the first UK lockdown on 23rd March 2020, and messaging to protect the NHS, could have accentuated a maladaptive public response for cardiovascular emergencies requiring urgent hospital treatment. People who were clinically vulnerable including those with diabetes and chronic renal failure (which are risk factors for ischaemic heart disease as well as people with heart disease and those aged 70 years and over were advised to 'stay at home

as much as possible' (NHS, 2020). This could have been misinterpreted, and created hesitancy about seeking help for symptoms of a heart attack.

270. An additional explanation is that those people who would have been expected to have a heart attack and therefore present to hospital instead died in the community from Covid-19 'before having a heart attack'. People with NSTEMI tend to be older and more comorbid, and it is this demographic who were at higher risk of death should they have contacted Covid-19.

271. There appeared to be no socioeconomic gradient for excess cardiovascular and diabetes deaths (Kontopantelis et al., 2021). This suggests that the consequences of delays to seeking help for heart attack transcended the wider population demographics. The years of life lost analysis did identify a socioeconomic gradient, and this may, in part, be because life expectancy varies by socioeconomic status.

272. The analysis of the national clinical registries for heart attack and PCI found that the rates of in-hospital death after acute myocardial infarction and or PCI were comparable to the rates of in-hospital death before the Covid-19 pandemic (Mohamed et al., 2021c) (Wu et al., 2021b). However, rates of death after PCI and for people with NSTEMI at 30-days appeared to increase during the pandemic. This suggests that in–hospital care was upheld, but that disease specific factors (perhaps such as worse clinical presentation and or Covid-19 infection) contributed to a higher risk of death despite treatment of the heart attack.

Other cardiovascular consequences

273. A cohort study in the United States comprising 153,760 individuals with Covid-19 who were compared with over 10 million controls found that from 30 days to one year after infection with Covid-19 individuals were at higher risk of ischaemic heart disease (as well as a range of other cardiovascular diseases) including acute coronary syndrome, ischaemic cardiomyopathy and angina (Xie et al., 2022). This signals the detrimental latent impact of the Covid-19 pandemic on the cardiovascular health of the nation.

274. In addition, the Covid-19 pandemic caused major disruption to cardiovascular research in the UK, with clinical research staff being redeployed to support NHS frontline services and clinical trials discontinued or paused until the appropriate mechanisms could be continued (British Heart Foundation, 2024b).

275. The consequences of the decline in admissions with acute coronary syndrome will also have been played out in latent disease effects (Nadarajah et al., 2022). That is, more new cases of heart failure, stroke, renal failure, atrial fibrillation and repeat heart attack, and their associations with subsequent mortality (Hall et al., 2024).

Summary

276. During the Covid-19 pandemic there was a substantial and widespread decline in the number of admissions to hospital with acute coronary syndrome. It was estimated that between January 2020 and May 2020 there were 40% less admissions with acute coronary syndrome than would be expected for that time of year in England. We calculated that between 1st March 2020 and 2nd Nov 2020 (shortly before the date of second lockdown in England) there were potentially 9,303 fewer admissions with acute myocardial infarction across the UK. For the first

decline in admissions to hospital, which occurred between 1st March 2020 and 17th May 2020 there were potentially 4,915 fewer admissions with acute myocardial infarction across the UK.

277. The onset of the decline was in early March 2020 or late February 2020, before the first UK lockdown and after the UK media reporting Covid-19 in China and around the time of the first reported UK death from Covid-19. The nadir in admissions was on 19th April 2020.

278. Women, the elderly, Asian and mixed ethnicity people, those with comorbidities and those living in the East Midlands were less frequently admitted to hospital in England with acute coronary syndrome. However, there was also a proportional increase in Black Asian and Minority Ethnic group patients from during the pandemic, but these patients were younger, more frequently male and more likely to present with STEMI.

279. It is possible that people either preferred not to attend hospital, were following advice to isolate and / or shield, wished to protect the NHS for use by others with Covid-19, died from Covid-19 before attending hospital, and/or were unable to attend hospital. It is possible that the response by the public was associated with public messaging.

280. Of people who were admitted with acute coronary syndrome, those who were Covid-19-positive were more likely to present with NSTEMI.

281. Although there was a recovery in admissions with acute myocardial infarction, this did not reach levels that were expected for that time of year, and from June 2020 there was a gradual decline in admission with acute myocardial infarction.

282. The declines in admissions with NSTEMI were greater than the declines in admissions with STEMI. Typically, STEMI is associated with more severe symptoms than NSTEMI, and NSTEMI more often affects older and more comorbid people than STEMI.

283. During the Covid-19 pandemic there was an increase in acute cardiovascular deaths. It was estimated that between February 2020 and June 2020 there were 8% more acute cardiovascular deaths than expected for that time of year.

284. The excess in acute cardiovascular mortality deaths began in late March 2020 and peaked in early April 2020.

285. Although hospitals remained the most common place for an acute cardiovascular death, there were proportionally fewer deaths in hospitals and more in the community – in people's homes and in care homes.

286. It is possible that older and more comorbid people, who are more likely to have NSTEMI will have stayed at home or in their care home during the pandemic.

287. Those people with NSTEMI who did present to hospitals were slightly younger, less comorbid and less unwell that would be expected, suggesting that people with NSTEMI who were older, more comorbid and more unwell did not attended hospital, and therefore who may have died in the community.

288. Patients admitted to hospital with acute coronary syndrome and who also had an invasive coronary procedure between March 2020 and May 2020 were more frequently critically unwell and in need of emergency care. This aligns with the notion that patients who did attend hospital were in the later stages of acute myocardial infarction or that they called for help when they were in a 'life or death' situation.

289. The timings of the decline in admissions with acute myocardial infarction and excess acute cardiovascular deaths appear to tally with each other, suggesting that they are associated. This is not unsurprising given the increased risk of death that occurs with untreated heart attack.

290. There will be many more adverse health consequences of the delays to seeking help for acute coronary syndrome, which have not been scientifically assessed, analysed and reported. This will include more new cases of heart failure, stroke, renal failure, atrial fibrillation and repeat heart attack, and their associations with subsequent death.

291. The evidence for this section was only possible because of established nationwide systems for the collection of structured health data including national clinical registries and administrative data, predominantly for England.

292. However, there was no formal tried and tested mechanism and overarching organisation to coordinate the rapid assimilation, curation, linkage and analyses of these data sources for government and public information, which during the pandemic was initiated and delivered by clinical and academic volunteers.

293. The author of this report, Gale, led the updated times series plots of activity for acute myocardial infarction that were displayed on a publicly available website (University of Leeds, 2024). According to data access bestowed to the analytics team at the University of Leeds, the analyses were only extended to 11th February 2021.

294. Publications of the analysis of data for cardiovascular deaths and, to a lesser extent, admissions with acute coronary syndrome relate to the first wave of the pandemic. The author is not aware of publications of the analysis of data specifically about cardiovascular deaths in the second and third waves of the pandemic for the UK and / or for the entire duration of the report period.

II - Chronic coronary syndrome

Preface

295. This section will provide evidence for the decline in non-acute (elective) care for ischaemic heart disease. Such activity will relate to chronic coronary syndromes because acute coronary syndromes are a medical emergency and present as unscheduled hospital admissions.

296. In contrast to acute coronary syndromes, published studies, data and quantitative information about the impact of the pandemic on chronic coronary syndromes is limited. Uniquely, however, there are survey data from patients and this provides an important perspective about the impact of the Covid-19 pandemic on care for chronic coronary syndromes.

297. A single centre study (Dumfries and Galloway Royal Infirmary, Scotland) reported a proportional decrease of 93% and 89% in each of the periods 21st March 2020 to 20th April 2020 and 21st April 2020 to 20 May 2020 for face to face cardiology outpatient clinics, with a proportional reduction of 80% and 47% in referrals by general practitioners to cardiology outpatient clinics during these two periods (Fersia et al., 2020).

298. A survey of stress echocardiography (a heart scan with the heart exercising and at rest used for diagnosis of chronic coronary syndromes) activity at 31 hospitals in England in July 2020 and November 2020, compared with January 2020, found a proportional decrease of 55% in

the number of studies performed in the first wave of the pandemic and wave with a recovery exceeding pre-pandemic levels in the second wave of the pandemic (Dockerill et al., 2021). The stress exercise service had stopped in 70% of sites in wave one, compared to 19% in wave two.

299. A study of patient experiences drawn from 2,000 anonymous posts from the British Heart Foundation's online forum by the Nuffield Trust found that many people (assumed to have cardiovascular disease) had shared experiences of cancelled appointments, even after they were told they were a priority (Hutchings, 2020).

    299.1 The study reported that face to face services like cardiac rehabilitation were either suspended or moved to remote.

    299.2 People felt they were missing out on peer support, unable to speak to their usual consultant and were unaware of who might answer their questions.

    299.3 Some people were concerned about the possible impact of the pandemic on their own condition, and some felt that during a pandemic their situation was less important.

    299.4 There were concerns about using the NHS for fear of getting the virus, thinking that staying away was safer.

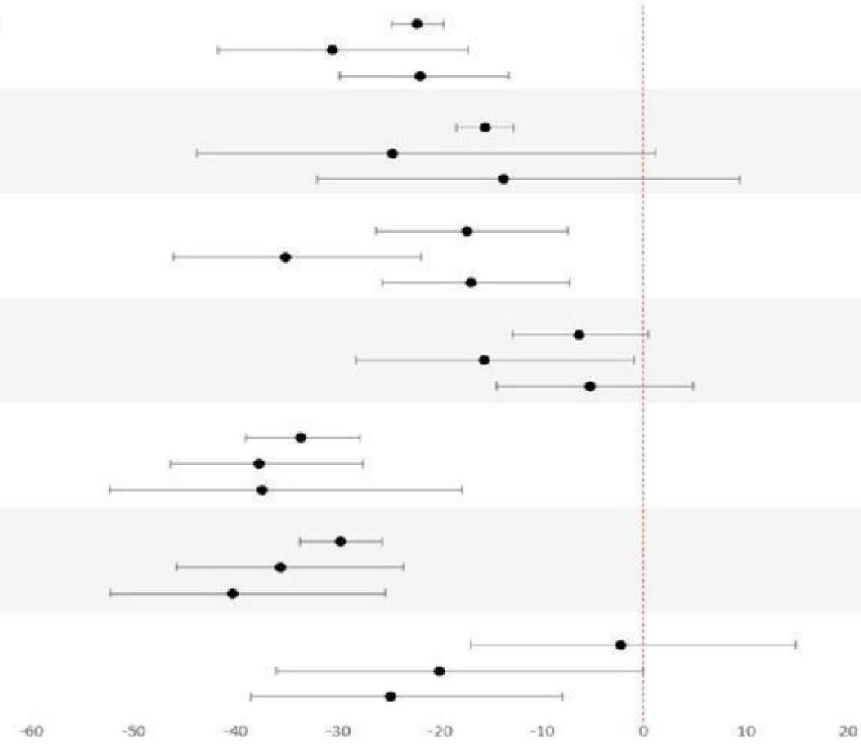
300. As part of the British Heart Foundation Data Science Centre's CVD-COVID-UK/COVID-IMPACT research programme,(Wood et al., 2021) a study of admissions and procedures for six major cardiovascular conditions (acute coronary syndrome, heart failure, stroke/transient ischaemic attack, peripheral arterial disease, aortic aneurysm, and venous thromboembolism) was conducted using the Admitted Patients Care Hospital Episode Statistics data for England, Scotland and Wales between 2016 and 2021 (Wright et al., 2023).

    300.1 There were fewer elective (non-acute) admissions for all cardiovascular conditions studies in 2020 with a total of 16,560 (23% proportional decrease) fewer in the three countries (22% proportional decrease for England and Wales, 30% proportional decrease for Scotland) (Figures **12** and **13**) (Wright et al., 2023). However, the confidence interval around the point estimate (percentage decrease) is wider for each of Scotland and Wales suggesting uncertainty in the precision of the estimate.

    300.2 No elective admissions for the studied cardiovascular conditions were higher than expected (Wright et al., 2023).

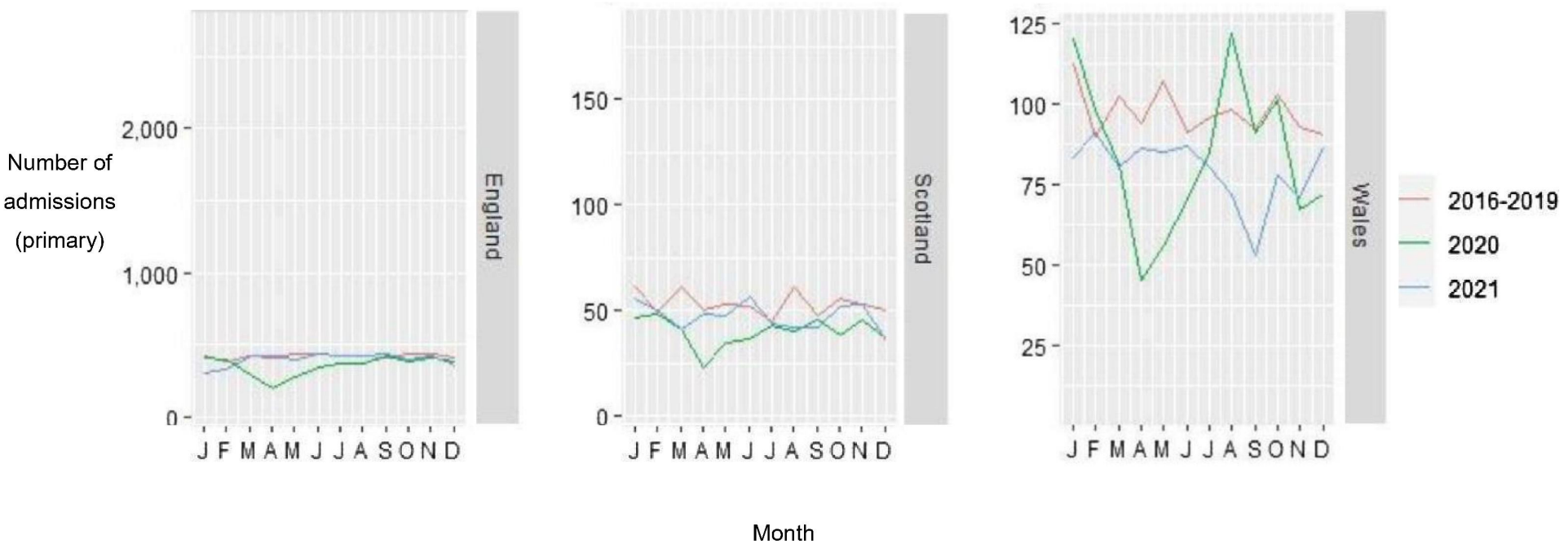
Figure 12. Annual counts and percentage change in elective admissions between pre-pandemic (2016–19) and 2020 for England, Scotland and Wales (Wright et al., 2023).

Condition	Mean No. 2016/19	Total No. 2020	Difference 2016/19 to 2020	% change (95% CI) 2016/19 to 2020
Elective admissions				
All conditions				
England	63852	49681	-14171	-22 (-25,-20)
Scotland	4775	3320	-1455	-30 (-42,-17)
Wales	4262	3328	-934	-22 (-30,-13)
ACS				
England	5031	4249	-782	-16 (-18,-13)
Scotland	640	483	-157	-25 (-44,1)
Wales	1168	1008	-160	-14 (-32,9)
HF				
England	11303	9344	-1959	-17 (-26,-7)
Scotland	751	488	-263	-35 (-46,-22)
Wales	461	383	-78	-17 (-26,-7)
Stroke/TIA				
England	5680	5318	-362	-6 (-13,0)
Scotland	628	530	-98	-16 (-28,-1)
Wales	893	846	-47	-5 (-14,5)
AA				
England	7175	4767	-2408	-34 (-39,-28)
Scotland	463	289	-174	-38 (-46,-27)
Wales	401	251	-150	-37 (-52,-18)
PAD				
England	28703	20179	-8524	-30 (-34,-26)
Scotland	1955	1260	-695	-36 (-46,-23)
Wales	1081	646	-435	-40 (-52,-25)
VTE				
England	5960	5824	-136	-2 (-17,15)
Scotland	338	270	-68	-20 (-36,0)
Wales	258	194	-64	-25 (-38,-8)



ACS= Acute Coronary Syndrome, HF = Heart Failure, TIA= Transient Ischaemic Attack, AA= Aortic Aneurysm, PAD = Peripheral Arterial Disease, VTE= Venous Thromboembolism

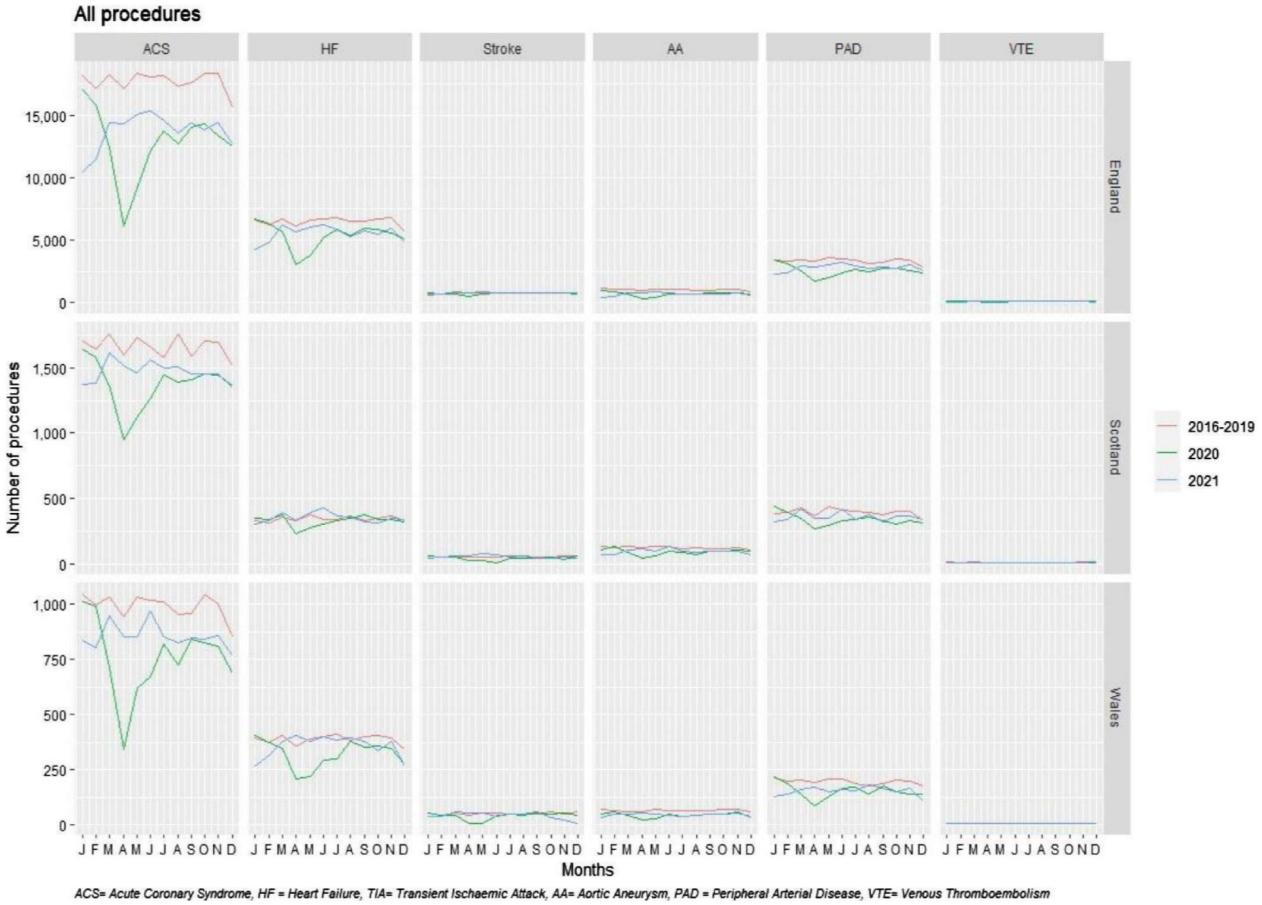
Figure 13. Monthly elective hospital admissions for cardiovascular disease as primary diagnosis across subtypes, across three countries in the UK and across pre-pandemic (2016–19) and pandemic (2020–21) periods (Wright et al., 2023).



300.3 In 2020, there were 96 554 (−24%) fewer total procedures for all six cardiovascular conditions combined in the three UK countries compared with the expected number in 2016 to 2019. In 2021, there were 76 541 (−19%) fewer cardiovascular procedures (Figure 14). In 2020, admissions for all cardiovascular disease procedures in the three individual countries were lower than expected and varied by country (England −25%, Scotland −16%, Wales −23%) (Wright et al., 2023).

300.4 In 2020 compared with 2016 to 2019, reductions were evident for PCI (range: −17% in Scotland to −27% in England), coronary artery bypass grafting surgery (−23% in Scotland to −44% in Wales), carotid endarterectomy (England −24% to Wales −43%) and limb angioplasty (−16% in England to −30% in Wales) (Figure 14) (Wright et al., 2023).

Figure 14. Monthly total procedures for cardiovascular conditions across three countries in the UK and across pre-pandemic (2016 to 2019) and pandemic (2020 to 2021) periods (Wright et al., 2023).



301. In England, there was a reduction in overall left main stem procedural activity, including PCI and coronary artery bypass grafting surgery procedures, with an estimated deficit of 1,300 cases (a proportional decrease of -48.8%) between March 2020 and July 2020, compared with previous years' (2017–2019) averages (Mohamed et al., 2021b). The left main stem is the name given to the coronary artery that supplies blood to the left side of the heart. Significant left main stem coronary disease is of prognostic (future clinical outcomes) importance due to

the large amount of heart muscle that it supplies, and is considered a Class 1 indication for revascularisation (Neumann et al., 2019).

302. A study of 126,491 patients who received PCI procedures at 44 hospitals in England between January 2017 and April 2020 as recorded in the National Audit of PCI register between January 2017 and April 2020 found that after 23rd March 2020 there was a 49% fall in the number of PCI procedures (Kwok et al., 2020a). The decrease was greatest in PCI procedures performed for stable angina (a proportional decline of -66%).

303. General practitioners were advised to postpone routine referrals to free up capacity for hospitals to deal with the large numbers of expected severe cases of Covid-19.

304. Analysis of about 500,000 patients registered at 84 practices in England using the Clinical Practice Research Datalink primary care dataset found that routine referrals (all diseases) were a proportional 74% lower between the weeks commencing 15th March 2020 and 21st June 2020 when compared with the same weeks in 2019 (Watt et al., 2020).

    304.1 Routine referrals (all diseases) had not recovered towards the end of June 2020, remaining at a proportional decrease of 50% (Watt et al., 2020).

    304.2 The reduction in referral occurred before the date of the first UK lockdown (Watt et al., 2020).

305. Given that chronic coronary syndromes are a progressive disease, with an expected morbidity and mortality rates as detailed in the earlier section of this report, it is logical to suggest that some patients with chronic coronary syndrome will have developed an acute coronary syndrome, and some will have developed additional cardiovascular diseases such as heart failure, stroke, and atrial fibrillation.

306. The extent of acute cardiovascular events and fatalities as a result of delayed care for chronic coronary syndromes is likely to be less than that identified for acute coronary syndromes. Deaths for chronic coronary syndromes that may have occurred as a result of the Covid-19 pandemic will be seen during the pandemic and also as latent effects. However, these deaths have not been investigated and quantified.

<u>Explanation(s) for decline in chronic coronary syndromes activity</u>

307. Routine referrals for hospital outpatient ischaemic heart disease consultations from primary care were postponed to enable hospitals to free up staff and infrastructure to deal with the anticipated large number of admissions to hospital with Covid-19.

308. Routine follow-up outpatient consultations for people with lower risk ischaemic heart disease were also postponed to increase hospital capacity

309. People referred to hospital by primary care with suspected higher risk ischaemic heart disease or who had higher risk ischaemic heart disease were offered hospital consultations either remotely or in person. That is, there was a triage of referrals and outpatient lists by hospitals of their patients with ischaemic heart disease that balanced the risk of harm of postponing an appointment with the risk of drawing staff away from critical hospital activities and exposing staff to Covid-19.

310. In addition to this there was a fear by the public of accessing services that may be used by others who were in greater need, and of their concerns about becoming infected with Covid-19.

Summary

311. Information from nationwide and local level studies provides evidence for the substantial decline in elective admissions and associated procedures for patients with chronic coronary syndromes during the Covid-19 pandemic.

312. Patient survey data are unique and informative. They reveal concerns by the public that elective care for cardiovascular disease was not prioritised, that their situation may deteriorate, and that they were fearful of attending hospital.

313. Chronic coronary syndromes are a progressive disease, and it is likely that people with a chronic coronary syndrome will have witnessed worse health related quality of life, more symptoms, psychological stress, acute cardiovascular events and fatalities.

314. The extent of acute cardiovascular events and fatalities as a result of delayed care for chronic coronary syndromes is likely to be less than that identified for acute coronary syndromes. Deaths for chronic coronary syndromes that may have occurred as a result of the Covid-19 pandemic will be seen during the pandemic and also as latent effects (which have not been enumerated and evidenced in the literature).

315. The limited breadth and depth of data, its analysis and the number of scientific publications and reports relating to the impact of the Covid-19 pandemic on chronic coronary syndromes is in stark contrast to that available for acute coronary syndromes.

III - Prevention of ischaemic heart disease

Preface

316. In the UK the prevention of ischemic heart disease is delivered through primary care services. Activity in primary care is routinely recorded using electronic health records from which datasets may be created for clinical service evaluation and research. The Clinical Practice Research Datalink is one such dataset that collects anonymised patient data from a large network of General Practices across the UK.

317. This section provides evidence that there was a substantial and widespread decline in visits by the public to General Practice during the Covid-19 pandemic.

318. Available data about the impact of the Covid-19 pandemic on primary care activity is reported as overall activity and has not been described by separate types of diseases such as cardiovascular disease and of this ischaemic heart disease. The available information about primary care activity is less than that for chronic coronary syndrome and much less than that for acute coronary syndrome, and is mostly derived from published research studies.

319. Data from Clinical Practice Research Datalink-Aurum, a large representative dataset of routinely collected primary care records, provides evidence for a large initial drop in primary care consultations during the Covid-19 pandemic (Watt et al., 2021).

319.1 Primary care consultations per person fell from an average of 4.1 before mid-March in 2020 to three consultations per person per year (representing about a 30% reduction) the week after the introduction of the first lockdown at the end of March 2020.

319.2 Overall there were 23 million fewer primary care consultations in 2020 compared with 2019. About 70% of this reduction was for people without any pre-existing non-communicable disease (such as cardiovascular disease, cancer, chronic respiratory and diabetes) (Watt et al., 2021).

319.3 Following the first lockdown, between 50% and 60% of primary care consultations were conducted remotely (Watt et al., 2021).

319.4 From March 2020 there was a steady recovery in the numbers of consultations in primary care so that by September 2020 consultation rates were close to normal (Watt et al., 2021).

320. Data from the Salford Integrated Record in England showed that between March and May 2020, there was a proportional 43% reduction in diagnoses of circulatory system disorders and a proportional 49% reduction in diagnoses of type 2 diabetes, in comparison to the expected levels based in pre-pandemic years (Williams et al., 2020).

321. Analysis of data from Clinical Practice Research Datalink-Aurum as well as from dispensing data from England, Scotland and Wales found that repeat prescriptions in primary care peaked in the week before the first UK lockdown was introduced (Watt et al., 2020). New prescriptions in primary care reduced following lockdown at the same rate as that for primary care consultations (Dale et al., 2023).

322. According to Public Health Scotland, in the week ending 22nd March 2020, there was a peak in prescription of cardiovascular medications 506473 items compared with an historical average in 2018-2019 of 442086 items in Scotland (Public Health Scotland, 2023a). The proportional change was greatest (a 46.3% proportional increase) for oral anticoagulants and least (13.5%) for antiplatelet medications, of the four medication groups studies (oral anticoagulants, lipid lowering drugs, antiplatelet drugs, and antianginal/anti arrhythmia/heart failure/hypertension drugs) (Public Health Scotland, 2023a).

323. A study performed by the British Heart Foundation CVD-COVID-UK/COVID-IMPACT program led by the British Heart Foundation Data Science Centre and in partnership with Health Data Research UK analysed 1.32 billion records of community-dispensed cardiovascular medications (for the treatment of hypertension, hypercholesterolemia and diabetes) from England, Scotland and Wales between 1st April 2018 and 31st July 2021 using NHS Digital's Trusted Research Environment for England (Dale et al., 2023).

323.1 It demonstrated that prescriptions for cardiovascular medications peaked in March 2020, with a proportional increase of 12% in March 2020 compared with March 2019 (Dale et al., 2023).

323.2 In April 2020 there was a sharp decline in the number of prescriptions, which amounted to about a 10% decrease year on year (Figure 15). In May 2020 the dispensing of prescriptions fell below the May 2019 level (Dale et al., 2023).

323.3 Compared with 2019 levels, in August 2020 there was a 9% proportional decrease in the dispensing of prescriptions. In October 2020 the decrease was about 1% and in November 2020 there was less than a 1% decrease compared with 2019

prescribing. The dispensing was about 5% higher in December 2020 (Dale et al., 2023).

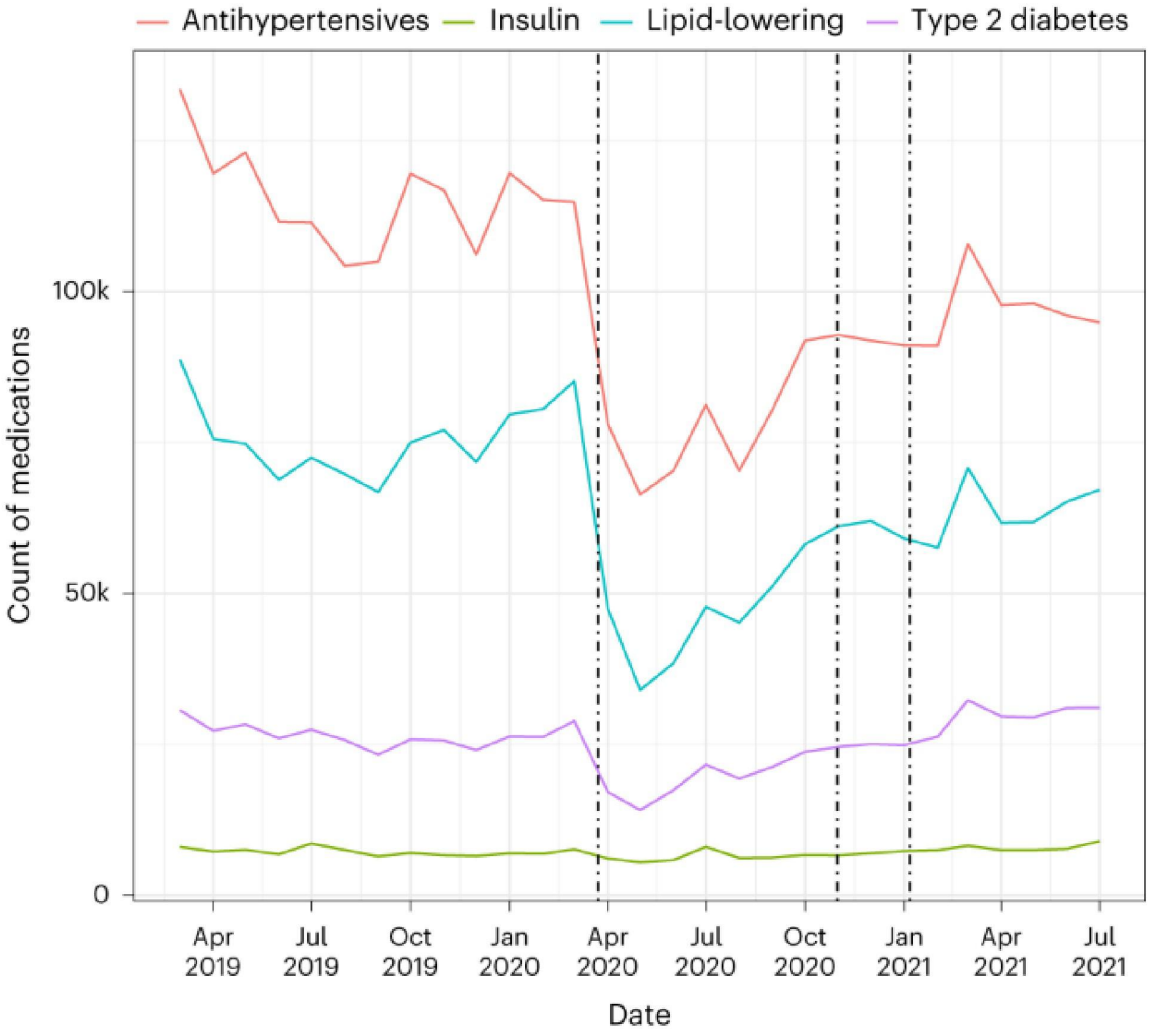
323.4 Throughout early 2021 until April of that year, the number of medications was below the previous year (Dale et al., 2023).

323.5 The magnitude of the reduction in counts was greatest for medications to treat hypertension, followed by lipid lowering therapies, type 2 diabetes medications and then insulin (Dale et al., 2023). Specifically:

- there was a decline in the dispensing of antihypertensive medications between March 2020 and July 2021, with 491,306 fewer individuals initiating treatment than expected had 2019 incident treatment levels sustained (Dale et al., 2023);
- there was a decline in the dispensing of lipid-lowering medications between March 2020 and July 2021, with 316,018 fewer individuals initiating treatment than expected had 2019 incident treatment levels sustained (Dale et al., 2023);
- there was a decline in the dispensing of type 2 diabetes medications between March 2020 and July 2021, with 43,619 fewer individuals initiating treatment than expected had 2019 incident treatment levels sustained (Dale et al., 2023); and
- there was a decline in the dispensing of insulin between March 2020 and July 2021, with 6,053 fewer individuals initiating treatment than expected had 2019 incident treatment levels sustained (Dale et al., 2023).

This difference in the numbers of prescriptions not dispensed for each disease area is likely a reflection of the numbers of people with these conditions. This is because the proportional changes were similar for each of the four groups of medications (Dale et al., 2023).

Figure 15. Counts by month for incident medications dispensed for the four different subgroups of cardiovascular disease medications. Vertical dotted lines indicate the timing of the first, second and third national English lockdowns on 26th March 2020, 5th November 2020 and 6th January 2021, respectively (Dale et al., 2023).



323.6 The decline in the dispensing of antihypertensive medications between March 2020 and July 2021 was predicted to result in 13,662 additional cardiovascular events, including 2,281 cases of myocardial infarction and 3,474 cases of stroke, should individuals remain untreated over their lifetime. If individuals could be identified for treatment within five years, this would reduce the total number of cardiovascular events associated with the pandemic to 2,716 cardiovascular events, suggesting that at least 1,554 myocardial infarctions and 3,014 strokes could be avoided (Dale et al., 2023).

323.7 The use of incident (new initiation of) medications to treat type 2 diabetes increased by 623 patients per month in the first half of 2021, compared to the equivalent months in 2019. This is despite the likely reduced detection of type 2 diabetes, and potentially reflects an increase in new-onset type 2 diabetes in the population during the

pandemic and/or an awareness of the additional risk of Covid-19 among the population and general practitioners for those with type 2 diabetes (Dale et al., 2023).

324. An analysis of 14,929,251 patients from routinely-collected UK primary care data from the Clinical Practice Research Datalink-Aurum (in England) and Clinical Practice Research Datalink-GOLD (in Northern Ireland, Scotland and Wales) databases and data from the Office for National Statistics was conducted to quantify the impact of Covid-19 on the diagnosis monitoring and mortality of people with type 2 diabetes in the UK (Carr et al., 2021).

    324.1 It estimated that between March 2020 and December 2020 there were nearly 60,000 missed or delayed type 2 diabetes diagnoses (Carr et al., 2021).

    324.2 From the same data source HbA1c testing (used in the diagnosis and monitoring of diabetes) was reduced by 63% between March 2020 and December 2020 (Carr et al., 2021).

325. During the pandemic many primary care visits were replaced by electronic or telephone consultations (Watt et al., 2021).

326. Although there had been a re-opening of services during the pandemic, standard mechanisms for screening for cardiovascular risk factors were not fully re-introduced (Dale et al., 2023).

    326.1 Declines in the numbers of consultation rates were reported to be greater for people aged 70 years, those of non-White and Chinese background, and in the East Midlands ethnicity (Nuffield Trust, 2021).

    326.2 The largest percentage reduction in consultations was in patients without a pre-existing non-communicable disease (Nuffield Trust, 2021). People with non-communicable diseases will include those people who are at risk of but as yet not diagnosed with cardiovascular disease or cardiovascular risk factors (such as hypertension, diabetes, high cholesterol, obesity). This finding also suggests that patients with a non-communicable disease such as ischaemic heart disease were able to access primary care.

327. Between 2013/14 and 2019/20, the number of NHS Health Checks taken up each year decreased by 12% overall, from around 1.4 million to 1.2 million (Nuffield Trust, 2021). As a percentage of the total eligible population, the proportion that were offered an NHS Health Check remained at 18%, while the take up decreased slightly from 9% to 8%.

328. In 2020/21 the number of NHS Health Checks undertaken was 190,710 (representing 1% of the total eligible population) and only 488,457 health checks were offered to the eligible population (representing 3% of the eligible population who were offered one).

329. The UK discovery cohort of the ZOE COVID study comprised 201,301 participants in England, Wales, Scotland and Northern Ireland who provided information about their diet and lifestyle using a mobile health app during the Covid-19 pandemic (Mazidi et al., 2021).

    329.1 The study reported that 34% of participants gained a mean of 3.7 kg in weight (Mazidi et al., 2021).

    329.2 It also reported more snacking, greater alcohol consumption and reduced physical activity) (Mazidi et al., 2021).

330. A retrospective cross-section survey of study of 36,980 adults in England was conducted between August 2018 and July 2020 (Jackson et al., 2022).

330.1 Compared with between 2018 and 2019 when there were no changes in the prevalence of smoking, the first UK lockdown (between 2019 and 2020) was associated with a 24% increase in the prevalence of smoking among 18 to 34 year olds. This age group also demonstrated an increase in attempts to quit smoking. There were no changes in smoking behaviours in other age groups (Jackson et al., 2022).

330.2 From the same data source, the first UK lockdown was associated with a 40% increase in high-risk drinking prevalence among all socio-demographic groups (Jackson et al., 2022). Alcohol reduction attempts also increased among high-risk drinkers from affluent social grades, but not the most deprived social sectors (Jackson et al., 2022).

331. For secondary prevention, international surveys that including UK centres showed that almost half of all exercise-based cardiac rehabilitation programs closed during the pandemic, (O'Doherty et al., 2021) and of programmes that continued, many used technology to provide virtual consultations (de Melo Ghisi et al., 2021).

332. Metrics reported by the Office for Health Improvement and Disparities shows that the attainment of target levels for individual patients' control of their cardiovascular disease and cardiovascular risk factors (such as hypertension, diabetes, high cholesterol, smoking, kidney disease and obesity) in England were adversely affected by the Covid-19 pandemic (Fingertips public health data). For example:

- people aged 80 years and over with coronary heart disease who had a last blood pressure reading of equal to or less than 150/90 mmHg in the last 12 months fell from 86.5% in 2019/2020 to 64.6% in 2020/2021, 77.3% in 2021/2022, and was 84.7% in 2022/2023 ;(Office for Health Improvement and Disparities, 2023b);

- people aged less than 80 years with a history of stroke or transient ischaemic attack who had a blood pressure reading of equal to or less than 140/90 mmHg in the last 12 months fell from 73.9% in 2019/2020 to 50.7%% in 2020/2021, 62.6% in 2021/2022, and was 71.4% in 2022/2023 (Office for Health Improvement and Disparities, 2023b);

- the proportion of people with diabetes referred for an education programme within nine months fell from 65.7% in 2019/2020 to 51.1%% in 2020/2021, 57.0% in 2021/2022, and was 62.1% in 2022/2023 (Office for Health Improvement and Disparities, 2024a);

- the proportion of people with diabetes with eye screening fell from 81.5% in 2019/2020 to 67.9%% in 2020/2021, and was 78.4% in 2021/2022 (Office for Health Improvement and Disparities, 2024a);

- the proportion of people with type 1 diabetes who received a blood test fell from 83.6% in 2019/2020 to 75.8%% in 2020/2021 (Office for Health Improvement and Disparities, 2024a);

- the proportion of people with type 2 diabetes who received a cholesterol check fell from 91.0 % in 2019/2020 to 79.3% in 2020/2021 (Office for Health Improvement and Disparities, 2024a); and

- the proportion of people who smoke and were offered support and treatments in the last 24 months fell from 89.7% in 2019/2020 to 75.5% to 73.4% in 2021/2022 (Office for Health Improvement and Disparities, 2024b).

333. For the Second Annual Audit Report for the CVDPREVENT audit, covering the period up to March 2021 (round two) data were received from 93% of general practices covering 93% of England's population (CVDPREVENT, 2022). The report covers the first year of the Covid-19 pandemic. At the time there was a change in the emphasis in the way the Quality Outcomes Framework was implemented to enable general practitioners to prioritise vaccination, and there was disruption to much of the usual Quality Outcomes Framework reporting. The number of new cases of hypertension fell substantially from February 2020, with recovery starting in May 2020 and reaching pre-pandemic rates in March 2021. The number of new cases of atrial fibrillation also declined, but less so, and the recovery of new cases detected was shorter in duration.

334. According to the Second Annual Audit Report for the CVDPREVENT audit covering the period up to March 2021, the proportion of people with hypertension who had their blood pressure recorded during the previous 12 months reduced by 25.2 percentage points between the two rounds of the audit (CVDPREVENT, 2022). The proportional reduction across sex, age and ethnic groups was similar, suggesting that no particular group missed out on recorded blood pressure monitoring.

Explanation(s) for the decline prevention of ischaemic heart disease activity

335. There are a number of possible reasons as to why there was such a large reduction in primary care consultations during the Covid-19 pandemic. These include:

- fear by the public of accessing services that may be used by others who were in greater need;
- fear by the public of accessing services because of concerns about becoming infected with Covid-19;
- a public preference to use NHS 111 services; and
- primary care services being constrained because of reduced capacity.

336. NHS England stated that patients should be seen remotely first then face-to-face if necessary (Andrea, 2020). Research found that 90% of GP consultations (compared with 31% in April 2019) and 46% of nurse consultations were conducted remotely by April 2020 (NIHR Applied Research Collaboration (ARC) West, 2020). Remote consultations do not enable a physical examination of a patient and preclude activities such as checking blood pressure (unless a patient has their own blood pressure monitor at home) and the sampling of blood (venesection). This may explain why there was a reduction in the monitoring of ischaemic heart disease and cardiovascular risk factors for ischaemic heart disease.

337. Alternative theories about the decline in the dispensing of prescribed medications include:

337.1 A change in the population numbers during the Covid-19 pandemic, such as more deaths and more migration, and therefore there was less demand for prescriptions.

However:

- in their paper, Dale and colleagues reported that the Office for National Statistics data for England, Wales, Scotland and Northern Ireland on mid-year population for 2020, which includes the period of disruption associated with the first UK lockdown, showed that population growth remained at ~0.4% (Dale et al., 2023). The level of change was consistent with the previous year;
- Dale and colleagues also stated that migration patterns remained relatively constant (Dale et al., 2023);
- although deaths were about 67,000 higher than the five-year average (which could potentially explain why less people received for prescriptions), Dale and colleagues undertook a sensitivity analysis and showed that when medications dispensed to individuals who died from Covid-19 and from all causes were excluded, the decline in prescriptions was consistent with those presented in their main findings (Dale et al., 2023); and
- in March 2020, prior to the first UK lockdown, there was a proportional 12% increase in dispensed prescriptions for cardiovascular disease (Dale et al., 2023). This suggests that patients were being prepared for a potential shortfall in primary care appointments and the ability to prescribe and or dispense medications.

337.2 The incidence of diabetes decreased during the Covid-19 pandemic and therefore there was less demand for prescriptions.

However:

- type 2 diabetes develops over many years. Therefore it is unlikely that people's behaviour during the pandemic had reduced the true incidence of diabetes (Dale et al., 2023).

Summary

338. During the pandemic, primary care visits declined markedly, with evidence for the numbers of consultations decreasing more in the elderly and some ethnic groups.

339. The dispensing of prescriptions for hypertension, high cholesterol and diabetes declined and it was estimated that this could be associated with an increase in cardiovascular disease.

340. The physical monitoring of cardiovascular risk factors including blood pressure, blood tests, eye screening, smoking cessation advice and education in primary care declined.

341. Data assets in the UK (predominantly for England) were able to offer insights into how the Covid-19 pandemic impacted care for people at risk of cardiovascular disease. However the volume and detail of the information are much less than that which is publically available for acute coronary syndrome. In particular, there were less research publications (which is the major source of Covid-19 pandemic impact intelligence for acute coronary syndrome) and less details about specific types of cardiovascular disease and ischaemic heart disease. This contrasts with the volume of structured clinical data routinely collected in the UK in primary care.

Maintenance and prioritisation of the healthcare system and pathways for ischaemic heart disease

Preface

342. This section provides information about how NHS services for ischaemic heart disease were reconfigured during the Covid-19 pandemic.

343. Organisations including the British Cardiovascular Society, the British Cardiovascular society and the NHS England issued guidance to healthcare professionals about how patients with ischaemic heart disease should be cared for during the Covid-19 pandemic.

344. For ischaemic heart disease there was prioritisation and maintenance of the established NHS pathways for the treatment of acute myocardial infarction, and less so for chronic coronary syndrome and the prevention of ischaemic heart disease.

    344.1 Information supporting this statement is provided in the respective sections about the impact of the pandemic on acute coronary syndrome, chronic coronary syndrome and the prevention of ischaemic heart disease above.

    344.2 The prioritisation of cardiovascular services was based on levels of risk of adverse outcomes associated with not treating the specific types of ischaemic heart disease.

345. There is no robust reason to argue that the maintenance and prioritisation of the healthcare system and pathways for ischaemic heart disease for England were largely different from that of the devolved administrative nations. This is because there was a common rationale to reduce the exposure of the patient, the treating healthcare professional and other patients already in hospital to Covid-19, to ensure there was as many unoccupied beds available for any surge of patients, and to ring fence critical hospital services for the management of patients with acute coronary syndrome. Furthermore, communication of change was widespread, originated from the operational arm of the NHS and specialist national societies, and directed at the UK cardiovascular community.

I - Acute coronary syndrome

346. The strategy for the hospital management of patients with acute coronary syndrome changed during the Covid-19 pandemic.

347. In March and April 2020, NHS England Specialist Commissioning undertook risk assessments for primary PCI for STEMI to ascertain whether services could be delivered. According to Sir Stephen Powis' Statement (INQ000485652) *"The managerial and clinical decisions that followed the risk assessments were not centrally managed by NHS England. Decisions were made by individual Trusts based on the risks posed by Covid-19 in the area at the time…".*

348. NHS England and NHS Improvement, with endorsement from the British Cardiovascular Society and the British Cardiovascular Intervention Society (whose membership and reach spans the devolved administrative nations), recommended the restructure of cardiology services during the Covid-19 pandemic (NHS England and NHS Improvement, 2020).

349. For STEMI it was recommended that:

- primary PCI remain the first line treatment for or STEMI presenting to hospital within 12 hours of onset of symptoms (Kurdi, 2020);
- cases of out of hospital cardiac arrest be transferred to a primary PCI capable hospital if there was clear ST segment elevation and no other significant comorbidities (Kurdi, 2020);
- primary PCI capable hospitals that did not offer PCI for STEMI may undertake primary PCI during normal working hours (Kurdi, 2020);
- primary PCI remained the default and first line option for reperfusion for patients with Covid-19 and STEMI, and that fibrinolysis be considered on a case-by-case basis should significant ambulance delays be anticipated (Kurdi, 2020);
- patients could be managed on level 1 (cardiology, non-coronary care setting) beds (Kurdi, 2020); and
- echocardiography and cardiac rehabilitation were not necessary for stable patients (Kurdi, 2020).

This was because there was an effective and established nationwide primary PCI for STEMI pathway, primary PCI for STEMI offers better clinical outcomes than fibrinolysis if the delay to treatment is similar, (Huynh et al., 2009, Keeley et al., 2003) has higher rates of reperfusion, (British Cardiovascular Society, 2020b) fewer complications and a shorter length of hospital stay, and STEMI is a medical emergency requiring immediate medical intervention (Dondo et al., 2020, Byrne et al., 2023).

350. During the Covid-19 pandemic, primary PCI for STEMI continued to be delivered at primary PCI capable centres. However, the service was expanded to include PCI capable centres that would then deliver a more localised primary PCI service during the daytime. Fibrinolysis was rarely used.

351. As detailed in earlier sections, data support the notion that the primary PCI for STEMI pathway in England was upheld and delivered at a high standard, comparable to that pre-pandemic (Wu et al., 2021b). However, the flow of cases to hospitals was substantially reduced. In part, this will have offset any potential reduction in capacity and capability should there have been hospital staff unable to attend clinical areas because of them being infected. As detailed in earlier sections the quality of care for patients with STEMI was upheld as measured against quality indicators (Aktaa et al., 2021).

352. For patients with acute coronary syndrome that was not STEMI (therefore for patients with NSTEMI and unstable angina) it was recommended that:

- such patients be assessed on a case-by-case basis (Kurdi, 2020);
- the normal pathway for NSTEMI continued, including PCI (Kurdi, 2020);
- coronary angiography be undertaken in higher risk NSTEMI, with risk determined by a Global Registry of Acute Cardiac Events risk score of greater than 140 (Kurdi, 2020);
- optimal medical therapy be undertaken in NSTEMI (with coronary angiography and PCI considered for patients with ongoing symptoms despites medical treatment or signs of haemodynamic instability) (Kurdi, 2020);

- patients with three vessel coronary artery disease be treated with PCI (Kurdi, 2020); and
- for patients with NSTEMI who would normally require coronary artery bypass grafting surgery, PCI should be utilised instead and inpatient stays reduced to between 36 hours and 48 hours (British Cardiovascular Society, 2020b).

This latter recommendation was because of the reduced intensive care capacity. In 2021/2022 there were 6,411 cases of urgent coronary artery bypass grafting surgery, and historically it has been just under 7,000 cases per year (NICOR, 2023b). Typically, patients who are candidates for coronary artery bypass grafting surgery rather than PCI have more complex anatomy of the coronary arteries and a higher SYNTAX score and receipt of PCI may be disadvantageous (NICOR, 2023b). In the Syntax study that randomly assigned 1,800 patients with three-vessel or left main coronary artery disease to undergo coronary artery bypass grafting surgery or PCI, patients who receive PCI more frequently had major adverse cardiac or cerebrovascular events at 12 months (with increased repeat revascularisation), but rates of death and myocardial infarction were similar between the two groups (Serruys et al., 2009). The prospective multicentre UK-ReVasc registry was conducted during the Covid-19 pandemic and enrolled 215 patients with 'surgical' coronary artery disease. It found that the length of hospital stay was reduced by half, with no difference in in-hospital mortality rates, and low event rates at 30 days follow up (Kite et al., 2022b).

353. For NSTEMI, a risk stratified and expedited approach was delivered. Lower risk patients were managed medically with antiplatelet medication, and interhospital transfers for PCI reduced. This and the reduction in the numbers of admission with NSTEMI resulted in shorter durations of hospital stays.

354. Historically, in the NHS the time to receipt of PCI for NSTEMI ranged from three to 10 days. That is, a patient would stay in hospital until there was availability for PCI at PCI-capable hospital. During the Covid-19 pandemic the rational was to treat as effectively and efficiently as possible the coronary artery disease that was the underlying cause of the NSTEMI, rather than deferring to a later date or to only use tablets as treatments Normal clinical practice was modified to decrease exposure of the patient and treating healthcare professionals, and other patients already in hospital to Covid-19, and to ensure that there were as many unoccupied hospital beds available for any surge of patients with Covid-19. In addition, it is likely that the patient flow was more efficient, when normally patients with NSTEMI would have to wait for available staff and services to enable an invasive coronary strategy.

355. As detailed in earlier sections the quality of care for patients with NSTEMI was upheld as measured against quality indicators (Aktaa et al., 2021).

356. The reconfiguration of pathways for acute coronary syndromes witnessed a preference to undertake PCI as close as possible to the date of admission to hospital, a substantial decrease in the proportion of cases receiving invasive coronary angiography without PCI, and a small increase in the proportion of people receiving same day PCI. There was an increase in the local delivery of services with rapid turnaround and minimal hospital transfers.

II - Chronic coronary syndrome

357. The strategy for the hospital management of patients with chronic coronary syndrome changed during the Covid-19 pandemic. In essence this concerned outpatient clinics, referral into cardiology for consultations from primary care, and appointments for imaging of the heart.

358. NHS England and NHS Improvement, with endorsement from the British Cardiovascular Society and the British Cardiovascular Intervention Society (whose membership and reach spans the devolved administrative nations) recommended the restructure of cardiology services during the Covid-19 pandemic (NHS England and NHS Improvement, 2020). This included a recommendation that all non-urgent elective procedures be postponed (Kurdi, 2020).

359. For chronic coronary syndromes attending hospital services there was:

    359.1 prioritisation and maintenance of urgent referrals to cardiology outpatient services from general practitioners. However, as described in earlier sections, the numbers of referrals decreased;

    359.2 transformation of cardiology outpatient services to enable remote working (predominantly telephone clinics), with face to face consultations occurring for those in whom it was deemed necessary following triage of the referral from the general practitioners by a cardiologist; and

    359.3 delivery (where possible) of cardiology outpatient clinics in areas distant from those areas where there were acute services. This was to reduce cross-contamination and spread of Covid-19.

360. The cancellation of elective procedures especially in high-risk patients was undertaken because they were at increased risk of contracting Covid-19 and had an increased risk of death.

361. Elective procedures were also cancelled because they would incur hospital admission (and therefore the occupation of beds that may be needed for patients who had Covid-19), some procedures were invasive and or aerosol-generating, and there was a need for Intensive Care Unit resources for Covid-19 cases.

III - Prevention of ischaemic heart disease

362. The strategy for the prevention of ischaemic heart disease changed during the Covid-19 pandemic. There was a de-prioritisation of the prevention of ischaemic heart disease.

363. Primary care services were reconfigured to enable delivery of the national pandemic Covid-19 vaccinations programme.

364. General practitioners were advised to postpone routine referrals to free up capacity for hospitals to deal with the large numbers of expected severe cases of Covid-19.

365. There was a transformation of primary care services towards remote consultations. However, this does not enable the full assessment of a person's cardiovascular risk factors that would be achieved with a face to face appointment.

Communication of change

366. In addition to the details of changes provided above, there were a series of communications aimed at a wider healthcare audience.

367. On 17th April 2020 the British Cardiovascular Society issued a practical guide to Covid-19 cardiac assessment and treatment (Radhakrishnan, 2020). On 17th April 2020 the British Cardiovascular Society issued YouTube videos aimed at UK cardiologists, with new videos uploaded during 2020 (British Cardiovascular Society, 2020d). On 19th March 2020 the British Cardiovascular Society created an online Covid-19 Clinicians Resource Hub (British Cardiovascular Society, 2020c).

368. NHS England provided information on its website and in social media about what the public should do in the case of symptoms of a heart attack (NHS England, 2020a) (Twitter, 2020).

369. On 15th July 2020 the BBC published an article online about 'Fewer heart attacks seen by NHS amid coronavirus', which also provided information about the symptoms of a heart attack as well as what to do in the case of symptoms of a heart attack (BBC, 2020).

370. In summer 2020, the University of Leeds developed and housed a publicly available website to provide information about the impact of the pandemic on acute coronary syndromes. This included advice to the public about what to do in the case of symptoms of a heart attack, and it reported the decline in admissions to hospital in England with acute coronary syndrome (University of Leeds, 2024).

371. By contrast, evidence for a decline in admissions with STEMI prompted a national campaign coordinated by the Swedish Society of Medicine, the Swedish Society of Cardiology, the Swedish Heart and Lung Foundation and the SWEDEHEART registry on 12th April 2020 (Mohammad et al., 2020). Notably, the campaign was widespread and launched in all major newspapers, television channels in Sweden, on the web, as well as social media and aimed to raise awareness of the symptoms of a heart attack and encourage patients to seek medical care.

Summary

372. During the Covid-19 pandemic the clinical pathways for the treatment of patients with ischaemic heart disease were reconfigured such that those in greatest need and at greatest risk of adverse cardiovascular outcomes were prioritised for treatment, whilst providing hospital capacity to treat patients with Covid-19 and reduce the exposure of patients and healthcare professionals to Covid-19. That is, the extent of the maintenance of cardiovascular services was proportionate to the risk of early adverse consequences of not treating the type of ischaemic heart disease.

373. Critical services such as primary PCI for STEMI were prioritised and expanded from regional to a local level, high risk NSTEMI were treated expeditiously, and prioritisation was given to higher risk patients with cardiovascular disease who were either referred to or under routine review in hospital outpatients. The prevention of ischaemic heart disease was de-prioritised to free up capacity in primary care.

Collection of data about ischaemic heart disease

Preface

374. This section provides information about the collection of data for people with ischaemic heart disease before and during the Covid-19 pandemic.

375. It has long since been accepted that UK healthcare data provide important insights into the health of the nation and how the NHS is functioning. The UK is recognised internationally for its nationwide healthcare data assets.

376. UK data for ischaemic heart disease include the routine collection of administrative, clinical and registry data. The extent, maturity and reporting of the data collection is greatest for England, Wales and less so for Northern Ireland and Scotland. Historically the data are collected in three silos of primary care electronic health records, national clinical audit and administrative data.

377. Historically, there has been no routine cross talk or curation of the multisource data assets for NHS cardiovascular disease service evaluations and audit, other than that which occurs for cardiovascular research. Historically, each of the three types of cardiovascular data silos is further segregated without intra-silo cross talk according to disease and treatments (in the case of the clinical audit data) and data providers (in the case of primary care electronic health records data). Notably, each person in the UK has a unique personal identifier, their NHS number, which therefore allows deterministic linkage of these data assists; this is unique to and an important 'data criterion' advantage of the UK compared with most other countries.

378. Collectively, the UK data assets for ischaemic heart disease had never previously been 'stress tested' to enable near real-time reporting and the routine linkage of the data assets. Prior to the Covid-19 pandemic, there was an under-appreciation of the importance and underinvestment in UK cardiovascular and wider data for healthcare intelligence.

379. During the Covid-19 pandemic there was prioritised data collection, linkages and reporting for acute coronary syndrome, and, to a lesser extent, chronic coronary syndromes and the prevention of ischaemic heart disease. This was undertaken by clinical academics in concert with data administrators because there was no 'a priori' established NHS, academic or administrative organisation to deliver this work across the boundaries of the three types of data silos. The British Heart Foundation had only just formed its Data Science Centre, for cardiovascular research, which played an important role in delivering insights about cardiovascular care and outcomes during the Covid-19 pandemic, but is a charity funded research organisation and undertook analysis and reporting for the purposes of research.

380. Whilst reading this section, one should be mindful of the potential missed opportunities for care and future prospects that the UK has for cardiovascular data intelligence, and how such learnings may be applied to other disease areas.

I - Acute coronary syndrome

Pre-pandemic data collection for acute coronary syndrome

381. Data for acute coronary syndromes care and outcomes were routinely collected through:

- HES (in England only); (NHS Digital, 2023) and
- The National Cardiac Audit Programme (Programme, 2021).

382. HES is a curated data product containing details about admissions, outpatient appointments and historical Accident and Emergency attendances at NHS hospitals in England (NHS Digital, 2023).

382.1 HES is created from data submitted to NHS England as part of the Commissioning Data Set, which is managed by the Secondary Uses Service. At pre-arranged dates during a specific financial year, the Secondary Uses Service takes a fixed snapshot of the Commissioning Data Set of cumulative activity recorded up to that point within that financial year.

382.2 This is then subject to additional processing to create a curated data product that is appended to finalised historical data that has been processed for previous years.

382.3 HES has been designed to support ongoing business needs for many organisations with multiple user requirements.

382.4 Historically, HES has been used for non-clinical purposes, such as research and planning health services. Because these uses are not related to direct patient care, they are called 'secondary uses'.

382.5 HES data covers all Sub Integrated Care Boards and Integrated Care Boards in England (previously Clinical Commissioning Group), including:

- private patients treated in NHS hospitals;
- patients resident outside of England; and
- care delivered by treatment centres (including those in the independent sector) funded by the NHS.
- Each HES record contains a wide range of information about an individual patient admitted to an NHS hospital, including:
- clinical information about diagnoses and operations;
- patient information, such as age group, gender and ethnicity;
- administrative information, such as dates and methods of admission and discharge; and
- geographical information such as where patients are treated and the area where they live.

383. See paragraph 118 for further information on the National Cardiac Audit Programme. Its audits relevant to ischaemic heart disease are:

- Myocardial Ischaemia National Audit Project;
- National Audit of Percutaneous Coronary Interventions; and
- National Adult Cardiac Surgery Audit.

Data collection for acute coronary syndrome during the pandemic

384. During the pandemic, data were collected for acute coronary syndrome. However, the type, format, extent and quality and timeliness of these data varied.

384.1 HES data were collected from hospitals when and where there were data clerks available within hospitals and within NHS Digital. After the first UK lockdown, the timeliness, breadth and depth of data was limited.

384.2 National Cardiac Audit Programme data were collected from hospitals when and where there were data clerks available within hospitals. In the run up to the first UK lockdown there was a mandate for all healthcare staff to be redeployed to front line services;(NHS England 2020b) this included healthcare professionals who normally would collect data about patients from the clinical areas for entry and submission to the respective audit of the National Cardiac Audit Programme.

384.3 In the run up to the first UK lockdown, and following this directive, it was apparent to Gale that if no data were to be submitted to the National Cardiac Audit Programme, then there would be no clinically defined 'data intelligence' and therefore no 'barometer' about the numbers, care and outcomes of patients with acute coronary syndrome. This was important given the 'a priori' hypothesis that lockdown and / or Covid-19 infection may alter the number of admissions to hospitals with acute coronary syndrome and the deaths for acute coronary syndrome.

384.4 On or about Monday 16th March 2020, Gale contacted colleagues to emphasise the importance of maintaining the national data collection and submissions to the National Cardiac Audit Programme.

384.5 Following personal communications with colleagues, and therefore through the National Cardiac Audit Programme, and thus the British Cardiovascular Society, British Cardiovascular intervention Society and therefore with NHS England, and with the British Heart Foundation, it was emphasised that data collection and submission to the National Cardiac Audit Programme should, where possible, be upheld. On 6th April 2020 the British Cardiovascular Society and a number of affiliated groups together with the Society for Cardiothoracic Surgery sent a joint letter to all members to encourage the continued collection of national audit data during the pandemic. On 6th April 2020, the National Institute for Cardiovascular Outcomes Research placed a message on its website about the letter from the British Cardiovascular Society dated 6th April 2020. The information on the webpage also stated that the National Institute for Cardiovascular Outcomes Research and the British Cardiovascular Society have been asked to provide as much national data as possible to assist the Scientific Advisory Group for Emergencies, NHS England and NHS Wales with data analysis, and that primarily, this is intended to help understand the impact of the pandemic, and decisions regarding relaxations of lockdown on our clinical services, but also may be of value to the wider academic community in researching its longer-term clinical consequences. On 17th April 2020, the British Cardiovascular Society wrote to its members asking that hospitals provide contemporary data for the Myocardial Ischaemia National Audit Project to the National Institute for cardiovascular Outcomes Research on a weekly basis (British Cardiovascular Society, 2020a).

384.6 During the first UK lockdown, cardiologists and biostatisticians were brought together principally from the University of Leeds and the University Keele to link, analyse and

report the National Cardiac Audit Programme data, majoring on data for acute myocardial infarction (NICOR, 2020).

384.7 Clinicians and academics principally from the University of Oxford, along with staff from NHS Digital (now NHSE), the Office for National Statistics, University of Leeds and the Keele University linked, analysed and reported HES data concerning acute myocardial infarction admissions and interventions (Mafham et al., 2020).

384.8 The work was endorsed by the Chief Scientific Advisor to the Government of the UK to provide health data intelligence to the Scientific Advisory Group for Emergencies responsible for ensuring timely and coordinated scientific advice is made available to decision-makers, to inform NHS care.

384.9 The Secretary of State for Health and Social Care issued NHS Digital with a Notice under Regulation 3(4) of the NHS(Control of Patient Information Regulations) 2002 (COPI) to require NHS Digital to share confidential patient information with organisations entitled to process this under COPI for COVID-19 purposes. The National Institute for cardiovascular Outcomes Research which includes the Myocardial Ischaemia National Audit Project registry (Ref: NIGB: ECC 1-06 (d)/2011) has support under section 251 of the NHS Act 2006 to use patient information for medical research without informed consent. For this rapid NHS evaluation, health data linkage was enabled under COVID-19 public health NHS England Directions 2020, conferred by Section 254 of the NHS Act 2006 to use patient information for medical research without informed consent.

384.10 In a parallel initiative, the British Heart Foundation Data Science Centre initiated CVD-COVID-UK, which aimed to understand the relationship between Covid-19 and cardiovascular diseases such as heart attack, heart failure, stroke, and blood clots in the lungs through analyses of de-identified, linked, nationally collated healthcare datasets across the four nations of the UK (Centre, 2020) COVID-IMPACT was then developed as an expansion of the CVD-COVID-UK approach and aims to address research questions looking at the impact of Covid-19 on other health conditions and their related risk factors. In line with the CVD-COVID-UK/COVID-IMPACT Consortium's principles – based on a collaborative, transparent and inclusive ethos – all related analysis plans, protocols, code, phenotype code lists and reports are made publicly available via the centre's collection on the Health Data Research UK Gateway, repositories in the centre's GitHub organisation and through open-access publications.

II - Chronic coronary syndrome

Pre-pandemic data collection for chronic coronary syndrome

385. Data for chronic coronary syndromes care and outcomes was collected through:

- HES; (NHS Digital, 2023).

HES has been described above (see paras [224] onwards).

Data collection for chronic coronary chronic during the pandemic

386. Data for chronic coronary syndromes care and outcomes was collected through:

- HES (NHS Digital, 2023); and
- Clinical studies, audits and service evaluations.

387. HES has been described earlier as noted above.

388. There is no information in the published literature about cardiology outpatient clinical services activity during the pandemic using HES data.

III - Prevention of ischaemic heart disease

Pre-pandemic data collection for the prevention of ischaemic heart disease

389. Across Great Britain, ischaemic heart disease risk factors are detected in primary care using mechanisms such as the:

- Quality of Outcomes Framework (QOF) in England (NHS England, 2023);
- Quality Assurance and Improvement Framework (QAIF) in Wales (Welsh Government, 2019); and
- Transitional Quality Arrangements (TQA) Framework in Scotland (Scottish Government, 2017).

Data collection for the prevention of ischaemic heart disease during the pandemic

390. During the pandemic data collection occurred to a lesser extent via the mechanisms established pre-pandemic. However, there was a reduction in the collection of this information not only because of the reduced numbers of patients but also because of reduced data entry.

391. Participating in the Quality and Outcomes Framework is voluntary, and there were major changes for its collection during the pandemic.

391.1 Due to the impact of the Covid-19 pandemic on activity in general practice, payment protection was applied to the 2020-22 Quality and Outcomes Framework service and may affect Quality and Outcomes Framework activity and/or its recording for that year (NHS Digital, 2022).

391.2 During 2020/2021 the majority of Quality and Outcomes Framework indicators were income protected (i.e. payments were made to practices irrespective of activity recorded for indicators in 2020-21) (NHS Digital, 2020).

391.3 In a letter published on 19th March 2020 by NHS England and Improvement it was confirmed that the Quality and Outcomes Framework 2019-20 year-end calculations were to be interrogated to ensure no GP practice is paid less than in the previous financial year (NHS Digital, 2021b). This means that the Quality and Outcomes Framework achievement figures included within the 2019/2020 publication may not

reflect the figures used in final payments made to practices (NHS Digital, 2019). It is stated that caution should be taken in drawing any conclusions from the 2019/2020 Quality and Outcomes Framework data without due consideration of the circumstances both locally and nationally as of 31 March.

392. Primary care data were utilised for research studies and Covid-19 planning. These included:

- CPRD (Medicines & Healthcare products Regulatory Agency, 2024); and
- General Practice Extraction Service with NHS Digital (NHS Digital, 2024).

Explanation(s) for those changes

393. There was a clear and immediate need to understand the impact of the pandemic on the care and outcomes of patients with acute coronary syndromes. There were established mechanisms for national clinical audit and reporting, and administrative data collection and reporting, as well as a national death registry and the unique patient identifier (NHS number) that would enable linkage of each patient's information recorded in different national datasets.

394. During and since the Covid-19 pandemic the author is not aware of information published in the literature about chronic coronary syndrome hospital outpatient activity for the NHS. This is likely to be because:

- chronic coronary syndrome was de-prioritised with respect to care continuity and risk to life when compared with acute coronary syndrome;
- those who undertook the analysis and reporting for acute coronary syndrome were not familiar with chronic coronary syndrome data, and were pre-occupied with acute coronary syndrome activity analysis; and
- chronic coronary syndrome activity data are historically not publicly reported and there is no national clinical audit for chronic coronary syndrome.

395. During the pandemic, the majority of the Quality and Outcomes Framework indicators were income protected. This was to enable general practices to direct resources towards the Covid-19 response and target care at the most vulnerable and high-need groups. As such there was less data collection about the prevention of ischaemic heart disease.

Summary

396. There are mechanisms for the routine collection and reporting of cardiovascular data in the NHS. For England and to a lesser extent Wales, Scotland and Northern Ireland they are well established and used for NHS operational activities and research.

397. Historically, however, these are funded and delivered as mutually exclusive and operationally divergent physical entities of primary care electronic health records data, national clinical audit data, and administrative data. The three data types are not linked or curated, despite each person in the UK having an NHS number that would enable this. Moreover, within each of these three data silos there is fragmentation such that there are a number of different primary care data warehouses with no cross talk or pooling of data, and several national cardiovascular

audits with no cross talk or pooling of data. There is national auditing or no public reporting for chronic coronary syndrome activity.

398. The maturity and extent of use of these data assets for cardiovascular is different in the four devolved administrative nations. Definitions and coding of clinical variables vary in different datasets, which hampers accurate and timely data comparisons and pooling.

399. The UK national cardiovascular data assets were never previously stress tested for use as pooled real-time reporting for data intelligence. Their use for cardiovascular data intelligence in this manner and format was not previously recognised or operationalised outwith research.

400. The collective response by organisations and people in the UK to make the most of routinely collected cardiovascular data in the UK for the understanding and planning of cardiovascular care during the Covid-19 pandemic was commendable. This serves as a proof of principle, from which much may be learned.

Healthcare system

Preface

401. This section provides information about the preparedness, planning and resilience of the UK healthcare system for ischaemic heart disease, and contrasts it with other countries. It should be read and considered in conjunction with the preceding sections.

Tools used in pandemic planning and preparedness

402. Across a range of sectors, it was clear that the management of people with acute coronary syndrome was a priority. The rationale behind this is explained in earlier sections of this report, and in brief is because acute coronary syndrome is a medical emergency which without prompt guideline recommended care is associated with a high risk of adverse clinical outcomes such as death, rehospitalisation and disability. Top down and bottom up approaches were implemented to ensure that acute coronary syndrome care was prioritised and healthcare professionals and the public were informed. This is detailed in earlier sections and included messaging from NHS England, the British Cardiovascular Society, the British Cardiovascular Intervention Society, the British Heart Foundation, individual hospitals as well as from cardiologists. The mode of delivery of the messaging was via the internet (on respective webpages), in published journal articles, at NHS hospitals (within cardiology unit meetings), across local regions (within newly formed regional cardiology groups and networks) as well as via social media.

403. Immediately before the UK lockdown, feedback from healthcare professionals who were treating patients with acute coronary syndromes detailed a decline in admissions with acute coronary syndrome. This notion was supported through communications that occurred across the UK at regional levels, as a result of groups of cardiologists re-forming the previously disbanded regional cardiac networks. The decline in admissions with acute coronary syndrome was then substantiated and enumerated using national data intelligence as described from paragraph 211 to 253.

404. Theories about the potential 'protective effect' of the UK lockdown on the development of acute coronary syndrome were largely dismissed, with evidence from national data showing an excess in acute cardiovascular deaths occurring at around the same period as the decline in admissions with acute coronary syndrome. This is described in greater detail from paragraphs 211 to 253.

405. For acute coronary syndrome, it was established very early on in the Covid-19 pandemic that:

- acute coronary syndrome care should be prioritised;
- pathways for acute myocardial infarction should be maintained, and that adaptation could be made to enable more rapid, and localised treatment, but that established pathways should be upheld and evidence-based treatments provided;
- the National Cardiac Audit Programme, HES data, and data from the Office for National Statistics would be of utmost importance for pandemic planning and preparedness (detailed above);
- regional cardiac networks should be re-established to enable cross talk, information sharing, local geographic standardisation of protocols (responsive to the local needs

of the public and the availability of clinical services in that particular area), and adaptation of cardiac services; and

- the public should be informed of the importance of attending hospital if they had symptoms of a heart attack.

406. Less priority was given to chronic coronary syndromes and even less to the prevention of ischaemic heart disease. To that extent, in some centres such as those that were less impacted by surges in Covid-19 admissions, there may have been an overreach of descaling of chronic coronary syndrome services. There was de-prioritisation of the prevention of ischaemic heart disease in primary care.

407. It was appropriate and necessary that there was prioritisation given to the treatment of acute coronary syndromes in preference to that of chronic coronary syndromes and the prevention of ischaemic heart disease during the Covid-19 pandemic.

408. Given the uncertainty of the extent of the surge in patients infected with Covid-19 at each hospital, it may be that more flexibility could have been given to the delivery of services for chronic coronary syndromes, and a more dynamic response to ischaemic heart disease care provided. That is, iterative and coordinated managerial appraisal of clinical services for ischaemic health disease undertaken nationally and locally may have better informed decisions about how and when to expand clinical services to chronic coronary syndrome and the prevention of ischaemic heart disease.

409. Having a clear and early action plan developed by senior clinical experts which was expeditiously recognised and communicated through specialist societies and regional networks to the local cardiology workforce enabled the prioritisation and high quality delivery of acute coronary syndrome care in the UK.

410. Prior to the pandemic Cardiac Networks existed in some regions, which during the Covid-19 pandemic was expanded by NHS England Specialist Commissioning to cover England as 13 Cardiac Networks, with Cardiac Networks in Wales, Scotland and Northern Ireland. This enabled a 'pathway' view rather than a hospital specific focus. The Cardiac Network provided a coordinated approach to cardiovascular care through shared learning, local feedback of the situation, and service planning and implementation.

Comparison to healthcare systems internationally

411. Overall, the UK secondary and tertiary healthcare system for ischaemic heart disease was insufficiently resilient to the Covid-19 pandemic.

412. However, the resilience of the UK healthcare secondary and tertiary systems for ischaemic heart disease varied according to type of ischaemic heart disease. It was strong for acute coronary syndromes and weak for chronic coronary syndromes and the prevention of ischaemic heart disease.

    412.1 Evidence detailed in earlier sections of this report shows that when people with STEMI attended hospital in the UK during the Covid-19 pandemic, the care they received was no different from that pre-pandemic.

    412.2 Evidence detailed in earlier sections of this report shows that when people with NSTEMI attended hospital in the UK during the Covid-19 pandemic, there were

modifications to the care delivery model that resulted in shorter waiting times for revascularisation and similar rates of delivery of medications from that pre-pandemic.

412.3 The clear distinction between the pre-pandemic and during pandemic periods was the substantial difference in the number of patients who attended hospital with STEMI and NSTEMI.

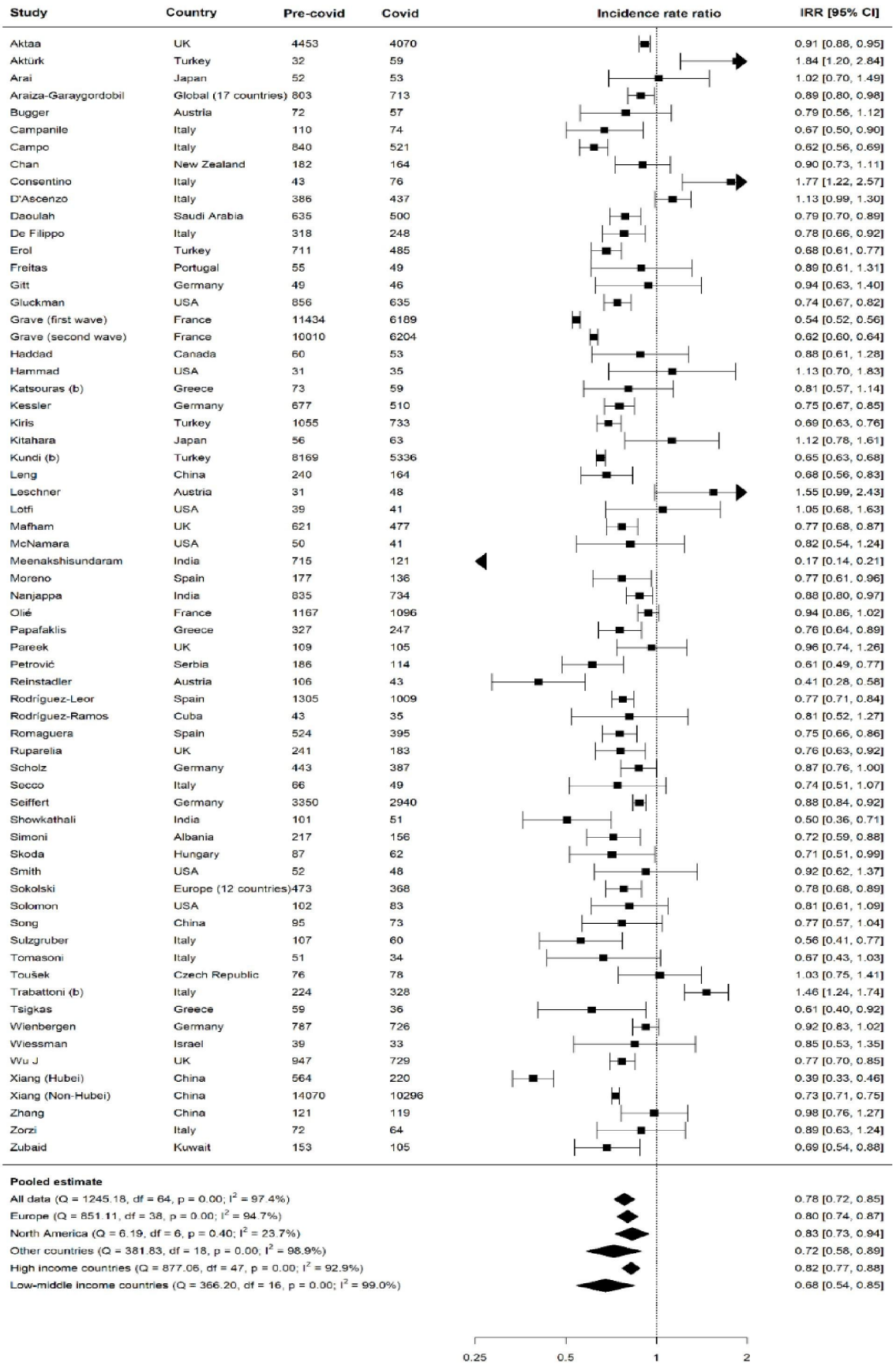
412.4 Chronic coronary syndromes care was de-prioritised at secondary and tertiary healthcare systems in the UK during the Covid-19 pandemic. For chronic coronary syndromes there were less referrals from primary care, more outpatient consultations postponed, more investigations postponed, and more non-urgent elective procedures postponed during the Covid-19 pandemic than pre Covid-19 pandemic.

413. A systematic review and meta-analysis of 158 observational studies of cardiovascular care and outcomes comparing a pandemic and pre-pandemic period covering 49 countries and six continents led by the author (Gale) of this report found that across all cardiovascular diseases and geographies there were fewer hospitalisations, diagnostic and interventional procedures, and outpatient consultations during the pandemic (Nadarajah et al., 2022).

413.1 The decline in incidence of admissions with STEMI in the low-middle income countries (incidence rate ratio 0.68, 95% confidence interval 0.54 to 0.85) was greater than that for high income countries (0.82, 0.77 to 0.88) (Figure 16) (Nadarajah et al., 2022).

413.2 The incidence of admission with STEMI in the UK declined by 23%, (Mafham et al., 2020) which compared with a decline of 20% across Europe and a decline in North America of 17% (Figure 16) (Nadarajah et al., 2022).

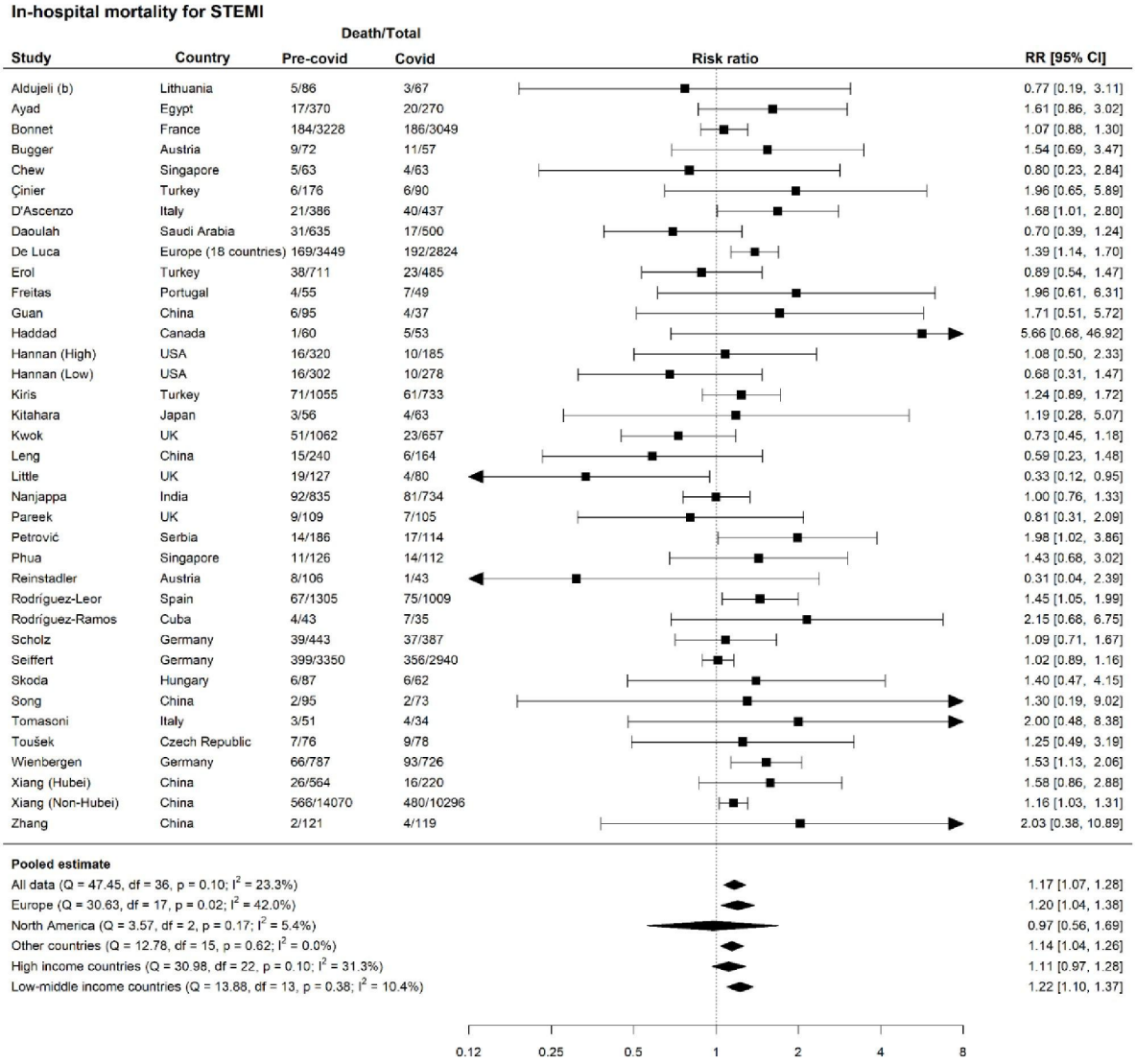
Figure 16. Summary forest plot of admissions with STEMI pre and during the Covid-19 pandemic, by country (Nadarajah et al., 2022).



413.3 Across Europe the duration of time between symptom onset and first medical contact was increased by a weighted mean difference of 69.5 minutes compared with pre-pandemic, (Nadarajah et al., 2022) whereas in the UK the durations pre and during the pandemic were similar (Wu et al., 2021b).

413.4 In the UK in-hospital mortality rates for STEMI were similar pre and during the pandemic, and compared with an increase in in-hospital mortality rates for STEMI across Europe (Figure 17) (Nadarajah et al., 2022).

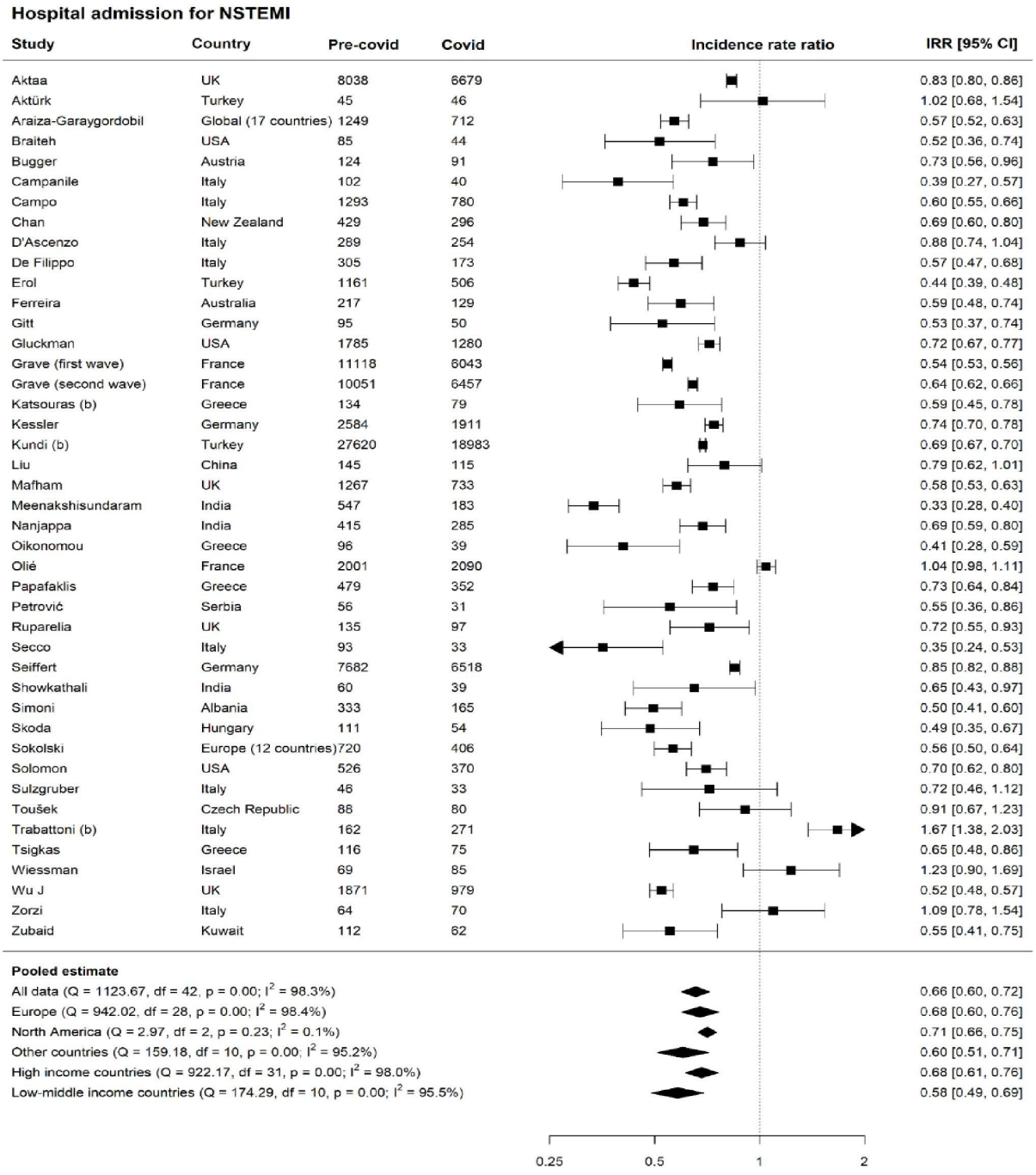
Figure 17. Summary forest plot of in-hospital mortality for admissions with STEMI pre and during the Covid-19 pandemic, by country (Nadarajah et al., 2022).



413.5 The decline in incidence of admissions with NSTEMI in the low-middle income countries (incidence rate ratio 0.58, 95% confidence interval 0.49 to 0.69) was greater than that for high income countries (0.68, 0.61 to 0.76) (Figure 19) (Nadarajah et al., 2022).

413.6 The incidence of admission with NSTEMI in the UK declined by 42%,(Mafham et al., 2020) which compared with a decline of 32% across Europe and a decline in North America of 29% (Figure 18) (Nadarajah et al., 2022).

Figure 18. Summary forest plot of admissions with NSTEMI pre and during the Covid-19 pandemic, by country (Nadarajah et al., 2022).



414. In contrast to other countries, where recommendations about the management of patients with acute myocardial infarction were modified, the UK upheld its processes of care for acute myocardial infarction. This was evidenced in pre-and pandemic periods, where the use of evidence-based care was very high (Wu et al., 2021b).

415. A systematic review and meta-analysis of 32 observational studies of STEMI found that low-middle income countries, particularly Eastern low-middle income countries, had worse performance metrics than in high income countries (Chew et al., 2021).

416. When compared to countries with similar healthcare systems, the UK provided a high quality service for people admitted with acute myocardial infarction during the Covid-19 pandemic.

    416.1 Sweden, which has a comparable (mainly government funded and universal for all citizens) healthcare system including primary PCI for STEMI also experienced a decline in admissions with acute myocardial infarction (albeit to a lesser extent that thin the UK) and also had shorter durations of time to PCI during the pandemic than pre-pandemic (Mohammad et al., 2020).

    416.2 Spain, which also has a free universal healthcare system that is available to all, did not change its reperfusion strategy for STEMI, with primary PCI performed for the vast majority of patients. There was a decline in admissions with STEMI, but an increase in the median time from symptom onset to reperfusion and a two-fold increase in the rate of in-hospital mortality compared with pre-pandemic (Rodriguez-Leor et al., 2020).

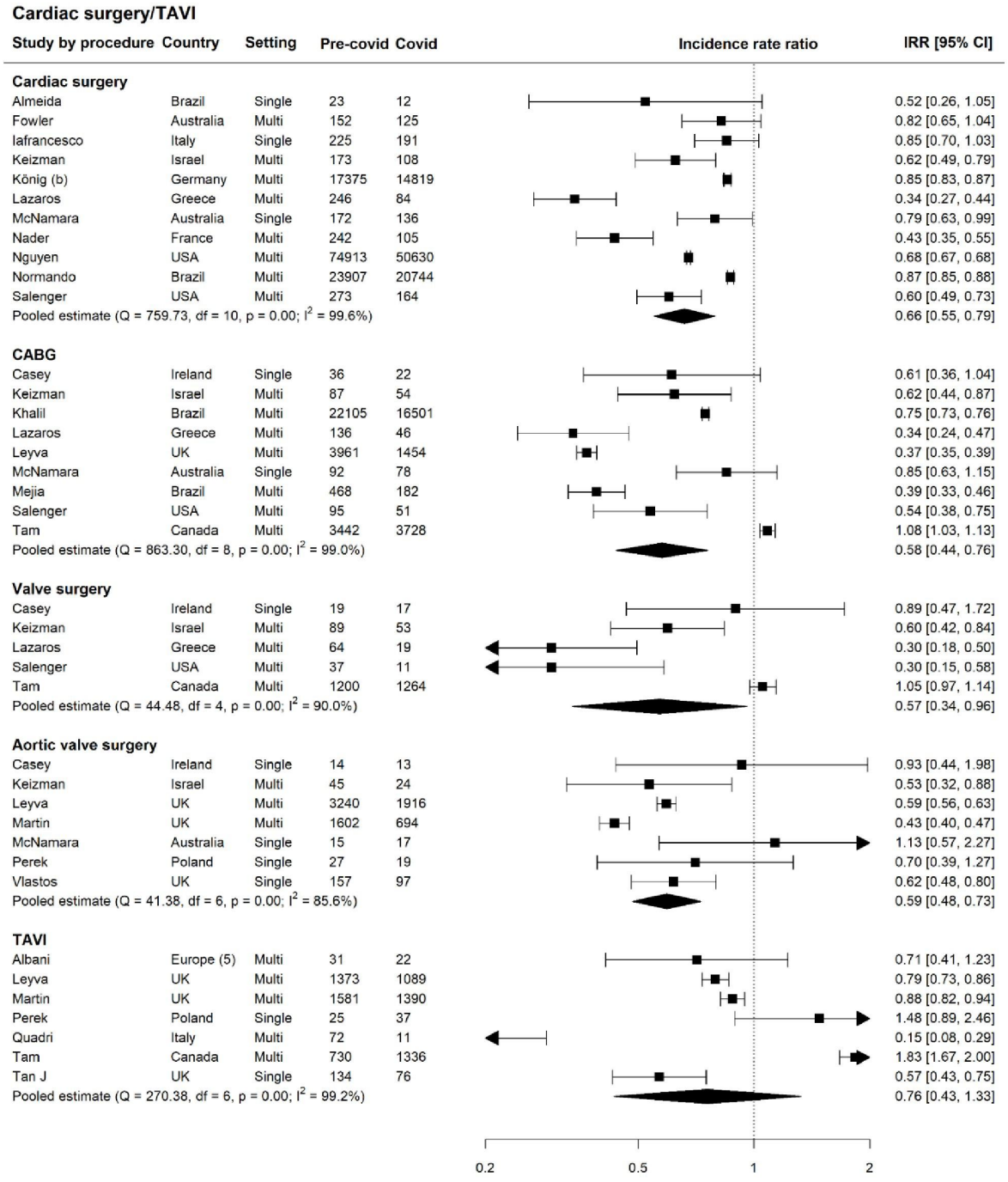
    416.3 Italy, which has a national health service that offers universal health coverage that is free or low costs at the point of delivery, experienced a substantial decline in admissions with acute myocardial infarction. Notably, the proportion of patients undergoing primary PCI remained high among those admitted for STEMI, but the rate of PCI performed for NSTEMI declined, there were longer durations in time from first medical contact to coronary revascularisation, and the case fatality rates for STEMI during the pandemic were three-fold higher than pre-pandemic (De Rosa et al., 2020).

    416.4 A study of PCI for STEMI in New York reported a similar decline in admissions with STEMI, longer times from symptom onset to hospital arrival and no difference in mortality rates compared with pre-pandemic (Hannan et al., 2021).

417. Nationwide data from the UK and the USA found that elective PCI decreased by over 50% during the pandemic (Nadarajah et al., 2022).

418. The decline in coronary artery bypass grafting surgery was greater in the UK than in several other countries (Figure 19) (Nadarajah et al., 2022).

Figure 19. Summary forest plot of cardiac surgical and transcatheter aortic valve implantation procedures pre and during the Covid-19 pandemic, by country (Nadarajah et al., 2022).



419. Across Europe there were substantial declines (in excess of 50% compared with pre-pandemic) in the use of transthoracic echocardiography, 12 lead electrocardiograms, ambulatory blood pressure monitoring and exercise tolerance testing, all of which may be used in the management of chronic coronary syndromes (Nadarajah et al., 2022).

Explanation(s) for insufficient resilience

420. The decline in admissions with acute myocardial infarction were generally comparable to those in Europe, however, they were greater than that of Sweden. For those who did attend hospital, the delays to seeking help and time to arrival at hospital in the UK were similar pre and during the pandemic, as were in-hospital mortality rates. This suggests that the services for acute myocardial infarction were protected, operational and delivered high standards of care compared with other countries – that is, these specific services were resilient within the context of reduced admissions with acute myocardial infarction.

421. Should the Covid-19 pandemic have been associated with a rate of admissions with acute coronary syndrome similar to (over 100,000 cases each year) or higher than that which occurred pre-pandemic, and or patients were more critically unwell (and required highly specialist interventions and monitoring), and / or there have been decreased availability of PCI operators and associated cardiology healthcare staff (though quarantine measures, illness, or being dispatched to other departments of the hospital), then the resilience of the service would be have been tested, and could have failed. In such circumstances it is likely that there would have been:

- in-hospital delays to reperfusion;
- an increase in the use of fibrinolysis for STEMI (which is associated with worse clinical outcomes);
- longer in hospital stays (thereby occupying beds that may have otherwise been used for Covid-19 patients);
- difficult clinical decisions about the selection of patients for specific treatment strategies;
- more acute complications from acute myocardial infarction;
- higher in-hospital and subsequent mortality rates; and
- more cases of heart failure, stroke and subsequent myocardial infraction later in a patient's life course.

Of note is that in the UK fibrinolysis is rarely used as a treatment option for STEMI and there is lack of experience (and potentially supply) in the use of fibrinolysis for STEMI among healthcare professionals.

422. Of note is that pre Covid-19 pandemic the UK cardiovascular workforce, including cardiologists, specialist nurses, radiographers and cardiac physiologists, was insufficient to cope with the demand for cardiovascular care.

423. Pre-pandemic there was good evidence to show that the UK primary PCI service for STEMI was effective, safe and had good clinical outcomes (Dondo et al., 2020). As such, and if the service could be protected and was coping, there was no major reason to modify this approach to care. This is in contrast to other countries where fibrinolysis was employed; evidence from randomised clinical trials shows that if the delay to treatment is similar, primary PCI is superior to fibrinolysis in reducing death, subsequent non-fatal myocardial infarction and stroke (Huynh et al., 2009, Keeley et al., 2003). Indeed, the early safeguarding of the UK nationwide primary percutaneous service is in contrast to recommendations in other countries that were drawn from preliminary information (very early in the course of the Covid-19 pandemic) about over-

burdened services due to the additional workload arising from Covid-19 patients and that alternative hospital measures were needed to reduce the spread of the infection.

424. Chronic coronary syndromes care was purposefully de-prioritised at secondary and tertiary healthcare systems in the UK during the Covid-19 pandemic because staff and services were redirected to the care of patients with Covid-19, and to limit the exposure of staff to Covid-19. That is, clinical services for acute coronary syndrome were protected at the expense of those for chronic coronary syndrome. This was a logical and appropriate decision given the fact that chronic coronary syndromes are associated with a much lower risk of major adverse clinical outcomes when compared with acute coronary syndromes.

425. The argument in favour of insufficient resilience for ischaemic heart disease care at secondary and tertiary healthcare systems in the UK should also be considered on the backdrop of:

- a persisting high burden of cardiovascular disease, increasingly associated with older ages and more co-morbidities, in the UK;
- under investment in infrastructure and clinical services for managing people with and at risk of ischaemic heart disease in secondary and tertiary healthcare systems in the UK; and
- missed learning opportunities for preparedness.

426. Prior to the Covid-19 pandemic clinical services for the care of people with ischaemic heart disease had been in decline for several years. The clinical workforce was overstretched, the mode of delivery of care not modernised, and the infrastructure had not kept pace with new developments in treatments and the growing burden of people with and at risk of ischaemic heart disease. This was reflected in, for example, longer waiting times for hospital appointments (NHS, 2023b) and diagnostic tests (House of Commons Library, 2024), and longer durations of ambulance times for people with suspected heart attack (Nuffield Trust, 2024).

426.1 In 2000 the National Service Framework for Coronary Heart Disease set out standards of care that local health communities were expected to achieve, and was supported by investment in services (NHS, 2000). This resulted in substantial secondary and tertiary healthcare systems infrastructure changes for the care of people with ischaemic heart disease in the UK such as delivery of the nationwide primary PCI service for STEMI, deployment of the rapid access check pain clinics, initiation of national clinical audits of cardiovascular disease and intervention, cardiac rehabilitation services. The framework was associated with improvements in care and outcomes for ischaemic heart disease (Gale et al., 2012).

426.2 In 2019 NHS England's Long Term Plan recognised the importance of cardiovascular disease and in particular its prevention (NHS, 2019). However, the extent to which investment and prioritisation of ischaemic heart disease was acknowledged is in direct contrast to the unmet population need. The success of historical investment in secondary and tertiary healthcare systems and resultant positive change in care and outcomes for people with ischaemic heart disease as a result of the National Service Framework for Coronary Heart Disease may have been misconstrued as a 'fait accompli'. As such, there has been disproportionate investment in and modernisation of clinical services for ischaemic heart disease that were established over a decade ago when compared with the burden of ischaemic heart disease in the UK.

426.3 There has been a substantial slowdown in the decline in the rate of premature deaths from cardiovascular disease since 2012 (between 2012 and 2019, the premature death rate for cardiovascular disease in the UK fell by 11% compared with a fall of 33% between 2005 and 2012) (British Heart Foundation, 2024d). In 2022 in the UK ischaemic heart disease was the most common cause of premature death and the second leading cause of death, being responsible for about 68,000 deaths in that year (British Heart Foundation, 2024c).

Alternative models adopted to maintain diagnostic and treatment pathways

427. There is sparse information in the literature about how other countries adopted alternative models of care to maintain diagnostic and treatment pathways for the spectrum of ischaemic heart disease.

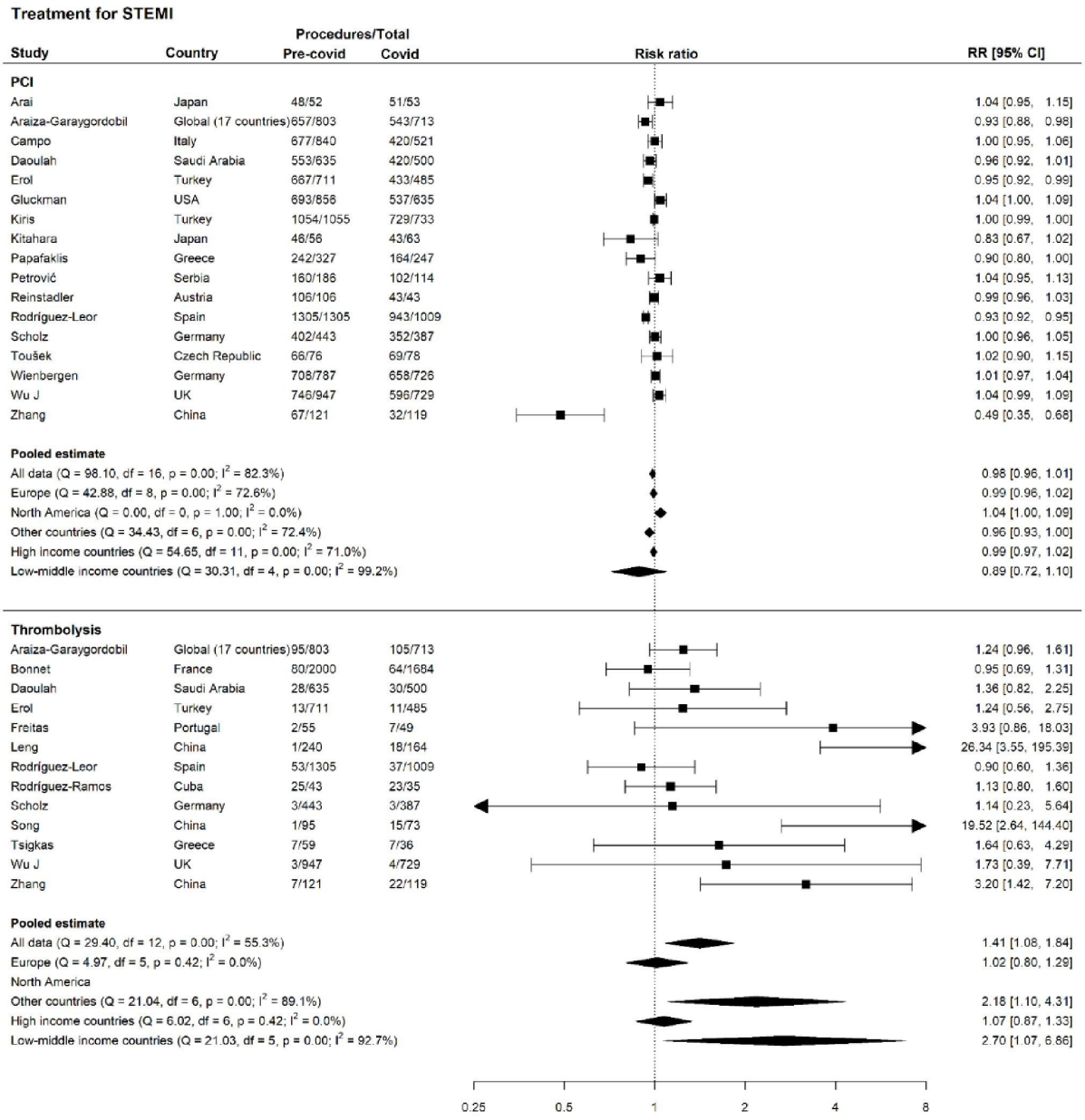
428. Internationally, the proportion of patients treated for STEMI with fibrinolysis increased during the pandemic (RR 1.41, 95% CI 1.08–1.84, I2 = 55.3%), driven by an increased use of fibrinolysis in low- and middle-income countries outside of Europe and North America (Nadarajah et al., 2022).

428.1 Reports from Wuhan argued that, because the clinical workforce was overwhelmed and there were limited supplies, fibrinolysis was a reasonable (safe and efficacious) alternative for STEMI care during the Covid-19 pandemic (Wang et al., 2020).

428.2 An article from North America proposed that although primary PCI for STEMI should remain the appropriate treatment strategy, a pharmaco-invasive strategy (fibrinolysis and PCI) in selected patients with STEMI with presumptive Covid-19 and low likelihood of mortality from STEMI may be reasonable to reduce risk of Covid-19 infection transmission to healthcare professionals (Butala et al., 2020).

428.3 In the UK the use of fibrinolysis and primary PCI for STEMI did not differ between pre-pandemic and pandemic periods (Nadarajah et al., 2022) (Figure 20).

Figure 20. Summary forest plot of choice of reperfusion for STEMI pre and during the Covid-19 pandemic, by country (Nadarajah et al., 2022).



428.4 In general, countries tried to maintain their capability and delivery of PCI for acute myocardial infarction, Results of the meta-analysis led by Gale found that for patients admitted with STEMI and NSTEMI, the proportion who received revascularisation did not change during the pandemic (PCI for STEMI hospitalizations, RR 0.98, 95% CI 0.96–1.01, $I2 = 82.3\%$; PCI for NSTEMI hospitalizations, RR 1.05, 95% CI 0.93–1.17, $I2 = 88.3\%$) (Nadarajah et al., 2022).

429. Many professional societies recommended cancellation of elective procedures particularly in high-risk patients due to their increased risk of contracting Covid-19 and their increased risk of mortality, mainly due to factors such as prolonged hospital admission, the invasive nature of certain procedures, aerosol-generating nature of procedures, and the potential need for Intensive Care Unit resources that have been otherwise prioritised for Covid-19 cases.

430. A number of professional societies recommended cancellation of elective procedures particularly in high-risk patients due to their increased risk of contracting Covid-19 and their increased risk of mortality, mainly due to factors such as prolonged hospital admission, the invasive nature of certain procedures, aerosol-generating nature of procedures, and the potential need for Intensive Care Unit resources that have been otherwise prioritised for Covid-19 cases (Patel et al., 2020; Welt et al., 2020; Hassan et al., 2020; Prachand et al., 2020; Prescott et al., 2022; Curzen, 2020).

Summary

431. Clear, appropriated and early decisions were made to protect and deploy the primary PCI services for STEMI, and that acute coronary syndrome care should be prioritised over that of chronic coronary syndromes and the prevention of ischaemic heart disease.

432. Even though there was a top down approach to guidance, there was effective collegiate working at the local and regional networks. Prior to the pandemic Cardiac Networks existed in some regions, which was expanded by NHS England to cover England as 13 Cardiac Networks, but not the devolved nations.

433. Less priority was given to the management of chronic coronary syndromes and even less to the prevention of ischaemic heart disease. The degree to which the specific services for ischaemic heart disease were reconfigured was proportionate to the clinical need and associated risk of major adverse cardiovascular events for non-treatment of type of ischaemic heart disease.

434. Despite other countries increasing their use of fibrinolysis for STEMI, the UK continued to deliver primary PCI for STEMI. Primary PCI for STEMI is associated with better outcomes than fibrinolysis.

435. It is plausible that if there had not been a decline in admissions with acute myocardial infarction and staff trained to deliver acute coronary syndrome care had been unavailable through illness, quarantine or redeployment, the UK primary PCI service would have been incapacitated and alternative models of care would have to be instigated.

Lessons learnt

Preface

436. This section provides expert opinion about the successes and shortcomings of the UK health care system including the healthcare approach to the Covid-19 pandemic for people with and at risk of ischaemic heart disease.

Successes

People

437. During the Covid-19 pandemic, across the cardiovascular community at all levels, there was a tangible and enduring feeling of purpose, professionalism, calling and comradery to deliver the best care and outcomes for patients. The cardiovascular community knew what to do, and why.

438. Publicity campaigns delivered by the British Heart Foundation and the British Cardiovascular Society in early April, 2020, (British Heart Foundation, 2024a) and NHS England in May 2020 as well as messaging by others in the ensuing months, (NHS England, 2020a) in which people with heart attack symptoms were encouraged to attend hospital, will have helped to allay fears of attending hospital when a heart attack was suspected.

Services

439. The NHS demonstrated that it has an adaptable cardiovascular workforce. Early in the course of the Covid-19 pandemic, there was limited scientific evidence and clinicians had to practise clinical judgement. Best practice was shared, and clinical protocols rapidly written, modified, disseminated and implemented, and rewritten if and when new evidence was available or as the situation changed, to standardise available care for patients.

440. Remote and virtual working is feasible and effective. It is possible to undertake virtual consultations, work remotely and digitally triage patients for outpatient clinics and follow up consultations.

441. Academic organisations are a key source of capacity and capability for cardiovascular data analyses and reporting.

442. The national primary PCI service was upheld and delivered high quality care for patients with heart attack.

Data

443. A key success of the Covid-19 pandemic was the ability to rapidly link and publicly report national NHS data in near real time. The work was endorsed by the Chief Scientific Advisor to the Government of the UK to provide health data intelligence to the Scientific Advisory Group for Emergencies. The speed at which this was achieved had never before been realised, and serves as feasibility assessment and pilot implementation that should continue. It shows that a number of different agencies can (and should) work together for a common good, and that the established and excessive 'red tape' and committees are a barrier to understanding how the NHS cares for people. The work was instrumental in providing evidence for the decline in admissions with acute coronary syndrome, the standards of care provided and the population outcomes. Without which, our knowledge about how the Covid-19 pandemic was affecting

people with acute coronary syndrome would be reliant upon first hand reports and anecdotes. Data intelligence enabled foresight about the potential consequences of reduced cardiovascular clinical activity, inequalities in care, and the pace of restoration of services.

444. Hospitals in England went to additional efforts to provide weekly uploads of data for the national clinical audits for cardiovascular disease.

Shortcomings

People

445. It is apparent that not everyone with or at risk of ischemic heart disease had equal care and outcomes. People at risk of ischaemic heart disease were disadvantaged from resource limitations in primary care, and those with chronic coronary syndromes had postponed hospital appointments. The repercussions of this includes later stages and more complex cardiovascular disease presentation, and longer hospital waiting times for specialist investigations and treatment (British Heart Foundation, 2023). Importantly, during the Covid-19 pandemic those at highest risk of adverse clinical outcomes delayed seeking help and this was associated with excess cardiovascular deaths.

446. Prior to Government directives about social distancing, the public appeared to react to the international crisis as it unfolded through the media. Even so, whilst social isolation was recommended for higher risk patients, such patients are also at higher risk of acute coronary syndrome (and heart attack). Indeed, those considered particularly vulnerable to the virus were advised in March 2020 to shield (Hutchings, 2020). The lack of information and clarity will have been problematic for people with cardiovascular disease, who were uncertain about their individual level of risk. This included if they had a particular condition or were taking a specific medication, whether the risk was the same if the condition was well managed (or surgery took place a long time ago), and how this was affected by other comorbidities or another long-term condition. In Sweden there was a widespread multimedia (television, newspapers, and internet) campaign about the symptoms of a heart attack and seeking help. Such messaging was not provided by the UK Government during the UK lockdowns.

447. Early in the course of the Covid-19 pandemic, there was a deficit of public information about the importance of attending hospital with symptoms of a heart attack.

Services

448. Given the uncertainty of the extent of the surge in patients infected with Covid-19 at each hospital, it may be that more flexibility could have been given to the delivery of services for chronic coronary syndromes, and a more dynamic response to ischaemic heart disease care provided. To that extent, there is a perception that it was perhaps 'too easy' to stop doing normal activities that would potentially preserve health. Indeed, local level managerial priorities for ischaemic heart disease appeared to vary, with some hospital trusts having 'retained capacity' due to the cancellation of elective eservices. Nonetheless, local level information was experiential, variable and not informed by near real time reporting of cardiovascular activity from national data. Using such information would have incurred clinical risk associated with a decision to redeploy staff and services to pre-Covid-19 pandemic period activity.

449. Infection protection and control guidance was muddled and iterative – sometimes conflicting and often changing. Many hospital-based investigations and treatments for admissions with acute coronary syndrome are either aerosol generating procedures or expose the patient and staff to infection, this includes cardiopulmonary resuscitation (which is necessary to save a

person's life if a patient is in cardiac arrest), cardiothoracic surgery, invasive coronary angiography, PCI and exercise tolerance tests.

450. A larger and protected specialist workforce, with the ability to undertake remote care and the availability of peripheral clinical hubs, may have provided greater confidence by the public in the NHS that it was able to cope with the surge in cases with Covid-19 and therefore allow more clinical services to continue for people with ischaemic heart disease. However, this was compounded by the historical lack of effective workface planning and investment that has resulted in insufficient staffing in cardiovascular medicine to cope with the demand irrespective of the heightened demand incurred by the Covid-19 pandemic.

451. The occurrences of other contagions in the UK, and in other countries, could have served as opportunities for secondary and tertiary healthcare systems pandemic preparedness and scenario planning, but were not realised. For example, the Middle East respiratory syndrome and severe acute respiratory syndrome epidemics within the past two decades have provided information on the effects of highly contagious and morbid respiratory diseases about operation activity in the cardiac catheterisation laboratory – specifically personal respiratory protection, environmental control measures to minimise spread, appropriate ventilation systems and infection control planning (Tsui et al., 2005). Such information from the literature and experience of outbreaks in other geographies and healthcare systems could have served as learnings for preparedness for the Covid-19 pandemic.

452. If there had been a surge of cases with acute coronary syndrome or a deficit in specialist teams, it is plausible that hospital services for acute coronary syndrome could have been overwhelmed - alternative models of care were not specified in advance.

453. The authors are not aware of formal NHS preparedness planning for ischaemic heart disease in the event of a pandemic.

Data

454. There is no universal dataset for cardiovascular disease, ischaemic heart disease or acute coronary syndrome for the four nations of the UK. Cardiovascular intelligence for the UK is gathered at different times from an array of different sources that have different levels of maturity, reporting, data content and data definitions. This includes heterogeneous use and definitions of ethnographic data.

455. Access to the national data assets by clinical and biostatistical teams at academic organisations in the UK for the purpose of providing ongoing intelligence about clinical activity was terminated on the 8th December 2020, with no provision for ongoing analysis at the same scale, depth and pace. No plans or communication about ongoing activity were offered to teams who had undertaken the original analytical work; access to data simply ceased. As such, contemporaneous insights into clinical activity for recovery planning were not possible, and should there have been another surge it is uncertain as to whom would undertake this work. There was strain between organisations about the housing of and access to data, and what was defined as Covid-19 research versus NHS service evaluation for Covid-19.

456. Data collection, analysis and reporting was heterogeneous. It varied according to devolved nation, primary care electronic health records data provider, type of national clinical audit, and administrative status. Analyses were not formally coordinated across organisations, and analyses and reporting majored on acute coronary syndromes and PCI at the expense of other cardiovascular diseases. However, this likely reflected the expertise of those involved in the analysis and reporting and their familiarity with the datasets. Administrative data (HES and

Office for National Statistics data at NHS Digital) were nationwide for England and offered activity information, but do not provide information about clinical care quality. Primary care data were unreliable given that the Quality Outcomes Framework was halted and there was no real-time reporting. The National Cardiovascular Intelligence Network, had little or no role in Covid-19 real time reporting of cardiovascular activity.

Summary

457. NHS staff who treated patients with cardiovascular disease during the Covid-19 pandemic went above and beyond their normal duties, and often made great sacrifices to ensure high quality care of patients.

458. Clinical services for ischaemic heart disease were rapidly reconfigured to prioritise care for those in most need at the time – acute coronary syndromes.

459. Barriers to data access and linkages were removed to allow insights into clinical activity to inform care.

460. Should the Covid-19 pandemic have caused the unavailability of specialist cardiovascular healthcare professionals, and or there was an excess of admission with acute coronary syndrome it is possible that hospital services for the treatment of people with acute coronary syndrome would not have been sustained in all localities in the UK, and that alternative (and potentially less effective) strategies for the management of patients be implemented.

461. A larger and sufficiently protected specialist cardiovascular workforce would have enabled the continuation of more NHS services for people with ischaemic heart disease.

462. There were missed opportunities in NHS preparedness, given that a number of viral pandemics had occurred in the run up to the Covid-19 pandemic.

463. The extent of information about the impact of the Covid-19 pandemic on admissions and delays to seeking care for heart attack beyond that of the first wave of Covid-19 is incomplete. Information about the care and outcomes of people with chronic coronary syndrome is limited.

464. Early messaging about attending hospital with symptoms of a heart attack is important.

Recommendations

Preface

465. This section provides four recommendations for the care of patients with and at risk of ischaemic heart disease. It emphasises the importance of placing people first, enhancing national data flows, preparedness planning, and effective communication so that cardiovascular services in the UK are resilient to future crises.

Cardiovascular disease prevention

466. Health outcomes for people living with and at risk of ischemic heart disease must be improved to increase resilience to threats such as a future pandemic and maintained during periods of significant pressure. Healthcare systems must take proactive steps to make mechanisms for detecting and addressing risk factors for ischaemic heart disease more robust to external stressors by:

- ensuring people with modifiable risk factors for ischaemic heart disease are identified using approaches that have high yields of identification and are tailored to the characteristics and demographics of people at risk;
- a public health campaign focussing on risk factors for ischaemic heart disease should be rolled out and tailored to at-risk communities to improve understanding of modifiable and non-modifiable risk factors such as age, family history and ethnicity to allow more proactive identification of people with or at risk of ischaemic heart disease;
- diagnostic services should be located close to a person's place of residence, making use of integrated neighbourhood teams and local diagnostic hubs. This is particularly important for older, and more vulnerable people who may struggle to access services. Localised diagnostic testing facilities should include ambulatory blood pressure monitoring, ambulatory heart rhythm monitoring and cholesterol testing;
- utilise and fund existing community healthcare professional assets such as pharmacists and dentists to provide prevention services. For example, those with modifiable risk factors should be offered evidence-based approaches to reduce their cardiovascular risk through guidance and information sharing;
- data-based detection tools such as the QRISK score and cardiovascular prediction algorithms should be used more effectively;
- digital mechanisms should be used more effectively. For example, NHS digital systems should be upgraded to ensure it can effectively collect and report data and communicate within and between primary and secondary care organisations. This must be remotely accessible; and
- at-home services should be supported where possible, such as delivering diagnostic devices to a person's place of residence e.g. heart rhythm monitoring tools and electrocardiograms. Options to develop the NHS app should be explored to enable risk factor identification, notification and diagnostics at home.

Maintaining cardiovascular care during health emergencies

467. For patients with established chronic coronary syndromes, virtual appointments should become the norm where patients do not require a face to face hospital appointment. This should be determined by specialists through remote triage after referral from a GP. The prescribing of medications should also be digitised and integrated with facilities used in primary care. 'One stop' diagnostics and treatment clinics should be the norm.

468. To avoid the clinical pathway for management of acute coronary syndrome being overwhelmed during a future pandemic, healthcare systems must:

- recognise the national primary PCI service as an essential component of cardiovascular care;
- ensure sufficient staff are trained in the specialist invasive (and non-invasive) management of acute coronary syndrome to provide contingency in the event of external stressors, and that specialist cardiovascular staff are not deployed to other areas of medicine;
- ensure specialist catheterisation laboratories and associated clinical infrastructure (including coronary care units) for treatment of acute coronary syndrome are not repurposed and are treated as a separate and independent utility; and
- ensure adequate numbers of trained ambulance staff (and equipment) to cope with a surge of cases in the community.

Cardiovascular workforce planning and investment

469. Effective workforce planning and investment in the cardiovascular workforce is fundamental to maintaining the cardiovascular health of the nation. There must be an expansion in the number and training of cardiologists as well as specialist nurses, radiographers and cardiac physiologists. There must be action across the whole career pathway - increasing the number of specialist training places as well as increasing the number of student places in medical schools and ensuring there are ways for experienced staff approaching retirement to pass on their knowledge and skills through bespoke job roles. The availability of suitable personal protective equipment and infection testing is key to ensuring the cardiovascular workforce is sufficient to meet demand during a future pandemic.

Assessing the resilience of cardiovascular care services

470. Clinical pathways for acute coronary syndrome and alternative models of care for people with chronic coronary syndrome must be regularly tested to ensure they are resilient to external stressors. The preparedness of ischemic heart disease services should be assessed annually using the format of the Surgical Preparedness Index (Glasbey et al 2022). Assessment should be tailored towards primary and secondary care services, and necessary changes should be piloted and enacted where weaknesses are identified.

Cardiovascular data intelligence

471. A publicly funded UK National Cardiovascular Data Centre should be established to coordinate, share, monitor and rapidly report real-time data on ischaemic (and other) heart disease care and outcomes. The centre should use the array of existing data sets in the four nations, including those of HES, Office for National Statistics, NHS England data bases, primary care electronic health records, National Cardiac Audit Programme, and the databases from the devolved nations. A patient's record in each of these databases may be linked so that a more complete picture of care is available for the UK. Near real-time data intelligence about the use of NHS clinical services across the UK and the attainment of established care quality metrics would be available. The Centre would establish standardised data definitions, routes for data flows, and dissemination of findings. The Centre would partner with external organisations to ensure contingency staffing of those with clinical data science skills. In order to improve planning for surge capacity during future emergencies, the system should be annually stress-tested.

Public health communications during health emergencies

472. The dissemination of appropriate, timely and consistent information about ischaemic heart disease must be made available to the public - via a range of sources - so that they are sufficiently informed of when and how to access treatment for clinical emergencies and routine care. The NHS website and app should be promoted as a trusted source of healthcare information and a first point of call for patient education. For example, it should provide easy-to-reach advice to reassure the public about the importance of attending hospital in the event of symptoms of a heart attack before, during and after a national emergency.

Making decisions and disseminating information about cardiovascular care during emergencies

473. Specialist cardiovascular societies should be encouraged to have a formalised decision making and crisis management structure, which enables decisive and timely clinical judgements about specialist care based on data intelligence. There should be standardised routes for dissemination of information to members, for example functional regional cardiac networks should be reinstated to achieve this.

Conclusion

474. Ischaemic heart disease is common and associated with significant morbidity, mortality and healthcare expenditure.

475. Healthcare services manage acute presentations, chronic care after established disease, and risk factor modification before clinical manifestation.

476. During the Covid-19 pandemic there was a substantial and widespread decline in the number of admissions to hospital with acute coronary syndrome, and excess deaths.

477. During the Covid-19 pandemic clinical pathways for the treatment of patients with ischaemic heart disease were reconfigured such that those in greatest need and at greatest risk of adverse cardiovascular outcomes were prioritised for treatment, whilst providing hospital capacity to treat patients with Covid-19 and reduce the exposure of patients and healthcare professionals to Covid-19. As such critical services such as primary PCI were maintained and executed to a high standard, but the management of chronic coronary syndromes and prevention of ischaemic heart disease was de-prioritised.

478. NHS staff who treated patients with cardiovascular disease during the Covid-19 pandemic went above and beyond their normal duties, and often made great sacrifices to ensure high quality care of patients.

479. Data assets in the UK (predominantly for England) were able to offer insights into how the Covid-19 pandemic impacted care for people at risk of cardiovascular disease, but were skewed towards acute presentations, and analysis was not coordinated or conducted by governmental organisations but reliant on academic institutions and charities.

480. A larger and sufficiently protected specialist workforce, and greater preparedness, would have enabled the continuation of more NHS services for people with ischaemic heart disease.

481. Establishing a UK National Cardiovascular Data Centre, utilising digital technologies, increasing capacity, and establishing standardised routes for data flows and dissemination can improve the robustness of ischaemic heart disease services in the NHS to future external stressors.

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