

# **National Audit of Percutaneous Coronary Interventions**

## Annual Public Report

January 2013 - December 2013



**NICOR** (National Institute for Cardiovascular Outcomes Research) is a partnership of clinicians, IT experts, statisticians, academics and managers which manages six cardiovascular clinical audits and a growing portfolio of new health technology registries, including the UK TAVI registry. NICOR analyses and disseminates information about clinical practice in order to drive up the quality of care and outcomes for patients.



The **British Cardiovascular Intervention Society** promotes education, training and research in cardiovascular intervention and develops and upholds clinical and professional standards.



The **Healthcare Quality Improvement Partnership (HQIP)** is led by a consortium of the Academy of Medical Royal Colleges, the Royal College of Nursing and National Voices. Its aim is to promote quality improvement, and in particular to increase the impact that clinical audit has on healthcare quality in England and Wales. HQIP hosts the contract to manage and develop the National Clinical Audit Programme, comprising more than 30 clinical audits that cover care provided to people with a wide range of medical, surgical and mental health conditions.



Founded in 1826, **UCL (University College London)** was the first English university established after Oxford and Cambridge, the first to admit students regardless of race, class, religion or gender, and the first to provide systematic teaching of law, architecture and medicine. It is among the world's top universities, as reflected by performance in a range of international rankings and tables. UCL currently has 24,000 students from almost 140 countries, and more than 9,500 employees. Its annual income is over £800 million.

---

## Authors

### This collaborative report was produced by:

Dr Peter F Ludman MA MD FRCP FESC  
Queen Elizabeth Hospital, Birmingham,  
Audit Lead for the British Cardiovascular Intervention Society (BCIS).

Lucia Gavalova – Project Manager, NICOR  
Darragh O'Neill – Information Analyst, NICOR  
Andrew Donald – Senior Analyst Developer, NICOR  
David Cunningham – Senior Strategist, NICOR.

This report is available online at [www.ucl.ac.uk/nicor/audits/adultpercutaneous/reports](http://www.ucl.ac.uk/nicor/audits/adultpercutaneous/reports). A full version of the analyses is available for download from the [BCIS website](#).

## Acknowledgments

The National Audit of Percutaneous Coronary Interventions is managed by the National Institute for Cardiovascular Outcomes Research (NICOR), which is part of the National Centre for Cardiovascular Prevention and Outcomes, based at University College London. The audit is commissioned by the Healthcare Quality Improvement Partnership (HQIP) as part of the National Clinical Audit and Patient Outcomes Programme (NCAPOP).

We would especially like to thank the contribution of all NHS Trusts, hospitals in Scotland and Northern Ireland, UK private hospitals and the individual nurses, clinicians and audit teams who collect data and participate in the audit. Without this input the audit could not continue to produce credible analysis, or to effectively monitor and assess the standard of PCI procedures in the United Kingdom.

### National Audit of Percutaneous Coronary Interventions

National Institute for Cardiovascular Outcomes Research (NICOR)  
Institute of Cardiovascular Science, University College London  
3rd floor, 170 Tottenham Court Road, London W1T 7HA

**Tel:** 0203 108 3927  
**Email:** [l.gavalova@ucl.ac.uk](mailto:l.gavalova@ucl.ac.uk)

# National Audit of Percutaneous Coronary Interventions

January 2013 - December 2013

.....

This is a report of the National Audit of Percutaneous Coronary Interventions (NAPCI). It has been produced specifically for anyone who wants to know more about the use of PCI procedures to treat angina and acute coronary syndromes including the treatment of heart attacks. It is written for people with little or no previous knowledge of PCI procedures, clinical conditions or clinical audit.

It is an abbreviated version of the United Kingdom's **National Audit of Percutaneous Coronary Intervention**. The full report is available for download at [www.BCIS.org.uk](http://www.BCIS.org.uk).

All words in **green** are included in the glossary at the end of the report.

.....

# Contents

<b>The Authors</b>	<b>2</b>	<b>List of figures and tables</b>	
<b>Contents</b>	<b>4</b>	<b>Figure 1</b>	Different types of acute coronary syndrome 7
<b>Executive summary</b>	<b>5</b>	<b>Figure 2</b>	A summary of how National Audit of Percutaneous Coronary Interventions data is used to support improvement 9
<b>1. Introduction</b>	<b>7</b>	<b>Figure 3</b>	Average age of patients treated by PCI in each PCI centre 11
1.1 Coronary heart disease and the role of PCI procedures	7	<b>Figure 4</b>	Age and sex of patients treated by PCI in the UK 11
1.2 The PCI procedure	7	<b>Figure 5</b>	Reperfusion treatment rates for patients with final diagnosis of STEMI (MINAP) 12
1.3 The role of the audit	8	<b>Figure 6</b>	Changing indications for PCI 12
1.4 Use of the data	9	<b>Figure 7</b>	Primary PCI rates per million population in the UK regions in 2013 13
1.5 Organisation of the National Audit of PCI Procedures	9	<b>Figure 8</b>	PCI centres and their provision of primary PCI therapy across the UK 13
1.6 The database	10	<b>Figure 9</b>	Hospitals performing less than 400 PCI procedures in 2013 14
1.7 Data collection and IT	10	<b>Figure 10</b>	Total PCI activity per million population in the UK countries 14
1.8 Data quality and data completeness	10	<b>Figure 11</b>	Rates of primary PCI activity for STEMI, per million population, in the countries of the UK 14
1.9 Case ascertainment	10	<b>Figure 12</b>	The total number of primary PCIs by PCI centre in 2013. Each centre is represented by a labelled dot. See Appendix 2 for a hospital code and corresponding name 15
<b>2. Findings</b>	<b>11</b>	<b>Figure 13</b>	Door-to-balloon within 90 minutes from arrival at the PCI centre 16
2.1 Patient characteristics	11	<b>Figure 14</b>	Average time delays to emergency treatment in patient admitted directly to PCI centres (Direct) versus transferred from another hospital to the PCI centre (IHT) 17
2.2 Access to PCI procedures	12	<b>Figure 15</b>	Percentage of patients presenting to a hospital with nSTEMI who are treated by PCI within 96 hrs and 72 hrs of admission to the first hospital they were admitted to 17
2.3 Care and treatment of patients	15	<b>Figure 16</b>	Time from first admission to PCI for nSTEMI according to admission route (direct admission (Direct) or by interhospital transfer (IHT)) 17
2.4 Improved access to evidence based treatment and guidelines	18	<b>Figure 17</b>	Use of drug eluting stents in PCI 18
2.5 Outcome and improving patient experience	19	<b>Figure 18</b>	Drug eluting stent use by countries of the UK 18
<b>3. The future</b>	<b>20</b>	<b>Figure 19a</b>	Percentage of patients treated using radial artery access by year 18
<b>4. Case studies</b>	<b>21</b>	<b>Figure 19b</b>	Percentage of cases performed using a radial approach, by PCI centre 19
<b>5. Research Use of PCI Audit Data</b>	<b>24</b>		
<b>6. Glossary</b>	<b>25</b>		
<b>7. References</b>	<b>27</b>		
<b>Appendix 1. List of participating centres in the UK</b>	<b>28</b>		
<b>Appendix 2. Hospital codes</b>	<b>35</b>		
<b>Appendix 3. BCIS data monitoring and audit group</b>	<b>36</b>		

# Executive summary

**Coronary heart disease** accounts for about one in five deaths in men and one in six deaths in women. The British Heart Foundation estimate there are over 1 million men living in the UK who have or have had angina (heart-related chest pain), and over 840,000 women.

Percutaneous coronary intervention (PCI) is used to treat patients with narrowed or blocked arteries that supply the heart muscle with blood. The procedure mechanically improves blood flow to the heart. Initially a 'coronary angiogram' is performed, where X-ray images of the heart are obtained, to visualise the position and shape of the arteries and any narrowing or blockages. If the clinical circumstances and the angiogram findings suggest that a patient will benefit from mechanical improvements to blood flow to their heart muscle, the majority (4 in 5) will be treated by PCI (and about 1 in 5 will be treated by **coronary artery bypass surgery**). During the PCI procedure, a small balloon is inserted in to the narrowed artery and inflated. This moves the fatty tissue and clot that is causing the obstruction out of the way and so widens the artery. In most cases a metal mesh (called a stent) is implanted to scaffold the wall of the artery open. Thus treatment by PCI aims to prevent coronary arteries blocking (which might cause a heart attack) and improve flow to the heart muscle to alleviate the symptoms of angina.

The audit described here allows clinicians to assess key aspects of the patterns and quality of their care when performing PCI between January and December 2012.

## Key findings include:

- There are now 117 PCI centres in the United Kingdom (98 NHS centres). All NHS centres now contribute to the audit.
- 92,589 PCIs were performed in 2013 and individual procedure data from 91,830 were recorded in the audit. The number of PCIs performed per million population (pmp) in the UK was 1,444 pmp in 2013 compared with 1,451 pmp in 2012 (a fall of 0.5%).
- The rate of primary PCI (to treat ST elevation Myocardial Infarction (STEMI) in place of thrombolysis) continues to rise, and reached 380 pmp across the UK in 2013. This treatment option was provided 24/7 by 58 of the 98 NHS PCI centres.
- Centre size: there is evidence that suggests improved outcomes for patients being treated in higher volume PCI centres, particularly those that perform at least 400 procedures

per annum. This forms part of the recommendations of the Joint Working Group on PCI of BCIS and the British Cardiovascular Society<sup>1</sup>. In 2013, 22% of NHS PCI centres performed 400 or less cases but all but 2 centres performed over 200 cases.

- The National Institute for Health and Clinical Excellence (NICE) recommend that "stents" should be used routinely where PCI is the clinically appropriate procedure for patients with either stable or unstable angina or with acute myocardial infarction. The great majority of procedures now involve stent insertion (92%), suggesting that this aspect of good practice is being met.
- Following concerns about the safety of drug eluting stents (DES) in September 2006, there was a fall in their use to 55% across the UK. Data from 2013 suggest continuous increase in their use (82% compared with 76.2% in 2012 ) now that safety issues are better understood, and are not dissimilar from what might be predicted from the National Institute for Health and Clinical Excellence (NICE) updated guidelines<sup>2</sup>. Nevertheless there are large differences in the rate of DES use in the different UK countries (see Figure 17).
- The use of the radial artery for access has increased progressively from 10% in 2004 to over 71% in 2013. This audit analysis supports the literature demonstrating a lower complication rate – in 2013 the rate of access site related complications was 0.3% when PCI is performed via the radial artery, compared with 1.3% where femoral artery is used for access. There however remains a large variation in the rates of radial access by different PCI centres.
- The overall rate of in-hospital death following PCI has stabilised in the last two years reflecting a new equilibrium in case mix. For all PCIs in-hospital mortality is 1.8%.  
  
For stable patients treated electively, in-hospital mortality is about 0.16%, for patients with unstable angina or nSTEMI (non-ST elevation Myocardial Infarction), the in-hospital mortality is approximately 0.69%.  
  
For patients with STEMI the in-hospital mortality is higher at about 4.9%.
- Analysis of risk adjusted outcome (major adverse cardiac and cerebrovascular events) from January 2012 to December 2013 (that is available on the [BCIS](#) as well as [My NHS – NHS Choices website](#)) shows that all operators and units in the United Kingdom are performing as well as would be predicted from the model used for risk adjustment.

1. <http://sbhci.org.br/wp-content/uploads/2010/08/British-Cardiovascular-Intervention.pdf>

2. <http://www.nice.org.uk/guidance/ta152>



- National and international guidelines for the emergency treatment of patients with STEMI, recommend that primary PCI treatment should be performed within 90 minutes of arrival of the patient at the PCI centre (door-to-balloon time), and within 150 minutes of a patient's call for help (call-to-balloon time).

In 2013, a call-to-balloon time of less than 150 minutes remains similar as in 2012 at 79%, 86% of cases for direct admissions and 51% for patients with inter-hospital transfer.

A door-to-balloon time of less than 90 minutes was achieved in 91%, and 77% within 60 minutes.

In 2013, 79% of cases were *admitted directly* to the PCI centre and 21% of patients were admitted to the PCI centre by *inter-hospital transfer*. Transfers between hospitals added

delays to treatment times. Patients who need to be transferred between hospitals for primary PCI had longer delays than those admitted directly to a PCI centre, with a difference of about 43 minutes.

- Delays to PCI for patients with nSTEMI – national and international guidelines recommend that patients with nSTEMI should have angiography followed by PCI if appropriate within 72 hours from the time of admission to hospital. In 2013 only 55% of patients met that recommendation.

This report contains more details and additional graphs of the audit findings. The complete analyses and all the details for the 2013 audit are available for download at the BCIS website [www.bcis.org.uk](http://www.bcis.org.uk).



# 1 Introduction

## 1.1 Coronary heart disease and the role of Percutaneous Coronary Interventional Procedures

**Coronary heart disease (CHD)** is the largest cause of death and disability in the United Kingdom. CHD causes around 94,000 deaths in the UK each year and around one in five men and one in seven women will die from the disease.

Coronary heart disease is usually caused by **atherosclerosis** which is a process where the walls of the arteries develop with fatty deposits called atheroma. Atherosclerosis manifests itself in a number of conditions:

Stable angina is when the artery becomes progressively narrowed and blood supply to the heart muscle will become restricted. People experience a tight constricting feeling, normally across the chest. It is brought on by physical exertion or stress. Stable angina is a chronic medical condition with a low but appreciable incidence of **acute coronary events** and increased mortality.

Acute Coronary Syndrome (ACS) results in symptoms that indicate a sudden or recent reduction in the blood supply to the heart and includes unstable angina and myocardial infarction (heart attacks); Figure 1. The symptoms for both unstable angina and a myocardial infarction can be similar (for example, chest pain or tightness, breathlessness and sweating) but can be distinguished with an **electrocardiogram** (ECG) and blood tests.

A myocardial infarction (heart attack) occurs when the coronary artery is totally blocked by a clot (thrombus) which forms over the fatty deposits in the wall of the artery. If the blockage persists the region of the heart muscle supplied by that artery will progressively die (myocardial necrosis). This syndrome is referred to as ST elevation myocardial infarction (STEMI), because usually this pattern (elevation of the ST segments) is seen on the ECG.

Sometimes the artery becomes partially blocked or only blocked temporarily. The ECG usually does not show ST segment elevation. Shortage of blood supply to the affected heart muscle is less severe or intermittent and may not lead to myocardial necrosis. If it does not then the syndrome is called unstable angina. If there is evidence of some myocardial necrosis without ST segment elevation it is referred to as non ST elevation myocardial infarction (nSTEMI).

Percutaneous Coronary Intervention is one of two coronary **revascularisation** techniques used to treat narrowed arteries, the other being **coronary artery bypass grafting** (CABG).

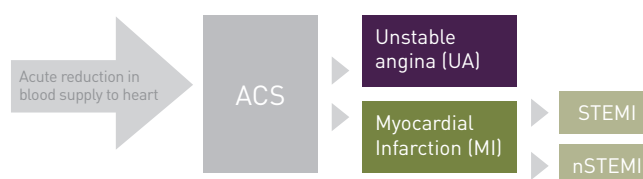
The PCI procedure works by mechanically improving blood flow to the heart. A small balloon is inserted which, when inflated widens the artery. In most cases a 'stent', a metal mesh scaffold is implanted to keep the artery wall open.

The National Institute for Health and Clinical Excellence (NICE)<sup>3</sup> recommends that PCI is used to manage angina and acute coronary syndromes in three ways:

- Alleviate the symptoms of angina.
- Prevent future myocardial infarction.
- Restore coronary blood flow during a heart attack (primary PCI).

The use of primary PCI has increased significantly in recent years because of worldwide research showing it to be more efficacious and cost effective than drug treatment (**thrombolysis**). National and International guidelines now recommend that in the emergency treatment of patients with ST elevation myocardial infarction, primary PCI should be performed within 90 minutes of arrival of the patient at the centre (**DTB time**), and within 120 minutes of a patient's call for help (**CTB time**). This primary PCI strategy requires emergency access to specialist **cardiac catheter laboratories** and staff 24 hours a day, 7 days a week. The use of primary PCI continued to increase and in 2013, primary PCI now makes up more than 97% of **reperfusion** treatment for patients with a final diagnosis of STEMI<sup>4</sup>.

**Figure 1. Types of acute coronary syndrome**



## 1.2 The PCI procedure

A percutaneous coronary intervention (PCI) starts with an angiogram. During an angiogram, x-ray images are made of the heart arteries, while a special dye is injected into them to make them visible. The procedure can be performed from the artery at the top of the leg (femoral artery) or in the wrist (radial artery) and is performed under local anaesthetic. A long thin tube (called a catheter) is fed into the artery. It is then guided under x-ray imaging control until the tip reaches the heart.

When the tip of the catheter is in position a special liquid is injected into the heart arteries so that they show up

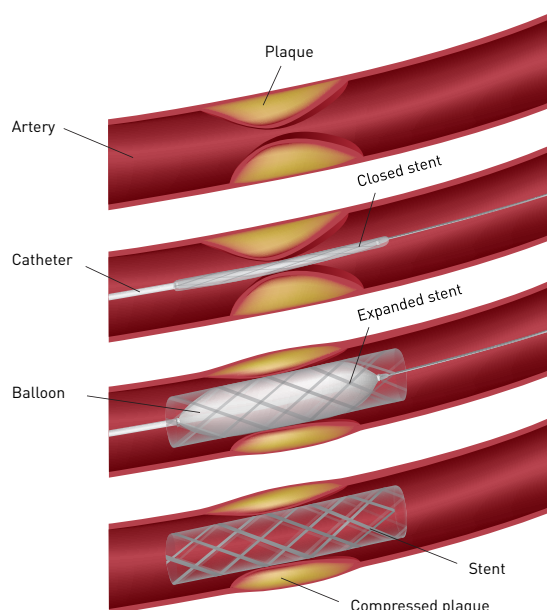
3. <https://www.nice.org.uk/guidance/conditions-and-diseases/cardiovascular-conditions/acute-coronary-syndromes>

4. How the NHS cares for patients with heart attack. Annual Report April 2013 - March 2014: <http://www.ucl.ac.uk/nicor/audits/minap/reports>

under x-ray. The position and shape of any narrowing in these arteries can therefore be identified. This part of the procedure is called an angiogram and is a prelude to a percutaneous coronary intervention (PCI), which would then occur immediately after the images are obtained.

In the PCI procedure, a very thin wire is guided under x-ray image control, across the narrowed part of the coronary artery. Once in place, a balloon is fed over this wire and so tracked across the narrowing. Inflating the balloon squashes the blockage (made of fatty tissue and sometimes clot) out of the way and widens the artery. This may need to be done several times to be successful in fully widening the artery. In most cases a stent is then implanted. A stent is a small metal mesh in the shape of a tube which can be used to scaffold the artery wall in order to keep it open. The stent is supplied crimped over a balloon, which is used to deploy it against the inner wall of the artery. As the balloon inflates, so the stent is expanded, pressing out against the arterial wall, so helping to hold open the newly widened artery. The balloon is then deflated and withdrawn, leaving the stent in place.

### The PCI procedure



In the last few years we have seen the development of 'drug eluting' stents, which are coated with drugs to prevent the development of **cell proliferation** which could otherwise block the stented artery. This drug passes into the wall of the artery to improve the longer term success rates of the procedure.

Following a PCI, most patients return home the next day, though some patients can be treated and discharged the same day. If a patient has been admitted following a heart attack then they usually remain in hospital for a bit longer (on average 3 days).

Generally, this is a very safe treatment, the potential complications being infrequent. The serious adverse events are called 'Major Adverse Cardiovascular and Cerebrovascular events' or MACCE. These include the need for emergency cardiac surgery, but this has been greatly reduced by the availability of stents and now arises in less than 0.1% of PCI procedures. A peri-procedural cerebrovascular accident occurs in about 0.3–0.4%. In-hospital mortality is rare (overall about 1 to 2%). The bulk of procedural risk is determined by patient and clinical characteristics, and a fatal outcome is usually in spite of the PCI procedure rather than caused by it. Patients treated for stable angina have a mortality risk of less than 0.2%, those treated for nSTEMI and UA about 0.6%, those for STEMI about 5%, and those who present in cardiogenic shock have up to a 50% mortality.

### 1.3 The role of the audit

Clinical audit is the process of monitoring the care and treatment of patients against a given benchmark, with a view to driving up the quality of care and improving outcomes for patients. The British Cardiovascular Society (BCIS) has continuously audited PCI activity since 1988 and in collaboration with NICOR since 2006. Each hospital submits an annual data return that summarises local PCI activity. An electronic system to collect data on each PCI procedure was developed after a pilot study in the late 1990s, and collected data from all PCI centres in the UK from about 2005. The audit provides information on the:

- Structure of the provision of PCI services across the UK (for example the number of PCI centres, number of PCIs per centre and population, number of operators).
- Clinical care and treatment provided by each hospital, measured against national aggregated data and agreed national standards (for example indication for treatment, use of stents, arterial access routes).
- Process of care (for example delays in receiving treatments such as primary PCI).
- Outcome for patients such as complications, adverse cardiac events and death.



## 1.4 Use of the data

PCI audit findings are used in various ways to support quality improvements (Figure 2). Access to national comparative data

allows clinicians and healthcare professionals to examine key aspects of the quality of care and impact on patients:

**Figure 2. A summary of how National Audit of Percutaneous Coronary Interventions data is used to support improvement**

Local level	Hospital performance	<b>Aggregated reports</b> are generated by the data submitted to NICOR and distributed monthly to all PCI centres.
		<b>Delays reports</b> calculate a number of time intervals between various stages of the emergency PCI pathway and generates graphs for door to balloon times.
		Risk adjusted reports of <b>MACCE</b> provide information on the number of actual events compared with predicted events.
National level	Clinical performance	The NICOR database has the facility to generate reports that can be used for consultant appraisal and revalidation. All UK Consultant PCI operators are therefore able to monitor their own activity and outcomes.
	Informing clinical guidelines	The Joint Working Group on Percutaneous Coronary Intervention of the British Cardiovascular Intervention Society and the British Cardiovascular Society used audit data to develop guidelines regarding the best practice of coronary intervention. <sup>1</sup>
	Transparency of data	The British Cardiovascular Interventional Society publishes: <ul style="list-style-type: none"> <li>• PCI centre and Individual PCI Consultant operator outcome reports</li> <li>• Comprehensive analysis of annual audit data from 1992 to present</li> </ul> Data underpinning the summary reports is published on data.gov.uk website.
	Quality accounts	Department of Health Quality Accounts 2011/12: In their Quality Account providers must report which of the national clinical audits they participated in. This information is published annually and made available to the public, in order to ensure the accountability of NHS institutions to the public, and to engage the leaders of hospitals in the quality improvement agenda of their organisation.
	Indicators for quality improvement	The NHS Information Centre: The NHS Information Centre Indicators for Quality Improvement are a library of clinician assured national quality indicators designed to help local clinical teams select indicators for local quality improvement.

## 1.5 Organisation of the National Audit of PCI Procedures

National Audit of Percutaneous Coronary Interventions is managed by the National Institute for Cardiovascular Outcomes Research (NICOR). The audit is one of six national cardiac clinical audits and one registry managed by NICOR, which is part of the Institute of Cardiovascular Science at University College London (UCL).

The purpose of NICOR is to provide information on quality and outcome of care provided to people with heart disease and to provide technical infrastructure, project management and statistical support for the national cardiac audits and clinical registries.

The British Cardiovascular Interventional Society provides intellectual and clinical leadership of the audit. The BCIS Data

Monitoring and Audit Group (see membership in appendix 3) is a working group of NICOR and BCIS and responsible for:

- Reviewing the UK wide audit data to assess whether hospitals and operators are meeting the evidence based standards. The BCIS has an **Outlier Policy** which is followed when the results suggest a centre or operator might not be meeting the required standards.
- Reviewing applications to use the BCIS dataset for research (see Section 5).
- Reviewing the BCIS dataset for potential changes to ensure it meets the current clinical practices needs.

National Audit of Percutaneous Coronary Interventions is commissioned by the Healthcare Quality Improvement Partnership (HQIP). HQIP holds commissioning and funding responsibility for this and other national clinical audits.

## 1.6 The database

The audit is based on the dataset developed by BCIS (and is maintained by the BCIS Data Monitoring and Audit Group) and reflects national evidence based guidelines and recommendations. The current dataset v5.6.2 was published in November 2014 and contains 113 fields including patient demographics, clinical information and process information e.g. date and time of call for help. The dataset is available on the NICOR and BCIS website.

## 1.7 Data collection and IT

Data can be either entered manually via dedicated interface or imported from existing hospital systems using commercial or locally developed software. All data uploaded by hospitals are encrypted on transmission and stored encrypted on the NICOR servers. NICOR manages access control to the servers via user IDs and passwords.

Data held within NICOR are managed within a secure environment for storage and processing provided by the UCL network and within the UCL Information Governance and security policies. NICOR is registered under the Data Protection Act. Additionally, NICOR – of which this audit is part – has support under section 251 of the National Health Service (NHS) Act 2006 (Ref: NIGB:ECC 1-06 (d)/2011) to collect and store patient identifiable information without consent.

All patient identifiable data are pseudonymised by the NICOR technical team before release to the project management and/or analysis team via a secure drop box on the NICOR server. Patient identifiable data are only accessed for the purpose of record linkage for example with ONS mortality data.

NICOR staff recognise that confidentiality is an obligation and regularly undergo information governance training to ensure understanding of the duty of confidentiality and how it relates to patient information.

## 1.8 Data quality and data completeness

Of 98 NHS PCI centres in the UK, all submitted data to NICOR in 2013 – this is an improvement from the last year when the last two hospitals started to participate in the audit. Seven of 19 private hospitals in the UK also submitted data to NICOR. A list of participating hospitals is provided in the Appendix 1.

Overall data completeness of the key fields is good although there is scope for improvement in 19 of the centres (Appendix 1).

Most of the centres import their data onto NICOR servers and to ensure the data are reliable number of logical and internal validation rules have been implemented. On import each record is checked that it satisfies specific criteria before it is

allowed in to the NICOR database. Some Scottish centres use a previously established electronic data collection system, but based on a different dataset. The differences in datasets mean that a number of assumptions and translation rules have been set up to ensure that data are analysable and comparable to data from other UK countries.

The audit has a dedicated project support helpdesk and the technical helpdesk support to the participating hospitals with regard to the dataset and clinical definitions, analysis views and any technical issues.

## 1.9 Case ascertainment

Annually the audit runs a survey with participating and non-participating centres (private) to obtain data on number of cases and procedures performed at their centre. In the UK, over 98% of PCI cases are included in the audit (figure based on self-reported data). NICOR is at the process of obtaining HES data with intention to explore the suitability of HES data for development of methodology and reporting of case ascertainment rates.

## 2 Findings

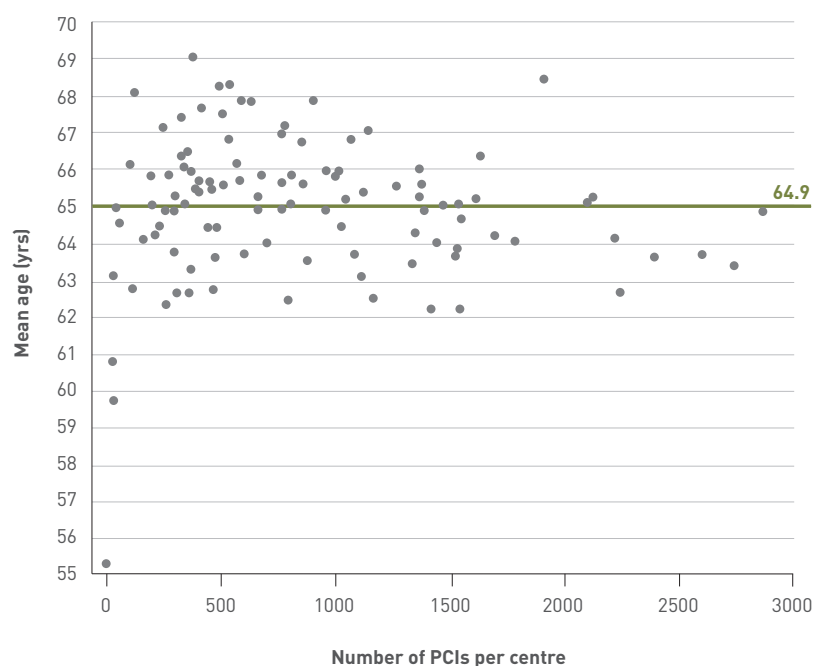
### 2.1 Patient characteristics

The characteristics of patients treated by PCI are shown in Figure 4: Characteristics of patients treated by PCI in the UK. Although the average age of patients treated by PCI is 65 years, there is a wide range in patient characteristics across

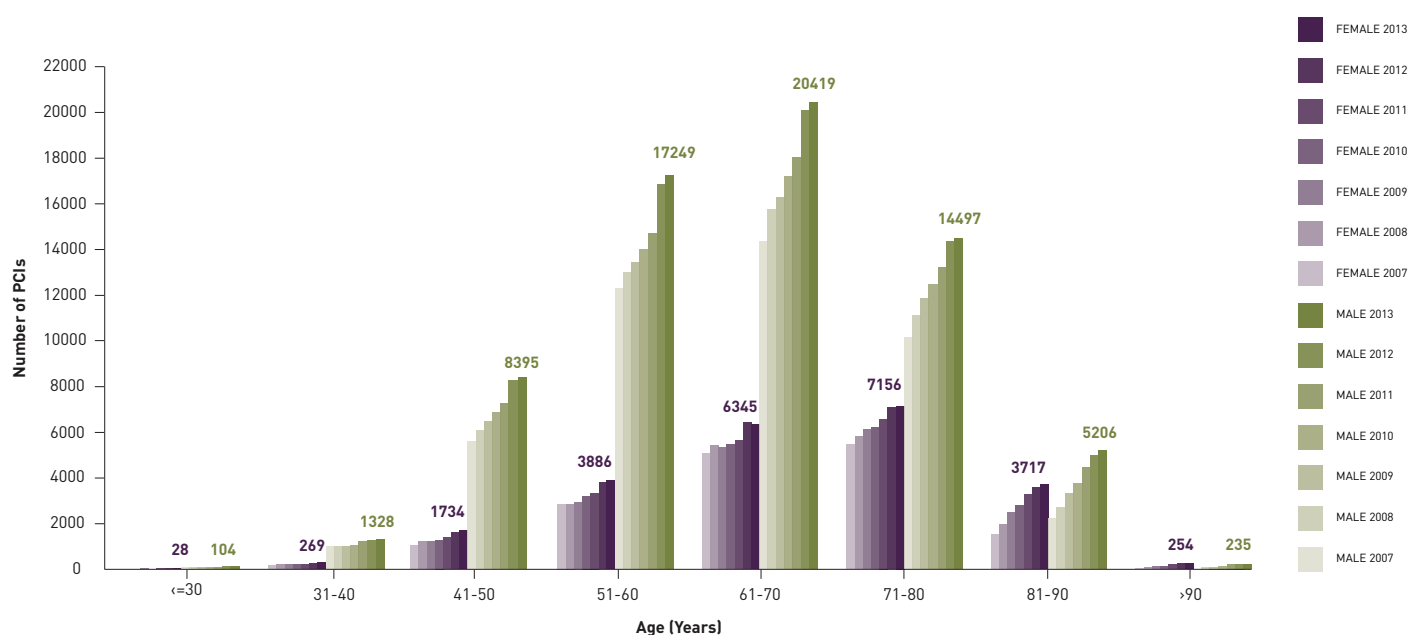
different regions in the UK. The mean age of patients treated in each PCI centre therefore differs and is shown in Figure 3.

Female patients treated with PCI tend to be older (mean age is 69 years) compared to men whose mean age is 64 years (Figure 4).

**Figure 3. Average age of patients treated by PCI in each PCI centre**



**Figure 4. Age and sex of patients treated by PCI in the UK**



## Indication for PCI

There are three main indications for PCI dependent on the type of syndrome patient presents:

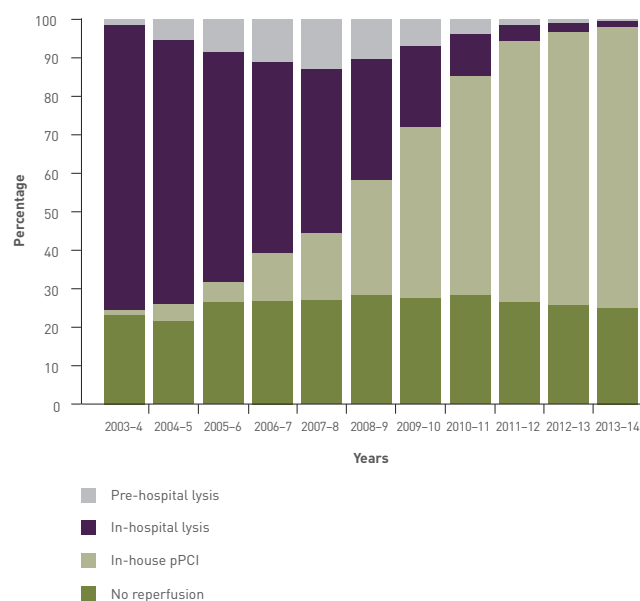
- ST Segment Elevation (STEMI)
- Non-ST Segment Elevation/Unstable Angina (nSTEMI/UA)
- Stable Angina

*Primary PCI* is now the preferred treatment of choice for patients with STEMI and now makes up more than 97% of reperfusion treatment for patients with a final diagnosis of STEMI (see 2014 MINAP Annual Report for overall reperfusion rates breakdown, including patients that received no reperfusion).

The overall reperfusion methods and strategies for pPCI in STEMI can be seen in Figure 5.

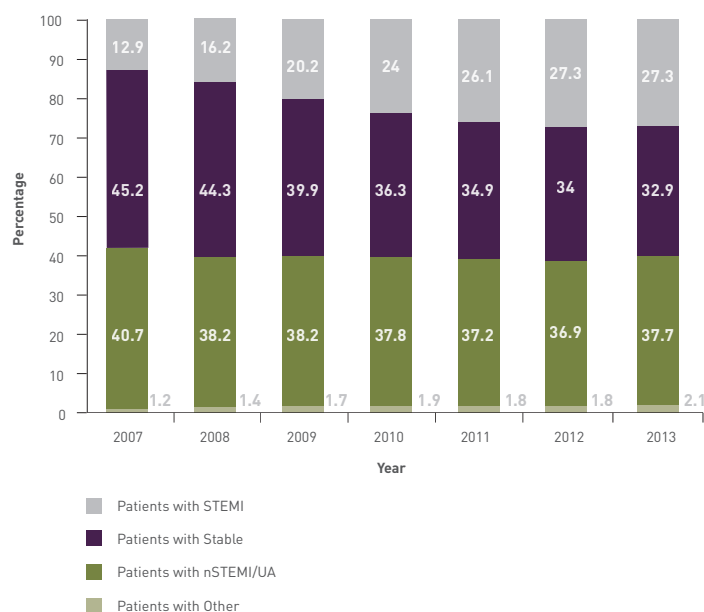
### Figure 5. Reperfusion treatment rates for patients with final diagnosis of STEMI (based on MINAP data)

Overall, the percentage of patients receiving PCI differing clinical presentations has not altered significantly since 2012.



In 2013, the indication for PCI was STEMI in 27% of cases, nSTEMI/UA in 38% and Stable angina in 33% (Figure 6).

## Figure 6. Changing indications for PCI



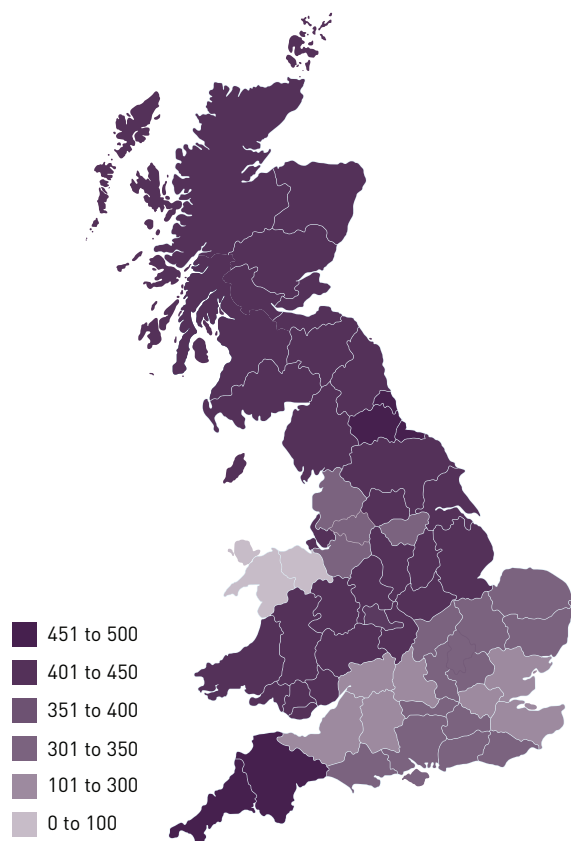
## 2.2 Access to PCI procedures

### Overall PCI rates in the United Kingdom

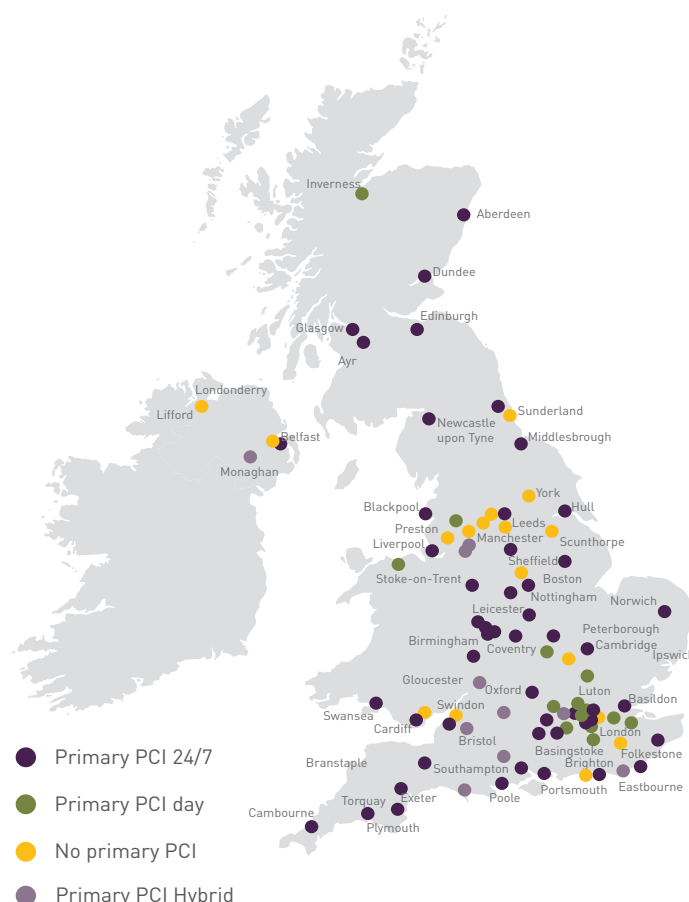
The optimal rate of PCI per million population (pmp) is difficult to judge and is dependent on many factors, including the varying characteristics of populations in different countries. While the rate of PCI pmp in the UK has, historically, been considerably lower than most other European countries, there have been steady increases in activity.

A total of 92,589 PCIs were performed from January to December 2013 and represents a rate of 1,444 PCI pmp compared to 1,451 pmp in 2012 (Figure 7).

**Figure 7. Primary PCI rates per million population in the UK regions in 2013**



**Figure 8. PCI centres and their provision of primary PCI therapy across the UK**



### Number of PCI centres largely unchanged

In 2013 in the United Kingdom there were a total of 117 PCI centres, and 63 centres performing angiography only. The structure of the provision of care has not changed much since 2013, perhaps because we are approaching an optimal number of centres for the population we are treating.

There has been a steady increase in centres providing Primary PCI for STEMI. This is an emergency treatment that needs to be available at all times. In 2006, only 32 centres offered primary PCI as a treatment for STEMI during working hours. In 2013, 81 centres provided a working hours service. In 2006, 18 PCI centres offered this service at all hours every day. In 2013 this has more than trebled and 60 centres now offer a 24/7 service. There are also a small number hybrid centres that collaborate with another centre to provide 24/7 pPCI service.

A map showing the distribution of this activity across the UK is given in Figure 8.

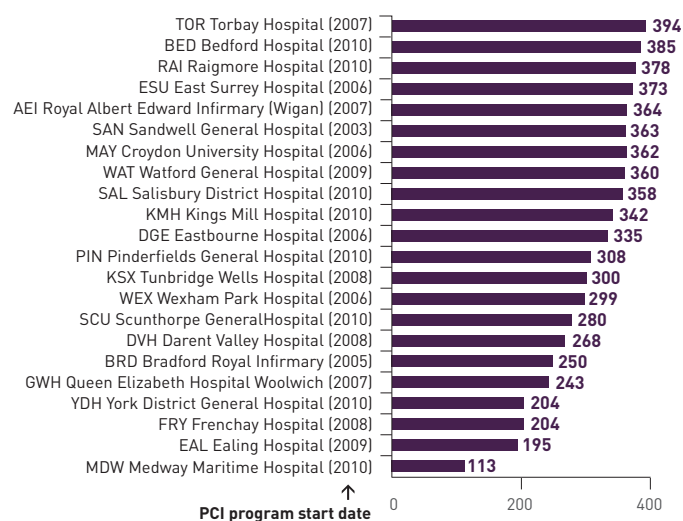
### Number of patients treated by PCI remains steady

There has been a very slight increase in the number of patients receiving PCI therapy, but less than the increase in population size, and so an overall fall in PCI rate pmp, comparing 2012 to 2013. There is evidence that patients treated in higher volume centres may have improved outcomes, particularly centres that perform at least 400 procedures per year. The BCIS and BCS 'Recommendations for good practice and training'<sup>5</sup> recommend that centres undertake at least 400 PCI procedures each year. In 2013, 22% of NHS PCI centres performed 400 or less cases. Nevertheless all but two centres performed over 200 cases (see Figure 9). Centres that perform less than 400 procedures per year are encouraged to increase their level of activity to a minimum of 400 procedures; whilst those that perform less than 200 procedures per year should have a robust plan in place to show how this standard can be achieved in the future.

5. [http://www.bcis.org.uk/resources/documents/pqi\\_recommendations\\_2005.pdf](http://www.bcis.org.uk/resources/documents/pqi_recommendations_2005.pdf)

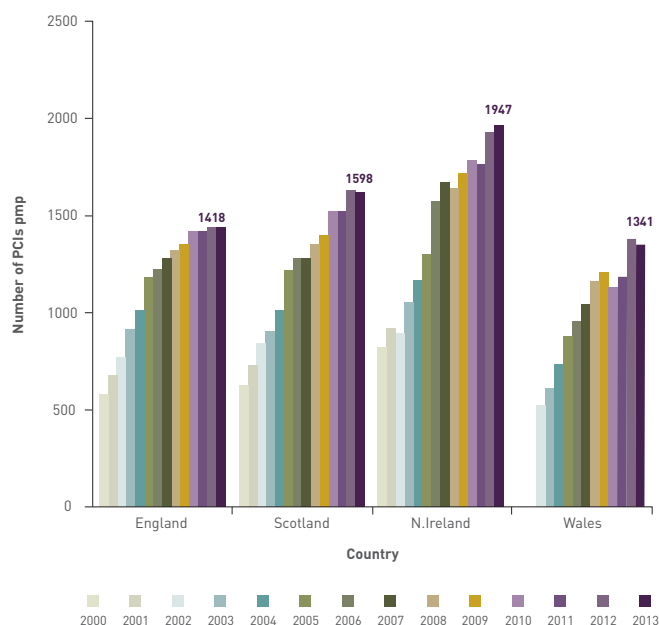


**Figure 9. Hospitals performing less than 400 PCI procedures in 2013**



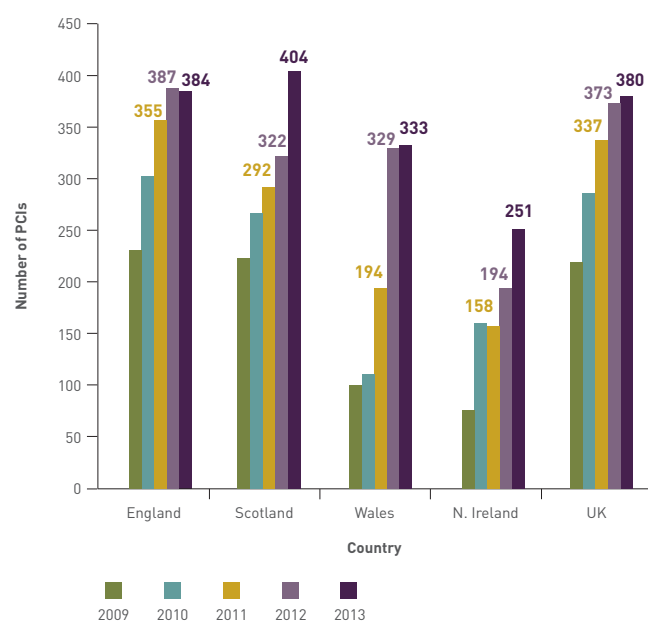
There remain differences in PCI rates between the countries of the United Kingdom (Figure 10).

**Figure 10. Total PCI activity per million population in the UK countries**



The rates of primary PCI appear to be levelling off in England, suggesting that almost all this population are provided with an appropriate primary PCI service. Increase continues particularly in Northern Ireland. The data from Scotland are harder to interpret as 2013 is the first year that all hospitals have contributed to the audit.

**Figure 11. Rates of primary PCI activity for STEMI, per million population, in the countries of the UK**



NB: All previous years updated with latest NICOR extract. For Scotland in 2013 data have been added from Hairmyres Hospital.

## 2.3 Care and treatment of patients

In the treatment of STEMI any delay in treatment by PCI is associated with a worse outcome for the patient. The data to support rapid treatment for patients with nSTEMI are less clear cut, but prolonged time spent in hospital awaiting investigation has many disadvantages for both patients and hospitals.

### Patients with STEMI

For STEMI patients there are 2 important procedural measures:

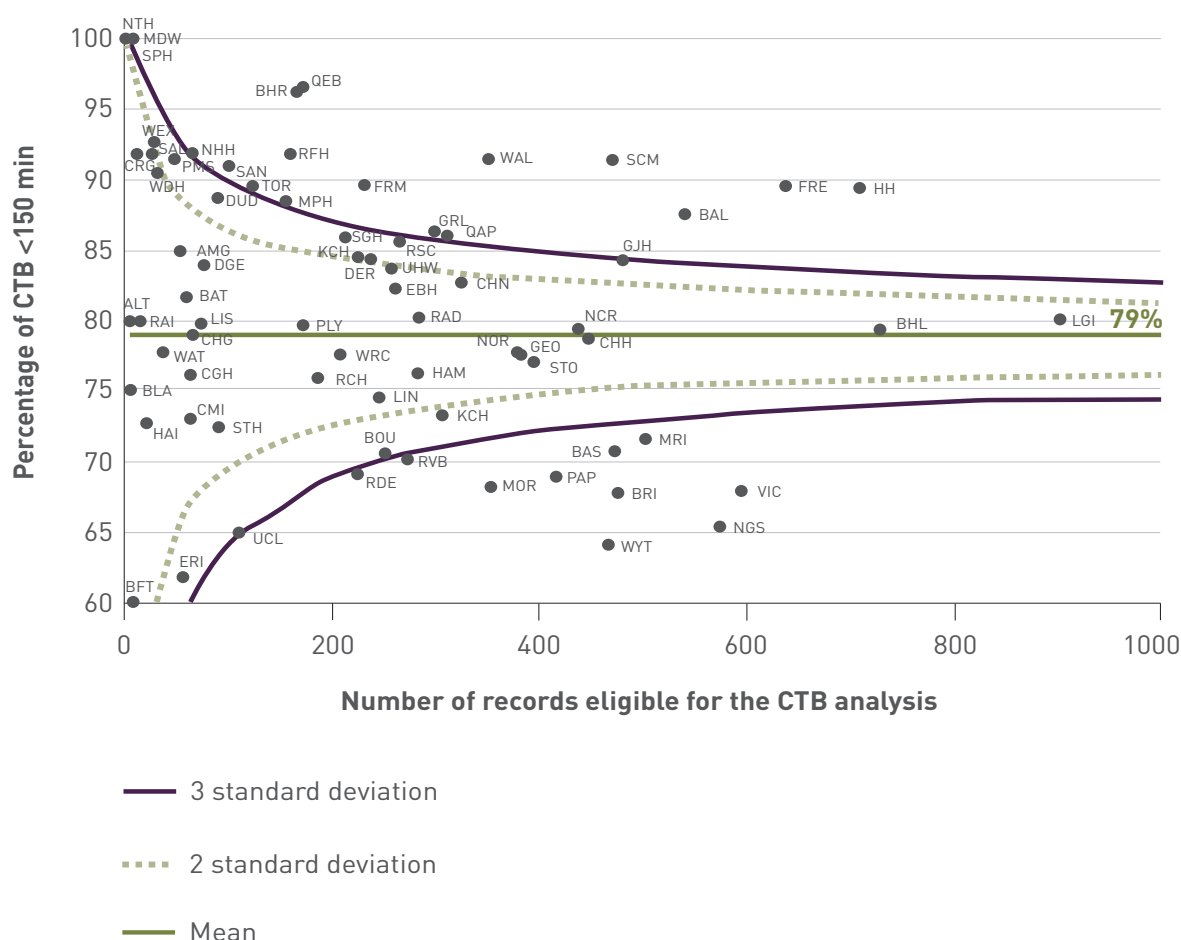
- Call-to-balloon time (CTB) – refers to the time the patient calls for professional help to the time of PCI treatment and it measures the entire process of care. It therefore includes potential delays caused by both the relevant ambulance service(s) and admitting hospital(s).

- Door-to-balloon time (DTB) – refers to the time a patient arrives at a PCI centre to the time of PCI treatment. This therefore assesses how quickly the PCI unit can perform primary PCI.

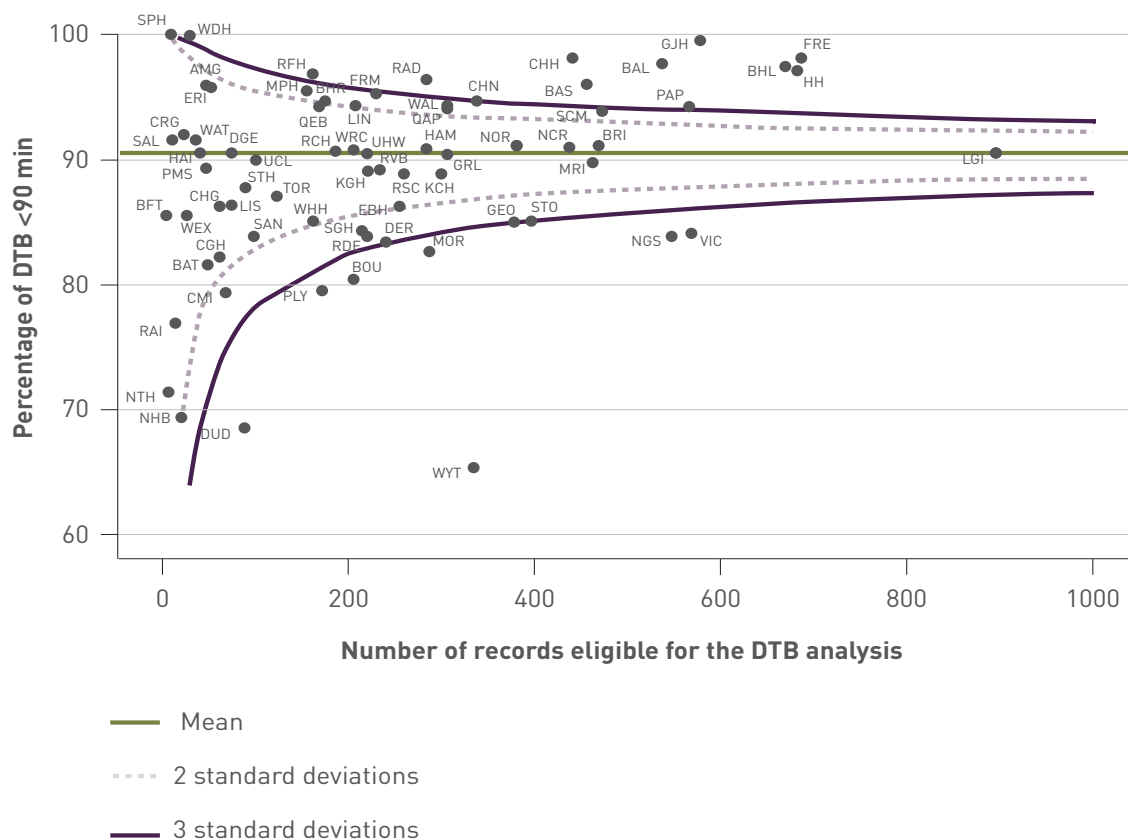
National and international guidance recommend that in the emergency treatment of patients with STEMI, primary PCI should be performed within 90 minutes of arrival at the heart attack centre (door-to-balloon time) and within 120 minutes of a patient's call for professional help (call-to-balloon time). To set an initial audit standard this 120 min delay was added to the mean time for previous treatment by a lytic agent in the UK (20 min), thus this analysis is based on a total time interval of 150 mins.

In 2013, 79% of all patients were treated within 150 minutes of calling for professional help and 91% treated within 90 minutes of arriving at a PCI centre (Figures 12 and 13).

**Figure 12. Call-to-balloon within 150 minutes of calling for professional help. Each centre is represented by a labelled dot. See Appendix 2 for a hospital code and corresponding name**



**Figure 13. Door-to-balloon within 90 minutes from arrival at the PCI centre. Each centre is represented by a labelled dot. See appendix 2 for a hospital code and corresponding name**



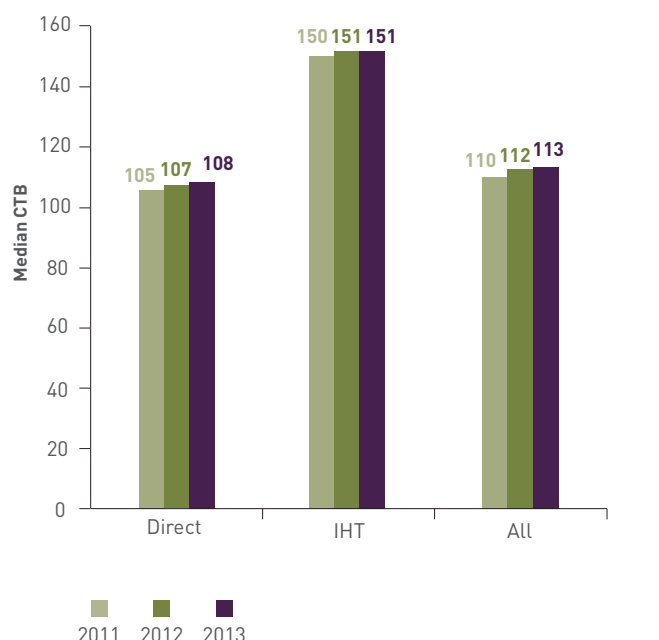
However, how the patient gets to the PCI centre can cause delays. There are two ways a patient can get to a PCI centre for treatment of their heart attack:

**Direct admission** The patient is brought directly at the PCI centre usually by ambulance or self-presents at the A&E of the PCI centre. In 2013, 82% of patients who received primary PCI were direct admissions to the centre.

**Interhospital transfer** In some instances patients are taken to a hospital that is not set up to perform emergency PCI. There are many reasons this might occur, for example the diagnosis might not be clear when the patient is assessed by the

paramedics at a patient's home. Sometimes the characteristic electrocardiographic changes are not present when a patient is first assessed (but develop at a later stage). On arrival at this A&E, a diagnosis of STEMI may now be made, and the patient then is transferred to a hospital that is set up to perform emergency PCI. In 2013, 19% of patients were transferred from another hospital to the primary PCI centre for treatment. Whilst there have been year on year improvements in treating patients within target times, transferring patients between hospitals causes additional delays which may result in worse outcomes. The differences in treatment times can be seen in Figure 14.

**Figure 14. Average time delays to emergency treatment in patient admitted directly to PCI centres (Direct) versus transferred from another hospital to the PCI centre (IHT)**



There has been little change in CTB or DTB times comparing 2012 to 2013. While there is always room for improvement this suggests that the process of care may be approaching the best that can be achieved with our current health care system for many centres.

#### Patients with nSTEMI and delays to PCI

Coronary angiography is important in determining the extent and severity of the coronary disease. NICE guidelines published in September 2014, recommend that as soon as a diagnosis of nSTEMI is made, coronary angiography, should be offered within 72 hours of first admission if clinically appropriate<sup>6</sup>. This leads to revascularisation, again if appropriate, by either PCI or CABG. This guidance specifically relates to patients who have an intermediate or higher risk of adverse cardiovascular events as predicted by the GRACE score.

We track those patients with UA/nSTEMI who end up being treated by PCI. Improvements have been made over the last four years, but there is room for much improvement, with only 55% of patients being treated within the recommended times (Figure 15).

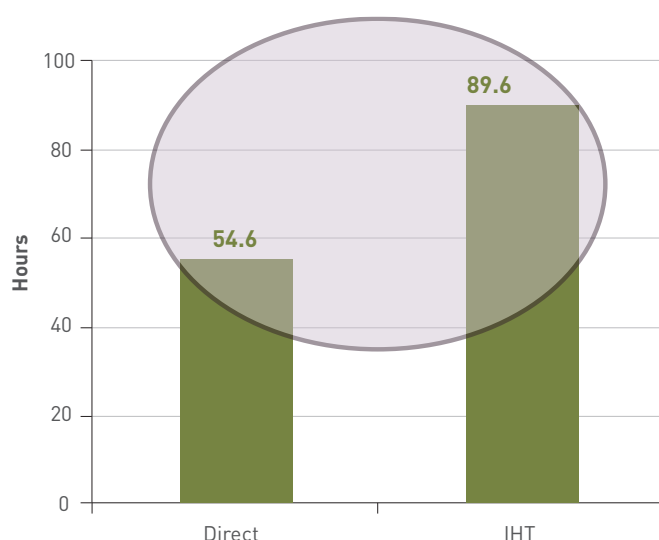
**Figure 15. Percentage of patients presenting to a hospital with nSTEMI who are treated by PCI within 96 hrs and 72 hrs of admission to the first hospital they were admitted to**



As with primary PCI transferring patients between hospitals causes additional delays. In 2013, transferring patients added about an extra 35 hour delay to treatment (Figure 16).

More details regarding the analyses of delays are provided in the full analysis available on the BCIS web site.

**Figure 16. Time from first admission to PCI for nSTEMI according to admission route in 2013 (direct admission (Direct) or by interhospital transfer (IHT))**



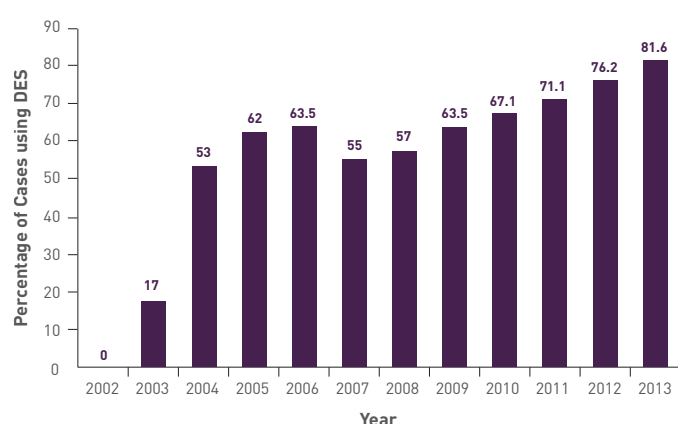
6. <http://www.nice.org.uk/guidance/qs68/chapter/quality-statement-3-coronary-angiography-and-pci-within-72-hours-for-nstemi-or-unstable-angina>

## 2.4 Improved access to evidence based treatment and guidelines

### Drug eluting stents

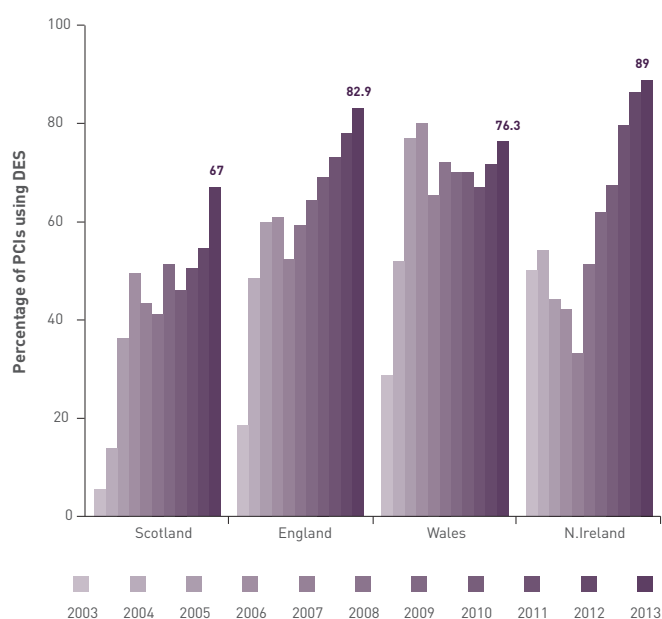
The National Institute for Health and Clinical Excellence (NICE)<sup>7</sup> recommend that “Stents should be used routinely where PCI is the clinically appropriate procedure for patients with either stable or unstable angina or with acute myocardial infarction”. The majority of procedures involve stent insertion (92%) which shows centres are following recommended best practice.

**Figure 17. Use of drug eluting stents (DES) in PCI**



Drug eluting stents slowly release medication to reduce excessive tissue growth and the chance of future blockages. In 2013, 82% of cases were treated with drug eluting stents (Figure 17) although there are large differences in practice between the countries of the UK (Figure 18).

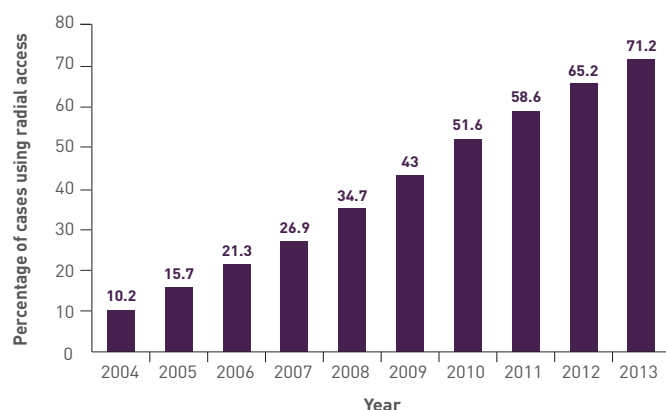
**Figure 18. Drug eluting stent use by countries of the UK**



### How the coronary arteries are accessed

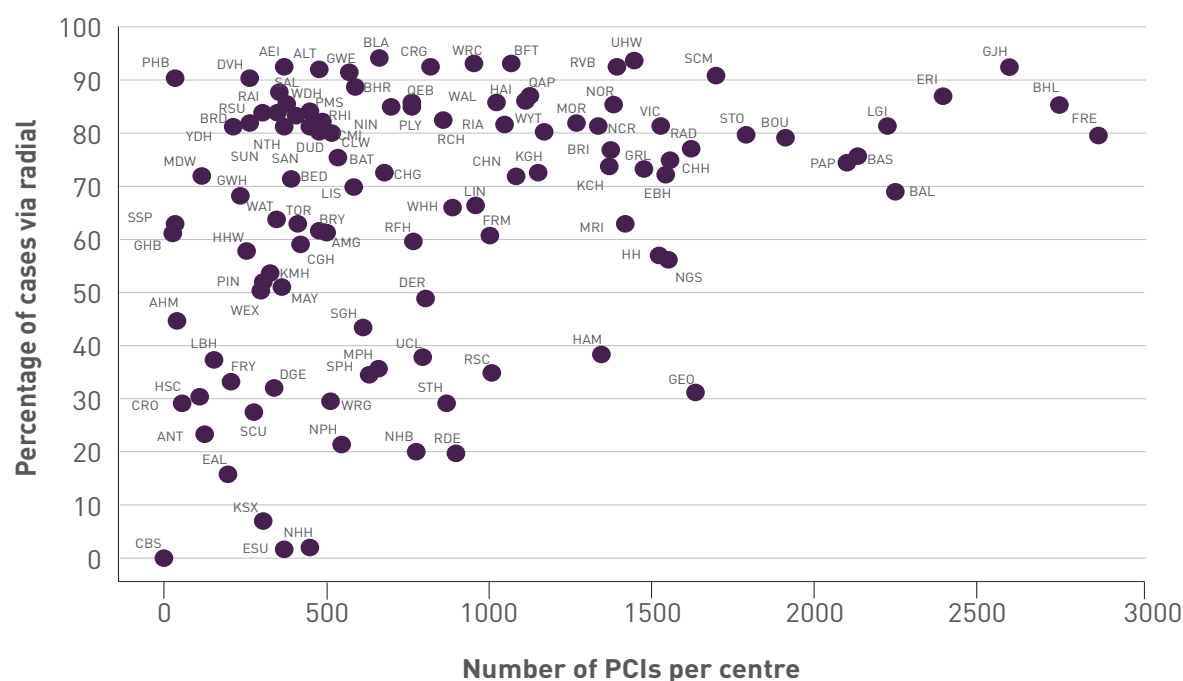
When performing coronary intervention, catheters are introduced to a patient's arterial system, so the coronary arteries can be accessed and treated. During the development of PCI techniques the large femoral artery (at the top of the leg) was used. However, some of the commonest complications after PCI relate to difficulty in stopping this artery from bleeding after removing the catheter at the end of the procedure. As PCI equipment has become smaller, it has been possible to perform almost all PCI from the thinner radial artery in the wrist. There is robust evidence that shows this is associated with a reduction in complication rate mainly because it is easier to stop any bleeding, and there are fewer nearby structures that can be damaged. There has been a continued increase in the adoption of this method which is now used for more than half of all procedures, this has been associated with lower complication rates over recent years. Though there has been an enormous increase in the use of this technique (Figure 19a), there is still a large variation in the use of this approach between different PCI centres (Figure 19b).

**Figure 19a. Percentage of patients treated using radial artery access by year**





**Figure 19b. Percentage of cases performed using a radial approach, by PCI centre**



## 2.5 Outcome and improving the patient experience

The complications from PCI have progressively fallen as techniques have evolved. Nevertheless, this has also meant the procedure can be offered to patients who are considerably sicker, and in whom a higher risk of complications is expected.

Emergency coronary artery surgery may be needed to treat a complication. In 2013, the rate of requirement for emergency surgery remains very low at less than 0.1%. The incidence of stroke also remain low at less than 1% of all PCI procedures.

The overall rate of death in hospital following PCI gradually increased reflecting changes in case mix, until the last 3 years, when case mix has become more stable, and primary PCI has been almost fully implemented across the UK. The biggest predictor of mortality is how sick a patient is when they are treated, and almost invariably, a fatal outcome is a result of the patient's underlying disease, rather than due to the PCI procedure – so it occurs in spite of PCI rather than due to it. In 2013, in hospital mortality following PCI for stable

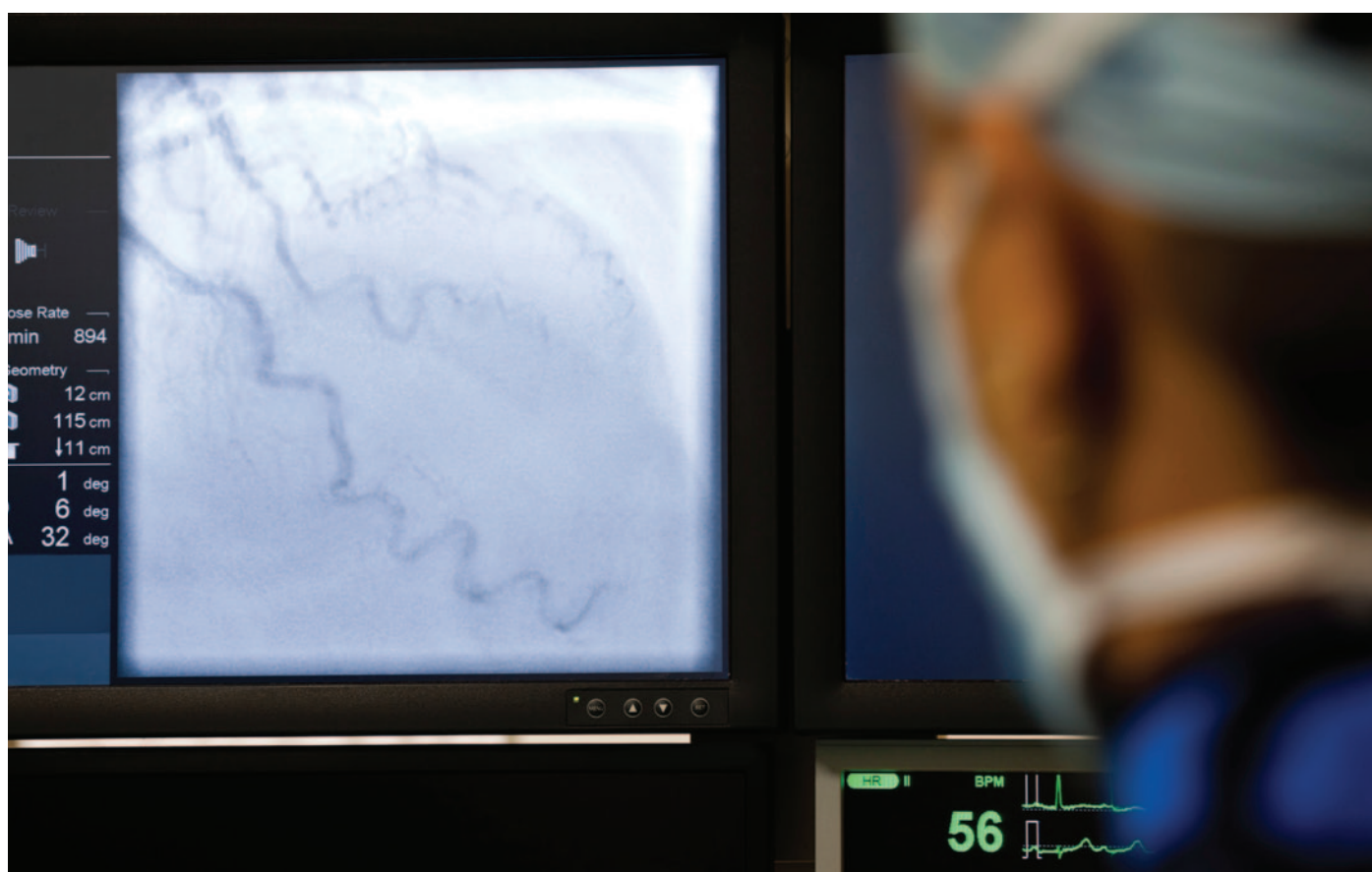
symptoms was 0.06%, following PCI for UA/nSTEMI was 0.7%, and for STEMI 4.9%. In the very sickest patients, who present with extremely damaged heart muscle, in cardiogenic shock, mortality is was about 31%. Nevertheless adverse outcomes will also depend on the quality of care given and the timeliness of treatment. For this reason the risk adjusted analysis attempts to account for the differences in how sick patients are when they present at the hospital, so that what remains of the variation in outcomes might be explained by the care received.

As part of the Government's Transparency Agenda introduced in 2012 some specialties have been required to report patient clinical outcomes by an individual operator, and PCI operators have been part of this initiative known as Consultant Outcome Publication.

For the second year running, the PCI Audit data shows that PCI practice with regard to the complication rates i.e. MACCE rates following PCI meets the expected standard.

More detailed findings are available at the [BCIS](#) website.

### 3 The future



High quality information is vital to improve the care, treatment and outcomes for patients undergoing PCI. Our future plans continue to focus on improving the quality of data to ensure accurate and timely data is readily available. In 2014/15 we plan to:

- Improve accuracy of data by improving the technology of the upload tools.
- Improve the variety of reports available to individual PCI Consultant Operators to allow them to monitor their practice and outcomes.
- Improve access to the audit data by developing a web-based application to enter/import patient data and access to the analyses. The web-based interface will allow for a wider access to variety of users at the participating centres to facilitate the use of data for improvements in data quality as well as quality of care.
- Improve data quality by encouraging the use of consistent definitions and support internal audit to assess accuracy. The responsibility for recording adverse events rests with the PCI operators, the data collection staff and clinical governance teams at the PCI hospital. These data cannot be validated by NICOR but we can support the process.
- Continue to encourage compliance with the minimum data standard set out by NICOR in collaboration with BCIS. More detail on the data standard can be found on the NICOR website: [www.ucl.ac.uk/nicor](http://www.ucl.ac.uk/nicor).
- Improve joint working: We will continue to strengthen the link with the MINAP audit. Both audits collect information on primary PCI procedures for patients with STEMI and elective PCI for patients with nSTEMI. The definitions of the two datasets have been aligned. Plans are also in place to develop a joint MINAP/BCIS database application to minimise duplication of work for hospital staff.
- Improve analysis by implementing a new risk adjustment model to reduce the potential for misleading conclusions on mortality and MACCE. This will also require accurate and complete risk factor data. We will work with centres to improve the accuracy of hospital reported data but will also continue to track mortality through ONS.
- Promote transparency: We will continue to publish process and outcome data for all PCI Consultant Operators in the UK on the BCIS website. In 2013, all PCI consultant risk adjusted MACCE rates were within the expected range which is extremely reassuring and shows that in the UK we deliver a safe and high quality service.

## 4 Case studies

Clinical audit data have shown to be a very valuable tool in driving an improvement in the quality of care and patient outcomes. National Audit of PCI has been providing comparative data relating to PCI procedures at the national level in the public domain (on the BCIS website) since 1992. However, the dataset has been developed not only to allow for the national reporting but also to facilitate review of the quality of care provided by the hospital and individual operators locally. This section presents some examples to demonstrate how these hospitals have engaged with their PCI Audit data to understand the level of care and services provided to their local population.

### 4.1 Raigmore Hospital

Dr Jamie Smith – Consultant Interventional Cardiologist  
Prof Steve Leslie – Consultant Interventional Cardiologist

Raigmore hospital is situated in the North of Scotland and provides cardiac services to over 300,000 people over a vast geographical area, covering almost 10 000 square miles, from the Skye to John O'Groats and down as far south as Oban. Our service provides PCI to the most remote population in the UK – the nearest surgical centre 100 miles away is 90 minutes by Sea King Helicopter and over 2 hrs by road ambulance, so primary PCI or immediate rescue PCI was not previously available to any of our patients.

We started PCI after a successful BCIS site visit in 2010. Since then approximately 380 PCI have been performed per year, with full use of IVUS, FFR and rotablation. We have initiated a CTO programme developing our local skill set aiming to deliver a full hybrid approach.

An office hours primary PCI service was established in 2013 but further out of hours expansion is being limited by unsuccessful business cases to take on a third interventionalist. Our pPCI numbers are therefore limited to around 40 per year. Out of hours, we have a very robust pre hospital thrombolysis service but unfortunately patients failing to reperfuse or re-infarct still have to face unacceptable transfer times to our tertiary centre.

Prior to 2010 we provided 30% less PCI to our population than the national average. Once established, our numbers rapidly increased, understandably putting our figures under close scrutiny during these times of austerity. The BCIS data set was integral in demonstrating that as opposed to over treating we were simply coming into alignment with national figures.

It was recognised that to ensure we were practicing safely and to monitor care and treatment for patients, it was essential to have a method for robust data collection and in 2013 we secured funding for our data clerk, Amanda.



Cath lab team at Raigmore Hospital



The BCIS data set is critical in reassuring us and our referring clinicians that we provide a safe and sustainable service. Despite our small population, our two operators undertake PCI in numbers greater than the majority of cardiologists in the UK. This goes some way to mitigate against the potential risks in a small volume PCI centre and the BCIS data set has been extremely reassuring in this regard.

At times it is good to be an 'early adopter' and an 'outlier' but for our low volume PCI service we remain delighted to be 'average' (or at least within 2 standard deviations with a favourable funnel plot!).

We would like to thank the BCIS team for allowing us to establish PCI to the great benefit of our population, to give us the confidence to continually develop our service and that we do so in a safe and transparent manner.

## 4.2 Birmingham Heartlands Hospital

Dr Beth Freestone – Consultant Cardiologist, Clinical Lead  
Ms Melanie Fellows – Service Improvement Manager, Cardiology  
Dr Michael Pitt – Clinical Director, Cardiology

The Cardiology Directorate of Heart of England NHS Foundation Trust provides cardiology services for the north and east of Birmingham, Solihull, and parts of Warwickshire and South Staffordshire, with a catchment population of approximately one million. The Cardiology directorate works across three sites, namely Birmingham Heartlands Hospital, Solihull Hospital and Good Hope Hospital. Elective and emergency percutaneous coronary intervention (PCI) for all 3 hospitals is performed on the Birmingham Heartlands site through 2 dedicated Cardiac Catheter labs.

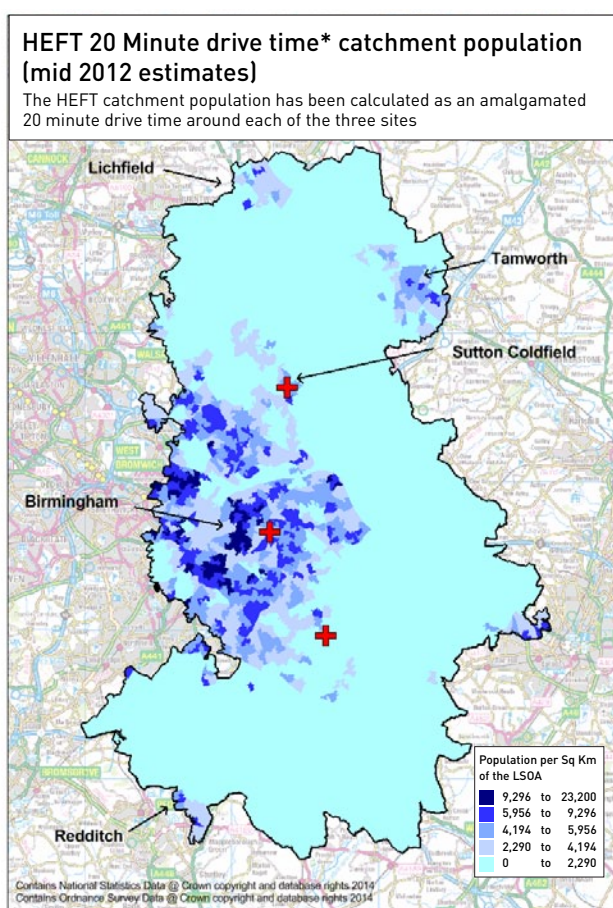
### Birmingham Heartlands Hospital primary PCI (pPCI) service

We are a non-surgical centre with eight coronary interventionists and last year performed 1672 PCIs (68% ACS of which 354 were STEMI). Birmingham Heartlands Hospital have offered a primary PCI service since our first patient in 25 November 2002 extending to a 24/7 service on 4 May 2004 providing 2375 primaries overall. The service has seen two significant process changes; 23 August 2008 when patients bypassed A&E and were brought directly to the assessment room on the Cardiology Ward and in July 2009 when Good Hope Hospital patients were transferred directly over to Birmingham Heartlands for their pPCI.

### Data collection methodology

Our BCIS audit data is collected on a local system (Dendrite) developed to support the duplicate data items requirements of MINAP and BCIS and to allow report validation. Data input

is by the clinical team during the procedure and outcome data completed by the project manager retrospectively. The entries are checked in terms of accuracy and completeness by cross-checking with our Radiology system (CRIS), timings of the pathway are reviewed, breach reports are produced and all the data is validated. Then any discrepancies are sent to Consultant Responsible for checking, before exporting to NICOR.



### Quality improvement programme (QIP)

The PCI dataset is used to inform our overall programme which includes a Primary PCI Programme, ACS Pathway Review, PCI quality mortality and morbidity meetings and Individual Consultant Performance Review.

### Primary PCI programme

In 2012 through our monitoring programme of monthly reporting of call and door to balloon pathways and any breaches, we were satisfied the national target of  $\rightarrow 75\%$  receiving their call to balloon treatment  $\leftarrow 150$  minutes had been met. However, on reviewing our compliance with the target in the national MINAP and BCIS public reports in comparison to other Trusts we were in fact under-performing.

We established a STEMI Pathway Improvement Team which consisted of visiting local trusts and walking their pathways, developing a 24/7 Cardiac Pathway Team, a 'Pitt Stop' approach for rapid assessment, re-established regular meetings with Head of Clinical Practice from the WMAS, produced monthly pathway breach reports (which allowed a more detailed understanding of our process issues) and we now benchmark our performance. Ongoing feedback on performance is now provided to the whole team via a quarterly pPCI newsletter as part of our QIP initiative.

### **ACS treatment times**

Through monthly reporting of nSTEMI <96 hours data we were able to establish our under- performance against the national average. We built a case to support the opening of a day case unit to support the timely transfer of patients across the 3 sites for PCI. However, with less than the national average nSTEMI patients achieving angioplasty within 96 hours in 2013 there is still work to be done and this pathway is still very much a work-in-progress.

### **Individual consultant performance**

The Consultant Outcome Reports are used in annual appraisals with the plan to use the detailed aggregate report in the future.

### **PCI quality review**

We undertake a monthly PCI Quality review where a random selection of the previous months patient activity are selected and

peer reviewed by a nominated presenter who provides feedback to the team. During this review, the clinical/technical, STEMI and nSTEMI timings, and quality of PCI data for the PCI are reviewed. Any complex or difficult cases from the previous month are also discussed.

### **PCI mortality and morbidity meeting**

Each month, the patients who have undergone a PCI procedure but then subsequently died are also discussed at the PCI Meeting. This is a multi-disciplinary forum in which the case is analysed, discussion is documented and death classified using the NCEPOD classification. Learning points from these cases are discussed, action points raised and the outputs from these meetings are fed back to the Trust Mortality Committee.

### **Summary**

Use of BCIS audit data has supported multiple aspects of our PCI quality improvement programme and will continue to do so.

We welcome the inclusion of the additional Out-of-Hospital (OOH) cardiac arrest data in 2014 and an improved risk adjustment model for 2015.

With public scrutiny of our data, appropriate categorisation of patients and risk adjustment is essential to contextualise the presentation of individual operator and unit outcomes. This will then hopefully help guard against risk adverse behaviour in operators and allow us to continue to improve management of the highest risk patient groups.





## 5 Research use of PCI audit data

Clinical research is used to test hypotheses, look at the safety and effectiveness of medications, devices, diagnostic procedures and treatments.

Audit and research are two distinct activities with different purposes. Research is used to investigate and assess different therapeutic options. Research generates new knowledge. Audit data are used to monitor the care and treatment of patients against existing standards of care. There are overlaps between audit and research. Audit data can provide high quality information for observational research, with advantages of very large sample size and an unselected population.

The National Audit of PCI has been running for more than a decade. It collects data on all PCI procedures in the UK and now contains over 700,000 records. These data are a valuable research resource especially as they can be linked with external databases. Linkage to databases such as the ONS life status provides key information about the relationship between care and treatment and patient outcomes. Outcomes include major adverse cardiac and cerebrovascular events (e.g. stroke and mortality), and process of care.

The BCIS Data Monitoring and Audit Group (DMAG) (Appendix 2 for membership) is responsible for reviewing and assessing the audit data and reviewing applications to use the audit data for research. The mechanisms for applying to use these data for research are available on the NICOR website ([www.ucl.ac.uk/nicor](http://www.ucl.ac.uk/nicor)). A full list of approved studies is also available via the website.

### 5.1 Publications

Ludman, PF. *The British Cardiovascular Intervention Society registry for Audit and Quality Assessment of Percutaneous Coronary Interventions in the United Kingdom*. Heart 2011; 97:1293-1297

Ratib, K et al. *Influence of access site choice on incidence of neurological complications after PCI*, American Heart Journal, Volume 165, Issue 3, March 2013, Pages 317-324

Mammas, MA et al. *Influence of arterial access site selection on outcomes in primary percutaneous coronary intervention; are the results of randomized trials achievable in clinical practice?* J Am Coll Cardiol Intervention 2013;6:698-706

Jones, DA, Gallagher et al *Mortality in South Asians and Caucasians after percutaneous coronary intervention in the UK; an observational cohort study of 279,256 patients from the BCIS National database*. J Am Coll Cardiol Intervention 2014;7:362-371

Mamas, AM et al. *Baseline bleeding risk and arterial site access in relation to procedural outcomes following percutaneous intervention*. J Am Coll Cardiol Intervention 2014

Cockburn, J et al. *Contemporary clinical outcomes of patients treated with or without rotational coronary atherectomy — An analysis of the UK central cardiac audit database*. International Journal of Cardiology 2014;170:381-387

Almudarra, S et al. *Comparative Outcomes After Unprotected Left Main Stem Percutaneous Coronary Intervention. A National Linked Cohort Study of 5,065 Acute and Elective Cases from the BCIS Registry (British Cardiovascular Intervention Society)*. J Am Coll Cardiol Intervention 2014;7:717

Mamas, MA et al. *Arterial access site utilization in cardiogenic shock in the United Kingdom; is radial access feasible?* Am. Heart J 2014;167(6):900-8

Sudhakar, G et al. *Long-term follow-up of elective chronic total occlusion angioplasty: analysis from the U.K. Central Cardiac Audit Database*. J Am Coll Cardiol. 2014;64:235-243.

Patel, N et al. *Outcomes after Emergency Percutaneous Coronary Intervention in patients with Unprotected Left Mainstem Occlusion: The BCIS (British Cardiovascular Intervention Society) National Audit of Percutaneous Coronary Intervention 6-Year Experience*. J Am Coll Cardiol Intervention 2014

Kunadian, V et al. *Outcomes in Patients with Cardiogenic Shock Following Percutaneous Coronary Intervention in the Contemporary Era: An Analysis from the British Cardiovascular Intervention Society (BCIS) Database*. J Am Coll Cardiol Intervention 2014 [in press]

Ratib K et al. *Access site practice and procedural outcomes in relation to clinical presentation in 439,947 patients undergoing percutaneous coronary intervention in the United Kingdom*. J Am Coll Cardiol Intervention 2014 [in press]

Mamas, MA et al. *Impact of left ventricular function in relation to procedural outcomes following percutaneous coronary intervention; insights from the British Cardiovascular Intervention Society*. European Heart Journal 2014 [in press]

## 6 Glossary

Term	Abbreviation	
Acute coronary syndrome	ACS	This term covers all cardiac episodes that result from sudden and spontaneous blockage or near blockage of a coronary artery, often resulting in some degree of cardiac damage. The underlying cause of the clot is rupture of the fine lining of a heart artery (plaque rupture), which allows blood to come in contact with the tissues of the wall of the artery, promoting the development of clot. The degree of damage and the type of syndrome (heart attack) that results from the blockage depends on the size and position of the artery and the amount of clot that develops within the artery. Not all acute coronary syndromes are suitable for treatment with primary angioplasty or thrombolytic drugs, and the decision is mainly guided by the appearances of the ECG.
Angina		Symptoms of chest pain that occur when narrowing of the coronary arteries prevent enough oxygen containing blood reaching the heart muscle when its demands are high, such as during exercise.
Angiogram		An X-ray investigation performed under a local anaesthetic that produces images of the flow of blood within an artery (in this case the coronary artery). Narrowings and complete blockages within the arteries can be identified during the angiogram and this allows decisions to be made regarding treatment. Often an angiogram is an immediate precursor to an PCI and stent implantation or to coronary artery bypass grafting.
Anti-platelet drugs		Drugs including aspirin, clopidogrel, prasugrel and ticagrelor that prevent blood clotting. Anti-platelet drugs act by reducing the 'stickiness' of the small blood cells that can clump together to form a clot.
Call-to-balloon time	CTB	The interval between the patient alerting the health services that they have symptoms of a heart attack and the performance of primary angioplasty.
Cardiac catheter laboratories		The cardiac catheter laboratory is the setting for the angiogram and angioplasty.
Case mix		The type or mix of patients treated by a hospital.
Coronary Heart Disease	CHD	A disease in which a plaque builds up inside the coronary arteries (atherosclerosis). These arteries supply oxygen-rich blood to heart muscle. Over time, plaque can harden or rupture. Hardened plaque narrows the coronary arteries and reduces the flow of oxygen-rich blood to the heart.
Door-to-balloon time	DTB	The interval between the ambulance arriving at a hospital and the performance of primary angioplasty.
Electrocardiogram		Also known as 'ECG'. A test to record the rhythm and electrical activity of the heart. The ECG can often show if a person has had a heart attack, either recently or some time ago. It can also tell if reperfusion therapy is appropriate and if it has been effective.
Funnel plots		<p>Funnel plots were first introduced in 1984 as a means of estimating bias in meta-analysis of clinical trials that contained varying numbers of subjects. In essence, each individual value is compared to the overall mean, and the control limits around that mean diminish as the number of subjects (or admissions) increases (as one would expect). A value which falls outside the 'funnel' is considered an outlier, and can represent abnormally high performance as well as abnormally low performance.</p> <p>The width of the control limits is determined by the statistical significance level from which they are calculated. To diminish the risk of a false positive 'outlier' we use +/- 3 standard deviations, which means that the chance of an outlier happening 'accidentally' (i.e. by random chance) is no more than 0.4%.</p> <p>The funnel plot was adapted for comparing clinical performance of surgeons, and can also be used to compare measures such as call-to-needle and call-to-balloon time.</p>
Hospital Episode Statistics	HES	Hospital Episode Statistics is the national statistical data warehouse for England of the care provided by NHS hospitals and for NHS hospital patients treated elsewhere. The HES database is a record level database of hospital admissions. <a href="http://www.hesonline.nhs.uk">www.hesonline.nhs.uk</a> .

Heart attack		A heart attack happens when the heart muscle is starved of oxygen-rich blood due to blockage in the artery. The damage to heart muscle carries a risk of sudden death, and heart failure in people who survive.
Major Adverse Cardiac and Cerebrovascular Events	MACCE	MACCE is a group of the most serious events that can occur when a patient is admitted with a heart attack. It includes all-cause death, stroke, MI and repeat revascularization.
Heart Attack Centre		A hospital that provides a primary PCI service to patients with ST elevation Myocardial Infarction.
Myocardial Infarction		A heart attack in which heart muscle damage is confirmed by blood testing.
Non-ST elevation Myocardial Infarction	nSTEMI	A heart attack that occurs in the absence of ST segment elevation on the ECG. In these patients urgent admission to hospital is mandated but immediate reperfusion therapy may not be required.
Office of National Statistics	ONS	ONS is the UK's largest independent producer of official statistics and the recognised national statistical institute of the UK. <a href="http://www.ons.gov.uk">www.ons.gov.uk</a> .
Outlier Policy		It is a policy which outlines the process that is followed when a hospital or individual operator appears to be performing outside expected limits of statistical variation. When a statistical outlier is identified the potential explanations are explored, these include errors with the way data are recorded, the treatment of an unusual case mix or treatment standards that need improvement. The process followed in addressing these questions is contained in the outlier policy.
Primary percutaneous coronary intervention	PCI	A technique to re-open the blocked coronary artery responsible for the heart attack. A fine catheter (tube) is passed, under local anaesthetic, from an artery in the leg or arm into the blocked heart artery. A small inflatable balloon and/or extraction catheter is then passed through the catheter and across the blockage restoring blood flow. This part of the technique is called angioplasty and when used as the initial treatment for heart attack can be referred to as 'primary angioplasty'. A stent is usually then inserted to help keep the artery open. The umbrella term that encompasses both balloon dilatation (angioplasty) and stent insertion (stenting) and some other less frequently used techniques is called percutaneous coronary intervention (PCI).
Re-infarction		The development of evidence of re-occlusion (further blockage) of the coronary artery that was responsible for the original heart attack. This would normally occur after the original blockage had been successfully treated.
Reperfusion treatment		The term used to cover both techniques, thrombolytic treatment and primary PCI, for reopening a coronary artery as an emergency. These treatments are suitable only for certain types of heart attack characterised by typical electrocardiographic appearances described as ST segment elevation.
Revascularisation		Interventions that improve the blood supply to the heart, including PCI or coronary artery bypass grafting.
Risk adjustment		This risk adjustment method is a process used to account for the impact of individual risk factors such as age, severity of illness and other medical problems that can put some patients at greater risk of MACCE events than others.
Stable elective patients		Elective surgery or elective procedure is surgery that is scheduled in advance because it does not involve a medical emergency. A stable condition is one in which the condition of the patient is not expected to change in the near future.
ST elevation myocardial infarction	STEMI	A heart attack characterized by a specific abnormal appearance on the ECG (ST segment elevation) thought to be indicative of complete occlusion of a coronary artery.

## 7 References

1. Dawkins KD, Gershlick T, de BM et al. Percutaneous coronary intervention: recommendations for good practice and training. *Heart* 2005; 91 Suppl 6:vi1-27
2. National Institute for Health and Clinical Excellence (2003) TA 71. Guidance on the use of Coronary Artery Stents. <http://publications.nice.org.uk/guidance-on-the-use-of-coronary-artery-stents-ta71>
3. National Institute for Health and Clinical Excellence (2008) TA 152. Drug-eluting stents for the treatment of coronary artery disease. <http://publications.nice.org.uk/drug-eluting-stents-for-the-treatment-of-coronary-artery-disease-ta152>
4. Doshi SN, Ludman PF, Townend JN, Buller N. Estimated annual requirement for drug eluting stents in a large tertiary referral centre, according to new NICE criteria. *Heart* 2004; 90(Suppl II):A41
5. National Institute for Health and Clinical Excellence (2011) CG126 Management of Stable angina. <http://publications.nice.org.uk/management-of-stable-angina-cg126>
6. National Institute for Health and Clinical Excellence (2010) CG94. Unstable angina and nSTEMI: the early management of unstable angina and non-ST-segment-elevation myocardial infarction. <http://publications.nice.org.uk/unstable-angina-and-nstemi-cg94>
7. Treatment of Heart Attack. National Guidance. Final Report of the National Infarct Angioplasty Project (NIAP) (2008)
8. Myocardial Ischaemia National Audit Project (2014). How the NHS cares for patients with heart attack. Annual Public Report. April 2013 - March 2014. <http://www.ucl.ac.uk/nicor/audits/minap/reports>
9. Grayson AD, Moore RK, Jackson M et al. Multivariate prediction of major adverse cardiac events after 9914 percutaneous coronary interventions in the north west of England. *Heart* 2006; 92(5):658-663
10. National Institute for Health and Clinical Excellence (2010). NICE clinical guideline 94. The early management of unstable angina and non-ST-segment-elevation myocardial infarction. <http://www.nice.org.uk/nicemedia/live/12949/47924/47924.pdf>

## Appendix 1 List of participating centres in the UK

### Key

This table presents data completeness rates for key variables used for various analyses to measure the process of care and patient outcomes.

**Purple** - less than 50%; **Lilac** - more than 50% but less than 90%; **White** - more than 90%; **0** = missing data

Hospital name	Type	Country	Date of birth	Sex	Medical history	Pre-procedure shock	Procedure urgency	Vessels treated	Renal disease	Diabetes	Discharge date	Discharge status	PCI hospital outcome	NHS number	Creatinine	Weight	STEMI Onset location
Aberdeen Royal Infirmary	NHS	Scotland	100	99.8	95.83	100	100	100	97.02	97.92	99.11	99.7	99.8	N/A	96.73	88.99	80.58
Acute Pennine Trust Fairfield	NHS	England	100	100	100	98.37	100	100	99.79	100	100	100	99.37	99.79	0	0.21	100
Altnagelvin Hospital	NHS	Northern Ireland	100	98.29	99.43	100	100	100	99.24	99.62	88.61	97.72	99.79	88.99	41.56	23.72	77.27
Basildon Hospital	NHS	England	100	100	87.6	99.14	100	100	68.65	97.15	98.94	99.36	99.77	99.87	72.81	23.41	96.87
Basingstoke and North Hampshire Hospital	NHS	England	100	100	100	100	100	100	100	75.95	100	100	100	99.55	47.66	33.85	91.73
Bedford Hospital	NHS	England	100	100	29.85	100	100	100	97.7	97.7	100	100	99.74	99.74	100	99.23	N/A
Belfast City Hospital	NHS	Northern Ireland	100	99.91	100	100	100	100	93.26	100	100	100	100	0	25.19	97.66	75.86
Birmingham City Hospital	NHS	England	99.81	99.25	100	100	100	100	93.79	98.12	99.81	99.81	100	99.25	78.91	62.9	100
Birmingham Heartlands Hospital	NHS	England	100	100	95.03	98.27	99.94	100	95.03	92.81	99.94	100	100	97	53.53	83.77	98.04
Blackpool Victoria Hospital	NHS	England	100	99.83	99.83	99.39	99.87	100	99.94	100	99.36	100	96.99	98.31	0	70.19	94.97
BMI Park Hospital	Private	England	Not participating														
BMI The Alexandra Hospital	Private	England	98.48	100	39.39	100	100	100	39.39	45.45	19.7	98.48	97.22	N/A	1.52	3.03	N/A
Bradford Royal Infirmary	NHS	England	99.65	99.65	100	100	100	100	100	100	98.94	98.94	98.85	99.3	99.65	99.3	100
Bristol Royal Infirmary	NHS	England	100	100	83.13	91.12	99.93	100	96.45	96.74	99.86	99.93	99.78	98.91	0.29	98.04	96.59
BUPA Hospital, Hull & East Riding	Private	England	Not participating														
Calderdale Royal Hospital	NHS	England	100	100	94.58	100	99.13	100	88.5	99.35	100	93.93	100	99.78	97.61	97.61	0
Castle Hill Hospital	NHS	England	100	100	99.16	100	100	100	100	99.88	100	100	99.94	99.4	99.22	97.78	99.38
Cheltenham General Hospital	NHS	England	100	99.86	70.11	100	100	100	97.38	97.8	100	99.72	72.4	99.17	97.38	69.56	96.43



Hospital name	Type	Country	Date of birth	Sex	Medical history	Pre-procedure shock	Procedure urgency	Vessels treated	Renal disease	Diabetes	Discharge date	Discharge status	PCI hospital outcome	NHS number	Creatinine	Weight	STEMI Onset location
Conquest Hospital	NHS	England	100	100	100	100	100	100	100	100	100	100	100	100	100	95.28	100
Craigavon Area Hospital	NHS	Northern Ireland	100	100	99.54	100	100	100	100	100	99.09	99.32	100	97.72	99.89	99.2	100
Cromwell Hospital	Private	England	100	100	98.28	100	100	100	94.83	96.55	93.1	94.83	100	N/A	56.9	72.41	100
Croydon University Hospital	NHS	England	100	100	95.97	98.77	100	100	97.16	96.21	99.53	99.53	100	99.04	99.29	78.91	100
Cumberland Infirmary	NHS	England	100	100	93.28	100	98.71	100	93.28	96.64	96.01	95.38	71.03	96.21	67.65	52.52	90.72
Darent Valley Hospital	NHS	England	100	100	98.63	100	100	100	84.64	98.98	96.93	97.95	100	100	97.61	96.93	80
Derriford Hospital	NHS	England	100	100	76.74	99.09	100	100	77.27	74.24	100	100	97.76	99.74	9.86	5.78	45.96
Dorset County Hospital	NHS	England	99.31	99.77	86.64	100	100	100	99.54	99.31	99.08	99.31	99.73	96.77	98.85	100	100
Ealing Hospital	NHS	England	100	100	100	53.54	100	100	97.96	74.49	100	100	99.49	100	89.29	81.12	33.33
East Surrey Hospital	NHS	England	99.73	100	100	72.55	100	100	67.39	65.5	100	98.65	99.73	99.46	7.82	14.02	50
Eastbourne DGH	NHS	England	100	100	100	100	100	100	100	100	100	100	100	99.71	100	93.51	100
Freeman Hospital	NHS	England	99.97	100	98.61	99.9	100	100	99.09	99.36	100	100	99.97	99.49	96.38	95.53	94.98
Frenchay Hospital	NHS	England	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Frimley Park Hospital	NHS	England	100	100	100	100	100	100	100	100	100	100	100	100	51.5	49.4	100
Glenfield Hospital	NHS	England	100	100	99.67	100	100	100	99.74	97.48	99.87	99.87	99.93	100	97.55	99.14	98.93
Golden Jubilee Hospital	NHS	Scotland	100	100	86.15	70.16	100	100	83.65	90.77	95.12	93.91	82.45	N/A	0.8	81.3	72.36
Hairmyres Hospital	NHS	Scotland	99.73	100	100	1.8	97.83	100	33.06	41.73	10.84	10.84	98.37	N/A	0	52.03	0
Hammersmith Hospital	NHS	England	100	100	100	99.79	98.44	100	98.44	94.66	94.66	100	98.59	98.41	94.51	89.99	95.65
Harefield Hospital	NHS	England	100	99.93	98.89	100	100	100	95.68	98.04	99.67	99.93	98.03	97.87	0.13	16.44	95.7
Harley Street Clinic	Private	England	100	100	85.85	100	99.03	100	95.28	96.23	100	100	98.06	N/A	94.34	98.11	100
James Cook University Hospital	NHS	England	100	100	99.35	100	100	100	98.47	99.47	100	100	99.94	99.88	98.82	99.76	100
John Radcliffe Hospital	NHS	England	100	100	100	100	100	100	100	95.13	100	100	100	98.56	90.51	35.39	96.77
Kettering General Hospital	NHS	England	100	100	99.75	100	100	100	100	100	99.75	100	99.48	99.83	55.11	64.74	99.64
King's College Hospital	NHS	England	100	99.94	94.73	100	100	100	96.12	97.08	99.36	95.17	99.63	98.21	79.73	78.4	93.88
King's Mill Hospital	NHS	England	100	99.39	100	97.66	98.48	100	99.09	99.09	98.79	99.09	100	98.79	81.82	93.33	N/A
Leeds General Infirmary	NHS	England	100	99.91	97	100	100	100	95.65	97.4	99.96	99.91	99.96	99.42	45.36	95.92	98.68
Leeds Nuffield Hospital	Private	England	Not participating														
Leicester BUPA Hospital	Private	England	Not participating														
Lincoln County Hospital	NHS	England	100	99.9	98.35	83.21	99.9	100	72.73	60.12	99.79	94.32	97.19	99.59	0.52	1.86	81.27
Lister Hospital	NHS	England	100	90.43	100	99.68	100	100	99.7	99.85	100	100	100	98.02	99.7	44.83	97.78
Liverpool Heart and Chest Hospital	NHS	England	100	99.73	100	100	100	100	100	100	98.24	98.24	99.96	99.66	10.32	9.68	80.09

Hospital name	Type	Country	Date of birth	Sex	Medical history	Pre-procedure shock	Procedure urgency	Vessels treated	Renal disease	Diabetes	Discharge date	Discharge status	PCI hospital outcome	NHS number	Creatinine	Weight	STEMI Onset location
London Bridge Hospital	Private	England	100	100	98.7	100	100	100	100	100	100	100	85.71	N/A	96.75	98.7	N/A
London Chest Hospital, Barts Health	NHS	England	98.86	96.19	96.89	98.59	100	100	98.2	99.69	97.15	99.26	96.04	77.63	0	59.38	0
London Independent Hospital	Private	England	Not participating														
Manchester Royal Infirmary	NHS	England	100	100	99.93	100	100	100	95.56	95.16	100	100	72.25	89.28	100	18.76	72.71
Manor Hospital	Private	England	Not participating														
Medway Maritime Hospital	NHS	England	100	100	100	96.97	100	100	56.64	62.83	96.46	98.23	100	78.76	0	16.81	72.73
Morrison Hospital	NHS	Wales	100	99.7	92.01	92.93	100	100	87.49	93.93	96.23	95.71	95.75	99.85	20.13	76.54	87.63
Musgrove Park Hospital	NHS	England	99.02	100	10.27	100	100	100	98.87	99.86	99.44	99.02	11.26	98.17	91.28	99.86	99.44
New Cross Hospital	NHS	England	100	100	100	100	100	100	100	100	100	100	100	100	91.08	24.07	100
Ninewells Hospital	NHS	Scotland	100	100	100	100	100	100	100	100	95.42	100	99.57	N/A	0	4.01	0
Norfolk and Norwich University Hospital	NHS	England	100	100	99.09	99.01	99.78	100	93.85	99.44	100	100	99.93	99.79	42.95	50.84	99.77
North Wales Cardiac Centre	NHS	Wales	100	99.83	93.86	100	100	100	97.78	97.95	100	100	100	99.49	97.44	96.08	100
Northampton General Hospital	NHS	England	100	99.1	100	100	100	100	99.78	99.78	100	100	100	98.88	97.31	100	100
Northern General Hospital	NHS	England	100	100	92.11	99.92	100	100	97.14	97.52	99.62	99.24	90.57	99.55	0	0	96.17
Northwick Park Hospital	NHS	England	100	100	100	100	100	100	97.26	99.27	100	100	100	99.26	100	14.08	100
Nottingham City Hospital	NHS	England	100	99.91	86.37	100	99.91	100	71.73	90.7	98.07	98.34	99.63	99.54	54.14	61.05	93.05
Papworth Hospital	NHS	England	100	99.95	52.55	100	100	100	99.53	20.06	98.08	98.18	99.77	99.91	40.72	74.05	77.3
Pinderfields General Hospital	NHS	England	100	100	100	100	100	100	100	100	100	100	99.68	100	99.68	56.17	N/A
Priory Hospital	Private	England	100	93.94	100	100	100	100	100	100	75.76	81.82	81.25	N/A	24.24	69.7	N/A
Queen Alexandra Hospital	NHS	England	99.47	99.91	99.91	100	100	100	99.91	99.21	100	100	100	98.76	96.75	62.62	98.68
Queen Elizabeth Hospital Woolwich	NHS	England	100	99.58	100	78.03	99.58	100	93.72	87.03	97.07	97.07	99.58	98.33	67.78	97.07	66.67
Queen Elizabeth Hospital, Edgbaston	NHS	England	100	100	100	100	100	100	99.87	100	100	100	100	99.11	99.87	100	100
Raigmore Hospital	NHS	Scotland	100	100	96.24	97.06	100	100	96.51	99.19	98.92	99.73	100	N/A	100	98.39	100
Ross Hall Hospital	Private	Scotland	Not participating														
Royal Albert Edward Infirmary	NHS	England	100	100	99.77	100	100	100	96.98	97.45	88.86	100	97.55	95.82	40.37	91.42	N/A
Royal Berkshire Hospital	NHS	England	100	100	100	100	100	100	99.83	100	100	100	100	97.61	33.33	31.12	100
Royal Blackburn Hospital	NHS	England	100	100	100	100	96.08	100	99.11	99.11	97.17	97.02	99.55	96.57	0	93.89	77.78

Hospital name	Type	Country	Date of birth	Sex	Medical history	Pre-procedure shock	Procedure urgency	Vessels treated	Renal disease	Diabetes	Discharge date	Discharge status	PCI hospital outcome	NHS number	Creatinine	Weight	STEMI Onset location
Royal Bournemouth General Hospital	NHS	England	100	99.91	68.26	100	99.95	100	87.17	96.58	74.35	98.76	100	99.78	46.96	75.9	79.3
Royal Brompton Hospital	NHS	England	100	100	98.51	99.51	100	100	91.91	97.51	99.63	99.63	96.78	93.8	0.25	69.61	71.88
Royal Cornwall Hospital	NHS	England	100	100	99.19	100	100	100	93.37	97.91	100	100	99.88	99.88	99.42	57.91	99.56
Royal Derby Hospital	NHS	England	100	100	94.72	99.47	100	100	98.4	98.4	99.51	100	99.88	99.75	43.19	97.55	98.66
Royal Devon & Exeter Hospital	NHS	England	100	100	100	100	100	100	100	100	100	100	100	99.67	73.94	99.55	98.55
Royal Free Hospital	NHS	England	100	99.76	100	100	100	100	100	100	100	100	100	98.04	37.83	33.45	98.24
Royal Gwent Hospital	NHS	Wales	100	100	97.97	97.2	100	100	99.32	99.15	98.98	97.12	98.25	92.05	35.53	98.65	80.95
Royal Infirmary of Edinburgh	NHS	Scotland	100	100	60.82	100	100	100	86.16	94.16	66.32	66.53	99.96	N/A	5.71	7.38	69.46
Royal Sussex County Hospital	NHS	England	100	100	94.47	100	100	100	92.79	98.52	100	99.9	98.81	99.6	23.59	60.81	99.68
Royal United Hospital Bath	NHS	England	100	100	36.95	98.79	100	100	84.38	72.79	69.3	69.49	99.81	99.45	52.21	63.05	77.22
Royal Victoria Hospital	NHS	Northern Ireland	100	100	73.49	100	100	100	88.69	93.62	99.72	99.65	99.93	0	36.92	90.98	94.81
Salisbury District Hospital	NHS	England	100	100	100	100	100	100	97.02	99.54	100	100	92.7	99.77	70.64	50	100
Sandwell General Hospital	NHS	England	99.75	99.5	100	100	100	100	97	99	76	76.75	99.19	98.75	78.25	79.75	99.22
Scunthorpe General Hospital	NHS	England	100	100	56.74	96.21	99.64	100	91.54	78.68	86.83	87.15	99.28	100	97.81	95.92	0
Southampton General Hospital	NHS	England	99.56	99.85	99.56	100	100	100	99.71	100	99.71	99.71	100	89.12	99.71	100	97.79
Spire Bristol	NHS	England	100	100	90.62	0	100	100	68.75	87.5	87.5	87.5	100	59.38	0	12.5	N/A
Spire Hospital Leeds	Private	England	Not participating														
Spire Shawfair Park Hospital	Private	Scotland	100	100	55	N/A	100	100	75	87.5	97.5	97.5	100	N/A	10	100	N/A
St Anthony's Hospital	Private	England	100	100	99.18	0	100	100	99.18	99.18	100	100	100	N/A	100	99.18	N/A
St George's Hospital	NHS	England	100	100	94.2	91.74	99.76	100	93.46	98.66	96.95	96.4	100	91.32	86.07	55.16	95.31
St Peter's Hospital	NHS	England	100	100	100	100	100	100	100	100	100	100	100	99.54	94.55	36.82	100
St Thomas Hospital	NHS	England	100	100	98.38	100	100	100	98.85	97.46	100	100	100	99.64	88.34	99.88	97.84
Sunderland Royal Hospital	NHS	England	100	100	100	100	100	100	100	100	100	100	100	98.85	100	80.8	100
The BMI Meriden Hospital	Private	England	Not participating														
The Great Western Hospital	NHS	England	100	99.75	99.5	100	100	100	100	100	99.26	99.26	100	99.5	80.15	84.62	98.28
Torbay Hospital	NHS	England	100	100	100	100	100	100	100	100	100	100	100	99.76	100	98.58	98.15
Tunbridge Wells Hospital	NHS	England	100	100	99.38	100	100	100	99.38	83.02	97.84	98.15	100	99.07	55.25	94.44	100
University College Hospital	NHS	England	100	100	97.92	99.8	100	100	97.7	97.48	98.68	98.9	100	93.02	67.76	77.19	90.67

Hospital name	Type	Country	Date of birth	Sex	Medical history	Pre-procedure shock	Procedure urgency	Vessels treated	Renal disease	Diabetes	Discharge date	Discharge status	PCI hospital outcome	NHS number	Creatinine	Weight	STEMI Onset location
University Hospital Coventry	NHS	England	100	100	89.61	99.5	100	100	95.67	98.27	98.94	99.52	97.56	97.68	1.25	48.51	99.26
University Hospital of North Staffordshire	NHS	England	99.95	99.32	99.42	100	100	100	88.24	98.9	99.37	99.74	99.83	99.58	28.44	40.04	97.87
University Hospital of Wales	NHS	Wales	100	100	98.11	99.51	100	100	97.1	99.19	96.3	99.19	98.41	85.32	29.02	97.31	57.07
Watford General Hospital	NHS	England	100	100	100	100	100	100	99.71	98.54	82.22	87.46	99.71	97.07	4.08	72.89	95.52
Wellington Hospital North	Private	England	100	100	99.2	100	100	100	91.24	100	99.6	100	99.6	N/A	97.61	100	0
Wexham Park Hospital	NHS	England	100	100	100	100	100	100	100	100	100	100	100	98.47	42.2	95.72	2.63
William Harvey Hospital	NHS	England	100	100	84.19	99.16	100	100	75.03	83.42	96.95	97.71	98.3	98.03	5.34	68.59	18.24
Worcestershire Royal Hospital	NHS	England	100	100	99.6	100	100	100	99.4	99.9	99.8	99.9	100	99.5	99.1	100	99.21
Worthing Hospital	NHS	England	100	99.61	91.76	100	100	100	91.57	99.61	99.22	99.22	99.8	100	55.88	33.14	100
Wycombe Hospital	NHS	England	100	100	98.69	100	100	100	95.68	98.69	96.06	98.12	100	99.44	72.23	66.23	86.57
Wythenshawe Hospital	NHS	England	100	100	100	100	100	100	97.38	99.85	100	100	100	99.77	99.93	43.53	99.62
York District Hospital	NHS	England	100	100	100	97.76	99.54	100	99.6	98	100	100	100	99.6	100	2	66.67

## Appendix 2 Hospital codes

NICOR code	Hospital name
AEI	Royal Albert Edward Infirmary
AHM	BMI The Alexandra Hospital
ALT	Altnagelvin Hospital
AMG	Wycombe Hospital
ANT	St Anthony's Hospital
BAS	Basildon Hospital
BAT	Royal United Hospital Bath
BED	Bedford Hospital
BFT	Belfast City Hospital
BHL	Liverpool Heart and Chest Hospital
BHR	Royal Berkshire Hospital
BLA	Royal Blackburn Hospital
BMI	The BMI Meriden Hospital
BOU	Royal Bournemouth General Hospital
BRD	Bradford Royal Infirmary
BRI	Bristol Royal Infirmary
BRY	Acute Pennine Trust Fairfield
CGH	Conquest Hospital
CHG	Cheltenham General Hospital
CHH	Castle Hill Hospital
CHN	Nottingham City Hospital
CLW	North Wales Cardiac Centre
CMI	Cumberland Infirmary
CRG	Craigavon Area Hospital
CRO	Cromwell Hospital
DER	Royal Derby Hospital
DGE	Eastbourne DGH
DUD	Birmingham City Hospital
DVH	Darent Valley Hospital
EAL	Ealing Hospital
EBH	Birmingham Heartlands Hospital
ERI	Royal Infirmary of Edinburgh
ESU	East Surrey Hospital
FRE	Freeman Hospital
FRM	Frimley Park Hospital
FRY	Frenchay Hospital
GEO	St George's Hospital
GHB	Spire Hospital Bristol

GJH	Golden Jubilee Hospital
GRL	Glenfield Hospital
GWE	Royal Gwent Hospital
GWH	Queen Elizabeth Hospital Woolwich
HAI	Hairmyres Hospital
HAM	Hammersmith Hospital
HBP	Spire Hospital, Hull & East Riding
HHW	Wellington Hospital North
HSC	Harley Street Clinic
IND	London Independent Hospital
KCH	King's College Hospital
KGH	Kettering General Hospital
KMH	Kings Mill Hospital
KSX	Tunbridge Wells Hospital
LBH	London Bridge Hospital
LBP	Spire Hospital Leicester
LCH	London Chest Hospital, Barts Health
LEB	Spire Hospital Leeds
LGI	Leeds General Infirmary
LIN	Lincoln County Hospital
LIS	Lister Hospital
LNH	Leeds Nuffield Hospital
MAY	Croydon University Hospital
MDW	Medway Maritime Hospital
MHO	Manor Hospital
MOR	Morrison Hospital
MPH	Musgrove Park Hospital
MRI	Manchester Royal Infirmary
NCR	New Cross Hospital
NGS	Northern General Hospital
NHB	Harefield Hospital
NHB	Royal Brompton Hospital
NHH	Basingstoke and North Hampshire Hospital
NIN	Ninewells Hospital
NOR	Norfolk and Norwich University Hospital
NPH	Northwick Park Hospital
NTH	Northampton General Hospital
PAP	Papworth Hospital
PHB	BMI Priory Hospital
PHN	BMI Park Hospital

PIN	Pinderfields General Hospital
PLY	Derriford Hospital
PMS	The Great Western Hospital
QAP	Queen Alexandra Hospital
QEB	Queen Elizabeth Hospital, Edgbaston
RAD	John Radcliffe Hospital
RAI	Raigmore Hospital
RCH	Royal Cornwall Hospital
RDE	Royal Devon & Exeter Hospital
RFH	Royal Free Hospital
RHH	Ross Hall Hospital
RHI	Calderdale Royal Hospital
RIA	Aberdeen Royal Infirmary
RSC	Royal Sussex County Hospital
RVB	Royal Victoria Hospital
SAL	Salisbury District Hospital
SAN	Sandwell General Hospital
SCM	James Cook University Hospital
SCU	Scunthorpe General Hospital
SGH	Southampton General Hospital
SPH	St Peter's Hospital
SSP	Spire Shawfair Park Hospital
STH	St Thomas Hospital
STO	University Hospital of North Staffordshire
SUN	Sunderland Royal Hospital
TOR	Torbay Hospital
UCL	University College Hospital
UHW	University Hospital of Wales
VIC	Blackpool Victoria Hospital
WAL	University Hospital Coventry
WAT	Watford General Hospital
WDH	Dorset County Hospital
WEX	Wexham Park Hospital
WHH	William Harvey Hospital
WRC	Worcestershire Royal Hospital
WRG	Worthing Hospital
WYT	Wythenshawe Hospital
YDH	York District Hospital



## Appendix 3 BCIS data monitoring and audit group

Name	Role	Organisation
Peter Ludman (Chair)	Consultant Cardiologist (BCIS audit lead)	Queen Elizabeth Hospital Edgbaston Birmingham
Mark DeBelder	Consultant Cardiologist	South Tees Hospitals NHS Trust
Rod Stables	Consultant Cardiologist	Liverpool Heart and Chest Hospital NHS Foundation Trust
Robert Henderson	Consultant Cardiologist	Nottingham University Hospitals NHS Trust
Andrew Wragg	Consultant Cardiologist	Barts Health NHS Trust
Adrian Banning	Consultant Cardiologist	Oxford Radcliffe Hospitals NHS Trust
Timothy Gilbert	Consultant Cardiologist	Norfolk and Norwich University Hospitals NHS Foundation Trust
Simon Redwood	Consultant Cardiologist (BCIS President)	Guys and St Thomas NHS Foundation Trust
Nick Curzen	Consultant Cardiologist (BCIS Secretary)	University Hospital Southampton NHS Foundation Trust
Jim Nolan	Consultant Cardiologist (BCIS Treasurer)	University Hospital of North Staffs Stoke on Trent
Emmanuel Lazaridis	Senior Information Analyst	NICOR
Darragh O'Neill	Information Analyst	NICOR
Lucia Gavalova	Project Manager	NICOR
Julie Sanders	Chief Operating Officer	NICOR
Tracy Whittaker	MINAP Project Manager	NICOR

This work remains the sole and exclusive property of UCL and may only be reproduced where there is explicit reference to the ownership of UCL. This work may be re-used by NHS and government organisations without permission. Commercial re-use of this work must be granted by UCL.