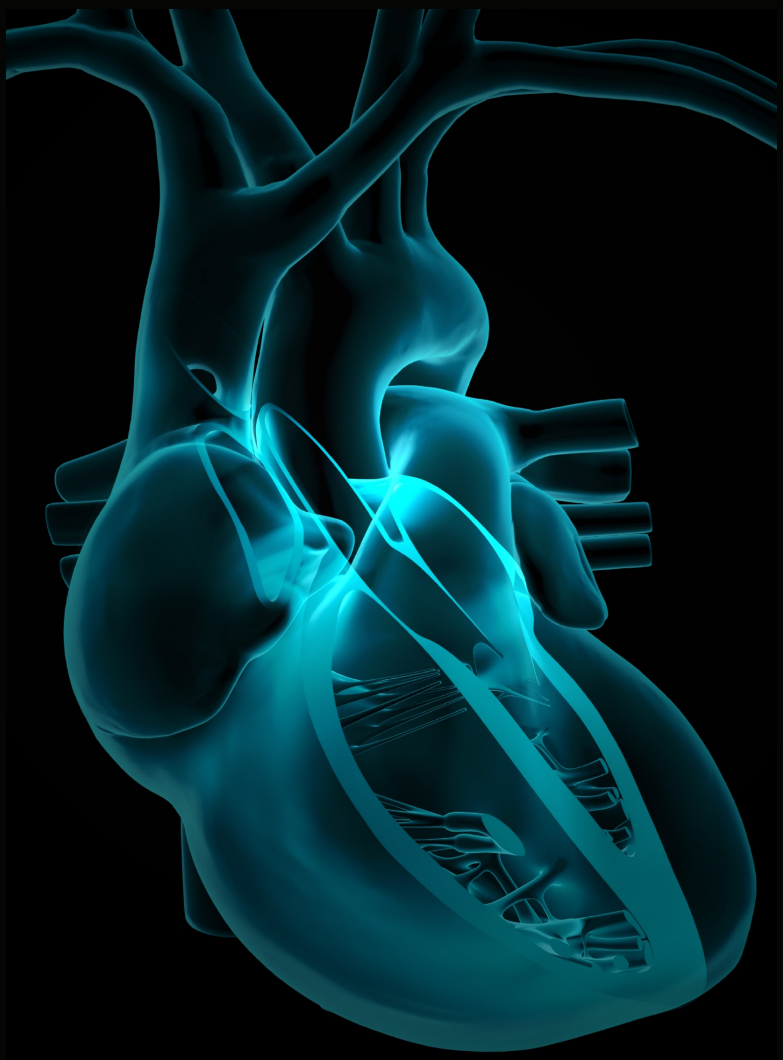


British Cardiovascular Intervention Society

National Audit of Percutaneous Coronary Interventional Procedures Public Report

Annual Public Report January 2011 - December 2011

NICOR is a partnership of clinicians, IT experts, statisticians, academics and managers which manages six cardiovascular clinical audits and three clinical registers. 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 of clinical audit in England and Wales. HQIP hosts the contract to manage and develop the National Clinical Audit and Patient Outcomes Programme (NCAPOP). The programme comprises 40 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

The analysis and writing of this report was performed by:
Dr Peter F Ludman MA MD FRCP FESC
Queen Elizabeth Hospital, Birmingham,
Audit Lead for the British Cardiovascular Intervention Society (BCIS).

Acknowledgments

The National Audit of Percutaneous Coronary Interventional Procedures 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 funded and commissioned by the Healthcare Quality Improvement Partnership (HQIP).

This report was completed in close collaboration with Tracy Whittaker and Andrew Donald from the NICOR team.

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.

This report is available online at www.ucl.ac.uk/nicor/audits/adultcardiacintervention. A full version of the analyses is available for download from the BCIS web site (www.BCIS.org.uk)

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

Tel: 0207 388 3950
Email: t.whittaker@ucl.ac.uk

Published 29th January 2013.

British Cardiovascular Intervention Society National Audit of Percutaneous Coronary Interventional Procedures

January 2011 - December 2011

This is a report of the British Cardiovascular Society's National Audit of Percutaneous Coronary Interventional (PCI) Procedures. 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 analyses is available for download at **www.BCIS.org.uk**

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

Contents

List of figures and tables

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. [1]

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 relieve 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 2011.

Key findings include:

- There are now 117 PCI centres in the United Kingdom of which 99 are NHS centres.
- The number of PCIs performed in 2011 in the UK was 1,405 per million population (pmp). This represents a slight fall, in part due to changed population estimates following the 2012 census.
- The rate of primary PCI to treat **ST elevation Myocardial Infarction** (STEMI) (in place of **thrombolysis**) continues to rise, and reached 341 pmp across the UK in 2011. This treatment option was provided 24/7 by 57 of the 99 NHS PCI centres.
- There is evidence that suggests improved outcomes for patients treated in PCI centres that perform at least 400 procedures per year. This forms part of the recommendations of the Joint Working Group on PCI of British Cardiovascular Intervention Society and the British Cardiovascular Society.[2] In 2011 29% of PCI units were performing 400 or less cases per year, but the majority of these were new units undertaking a gradually increasing volume of work.
- 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"[3]. 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 2011 suggest an increase in their use 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.[4, 5] Nevertheless there are large differences in the rate of DES use in the different UK countries.
- The use of the **radial artery** for access has increased progressively from 10% in 2004 to over 58% in 2011. This audit report supports the literature demonstrating a lower complication rate when PCI is performed via the radial artery, with approximately a halving of **access site related complications**. There remains a large variation in the rates of radial access by different PCI centres.
- The overall rate of in hospital death following PCI has gradually risen over the past few years. This is due to a change in **case mix**. There has been no evidence of a change in the outcomes when patients with similar clinical presentations are compared. For **stable elective patients**, in hospital mortality is about 0.2%, for patients with unstable angina or NSTEMI (non-ST elevation Myocardial Infarction), the in hospital mortality is approximately 0.6 %. For patients with STEMI the mortality is higher at about 4 %.
- Analysis of risk adjusted outcome **(major adverse cardiac and cerebrovascular events)** from the 2009, 2010 and 2011 data combined shows that all units in the United Kingdom are performing as well as would be predicted from the model used for risk adjustment.
- 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 (DTB) time), and within 150 minutes of a patient's call for help (call-to-balloon (CTB) time). There has been a year on year improvement. A door-to-balloon time of less than 90 minutes was achieved in 92% of cases. A call-to-balloon time of less than 150 minutes was achieved in 80% of cases. This compares very favourably with international data.

- The improvement in delays to **reperfusion** treatment by each unit is presented and shows that those who had the poorest performance in 2010 have improved the most in 2011.
- Patients who need to be transferred between hospitals for primary PCI had longer delays to treatment than those admitted directly to a PCI centre, the transfer delaying treatment by about 50 minutes.
- There has been a further improvement in the number of hospitals sending data to NICOR and a marked improvement in the quality of data submitted.

The rest of this report contains more details and graphs of the audit findings. The complete analyses for the 2011 audit are available for download at the BCIS web site 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:

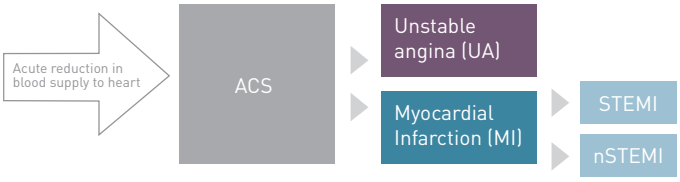
Stable angina occurs when the artery becomes progressively narrowed and blood supply to the heart muscle becomes restricted. People experience a tight constricting feeling, normally across the chest. It is brought on by physical exertion or stress. Stable angina is a chronic medical condition with a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

Patients with acute Coronary Syndromes (ACS) present with a set of symptoms that indicate a sudden or recent reduction in the blood supply to the heart and includes **unstable angina** and myocardial infarction (heart attacks). 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).

Fig 1. Different types of acute coronary syndrome



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)[6, 7] 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 clinical and cost effective than drug treatment (**thrombolysis**).[8] 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 150 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. In 2011, primary PCI made up more than 95% of **reperfusion treatment** for patients with STEMI.[9]

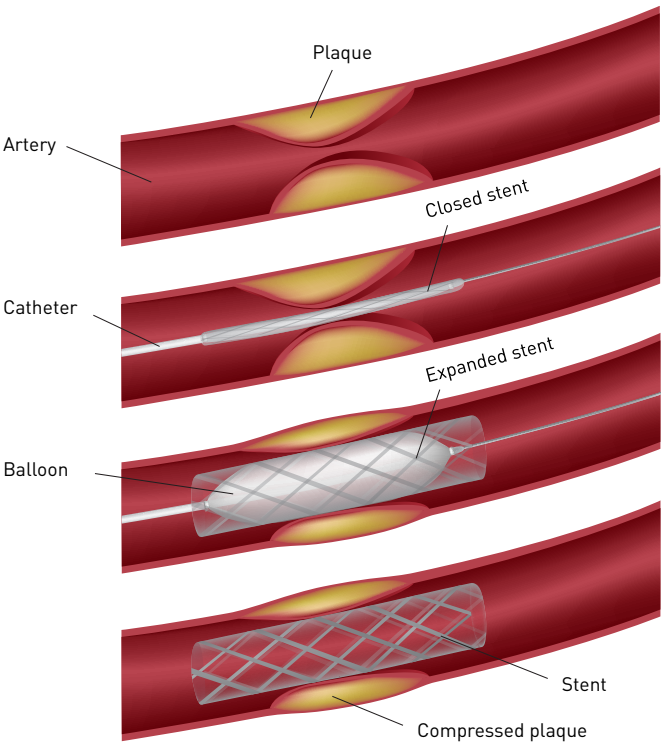
1.2 The PCI procedure

A percutaneous coronary intervention 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. Through this area 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 liquid is injected into the heart arteries so that they show up 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 (Figure 2). Once in place, a balloon is fed over this wire and so tracked across the narrowing. Inflating the balloon squashes

Fig 2. The PCI procedure



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, 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.

In the last few years we have seen the development of 'drug eluting' stents, which are coated in 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 can be broadly split into those that occur during or very shortly after angioplasty, and those that occur weeks or months later (see Figure 3).

Fig 3. Potential PCI complications

During PCI	PCI procedures are very rarely associated with Major Adverse Cardiac and Cerebrovascular Event (MACCE). This includes complications such as stroke, heart attack, need for emergency coronary bypass surgery or death. Risk of adverse outcome is mainly determined by a patients presenting condition. For example, the treatment of a patient in a stable situation is associated with complication rates of less than 1 %. However, when primary PCI is used to treat a heart attack this may rise to 10% or more.
	Repeat revascularisation.
Complications after discharge	After PCI, the symptoms of angina are usually much improved. There follows a period when the walls of the newly stretched arteries heal. If a simple metal stent has been deployed, then over the course of the first six months cells grow over this part of the artery wall, and form a new lining, embedding the stent within the artery wall. If the healing process is over exuberant this can lead to renarrowing of the artery (so called 'restenosis'), and a recurrence of angina. If this is going to occur it usually does so within the first six months. If a drug eluting stent has been implanted, there is much less proliferation of cells around the stented site. This means that the chance of recurrent symptoms in the first few months is much lower. After both types of stent there is a small risk (less than 1 % per year) of the treated vessel blocking abruptly, usually due to clot formation. This risk is slightly higher for simple metal stents early after the PCI, and slightly higher for drug eluting stents later after the PCI.

1.3 The role of the audit

Clinical audit is the process of monitoring the care and treatment of patients against a given standard, 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. Each hospital submits an annual 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:

- the structure of the provision of PCI services across the UK
- clinical care and treatment provided by each hospital, measured against national aggregated data and agreed national standards
- the process of care e.g. delays in receiving treatments such as primary PCI
- the 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 4). Access to national comparative data allows clinicians and healthcare professionals to examine key aspects of the quality of care and impact on patients:

Fig 4. A summary of how the national audit data are used to support improvement.

Local level	Hospital performance	Aggregated reports are produced for each hospital that summarises data completeness and a variety of anlyses of appropriateness, process and outcomes.
		Delays reports calculate a number of time intervals between various stages of the PCI pathway for 2 clinical presentations and 4 admission scenarios. It also generates graphs for door to balloon times.
		MACCE reports provide information on the number of actual events compared with predicted events.
	Clinical performance	Clinical audit outcome data can be used to support the **revalidation of cardiologists**. Plans are in place to develop operator level reports for this purpose.
National level	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.[2]
	Transparency of data	The British Cardiovascular Interventional Society provides comprehensive analysis of annual audit data from 1992 on the BCIS website (http://www.bcis.org.uk). The National PCI data will also be published on data.gov.uk website following the publication of this report in January 2013.
	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.

1.5 Organisation of the national audit of PCI

The National audit of PCI is managed by the National Institute for Cardiovascular Outcomes Research (NICOR). The audit is one of six national cardiac clinical audits managed by NICOR, part of the National Centre for Cardiovascular Prevention and Outcomes at University College London. 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 clinical leadership to the audit. The BCIS Data Monitoring and Audit Group is a working group of BCIS and responsible for:

- reviewing and assessing the UK wide audit data
- reviewing applications to use the audit data for research (see Section 4)
- reviewing potential changes to the dataset

The national PCI audit 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 dataset

The audit is based on a dataset developed by BCIS and reflects national evidence based guidelines and recommendations. The current dataset v5.5.6 was published in January 2012 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 BCIS and NICOR websites.[i, ii]

1.7 Data collection and IT

Data are usually imported from existing hospital systems using commercial 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. All patient identifiable data are pseudonymised by the NICOR technical team before release to the project management team via a secure drop box on the NICOR server. Patient identifiable data are only available for the purpose of record linkage. 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).

i. http://www.bcis.org.uk

ii. 2 http://www.ucl.ac.uk/nicor/audits/adultcardiacintervention/dataset

2 Findings

2.1 Data completeness

Of 99 NHS PCI centres in the UK, all but 2 submitted data for 2011 to NICOR. The centres that failed to submit were one Scottish Centre (Hairmyers Hospital), and one centre in Northern Ireland (Altnagelvin). Seven of 18 private hospitals in the UK also submitted data to NICOR.

There has been a further improvement in the completeness of the fields for each of the procedures entered for the 2011 data. The percentage completeness for hospitals in England and Wales is provided in Appendix 1.

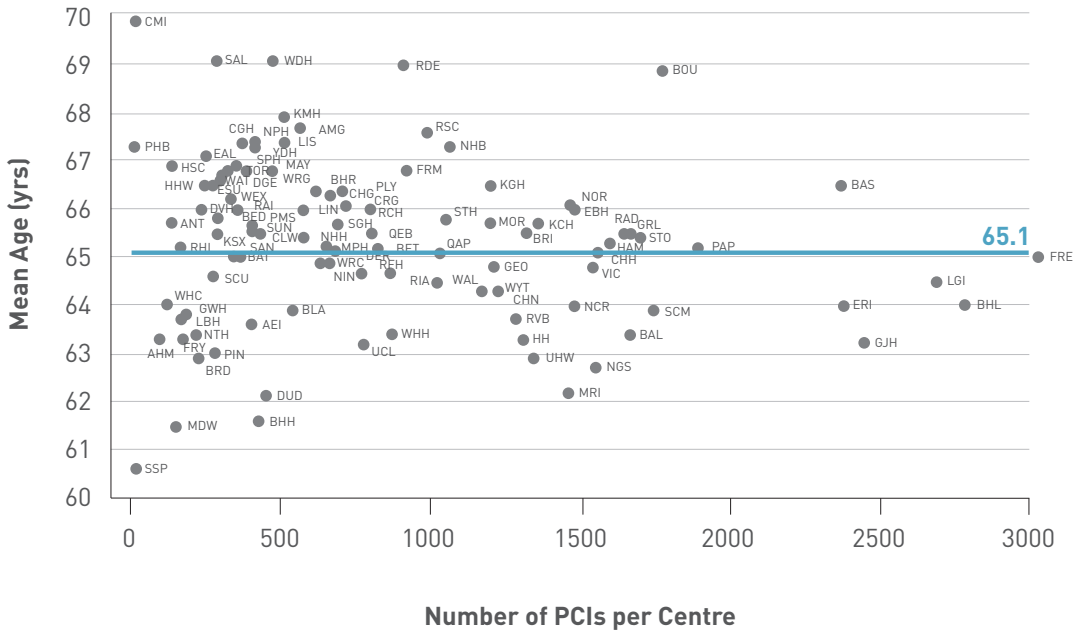
2.2 Patient characteristics

The characteristics of patients treated by PCI are shown in Figure 5. Although the average age of patients treated by PCI is 65.1 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 6. A full list of hospital codes and names are provided in Appendix 1.

Fig 5. Characteristics of patients treated by PCI in the UK

	2007	2008	2009	2010	2011
Age (mean)	64.3	64.4	65.0	65.1	65.3
Sex (male)	73.6%	73.8%	73.9%	74.0%	74.0%
Diabetic	17.5%	18.0%	18.2%	18.7%	19.5%
Previous CABG	8.5%	9.1%	8.6%	8.4%	7.9%
Previous PCI	18.6%	21.1%	22.3%	22.6%	22.7%
Previous MI	29.5%	30.2%	28.8%	28.4%	27.6%
Current smoker				26.0%	26.1%
Ex smoker				39.0%	37.0%
Never smoked				35.1%	37.0%

Fig 6. Mean age of patients treated by PCI in each PCI centre

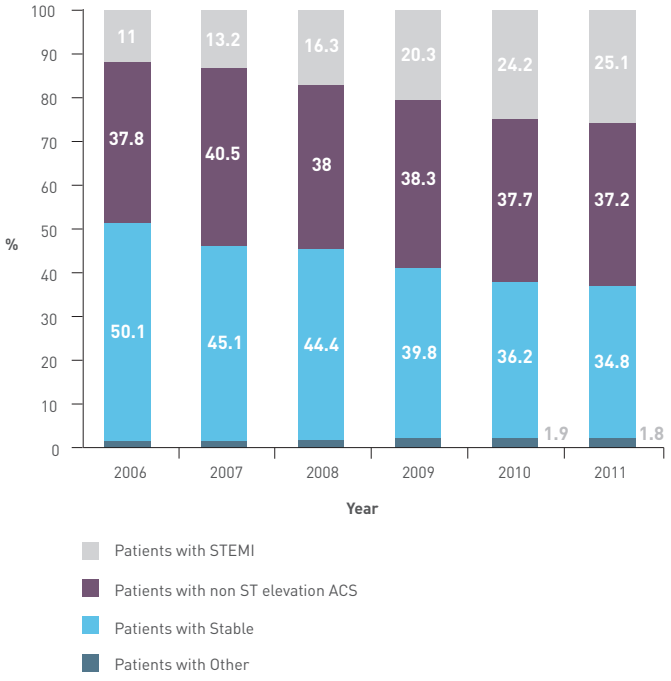


Using PCI to treat different groups of patients

Primary PCI is now the preferred treatment of choice for STEMI and now makes up more than 95% of **reperfusion treatment** for patients with STEMI.[9] This is supported in this audit which has seen a year on year increase in the use of primary PCI in place of thrombolysis to treat patients presenting with STEMI.

Overall, the percentage of patients receiving primary PCI for STEMI has more than doubled over the last few years; the percentage of patients with stable angina has decreased from approximately 50% to 35%, while those with non ST elevation acute coronary syndromes has remained level at approximately 37% (Figure 7).

Fig 7. Indications for PCI



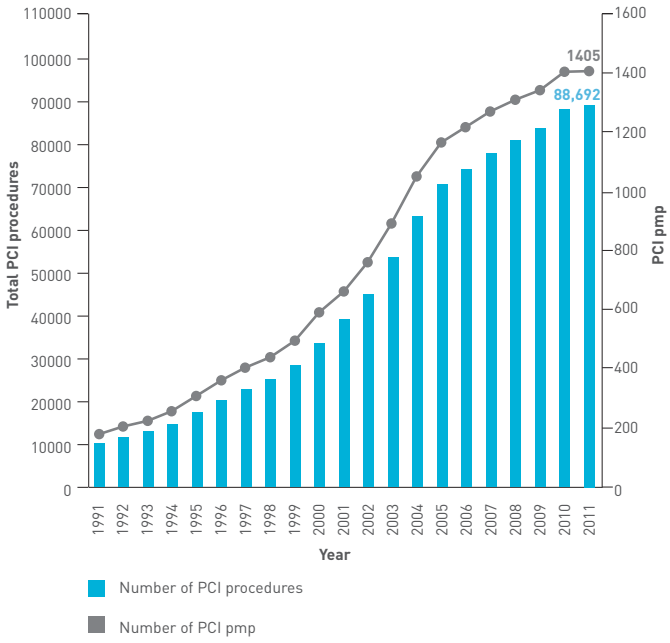
2.3 Improving access to PCI procedures

Increasing overall PCI rates in the United Kingdom

The most appropriate rate of PCI 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 88,692 PCIs were performed from January to December 2011and represents a rate of 1,405 PCI pmp (Figure 8). This represents a small fall in rates pmp compared with 2010. The main reason for this apparent fall is that the 2011 census demonstrated a larger population size for all the UK countries than had been expected based on the estimates from the 2002 census.

Fig 8. Increase in PCI activity 1991-2011



The increase in PCI activity has been possible by increasing the number of PCI centres, extending the service to 24/7 coverage within the centres and increasing the volume of procedures undertaken each year:

An increase in the number of centres

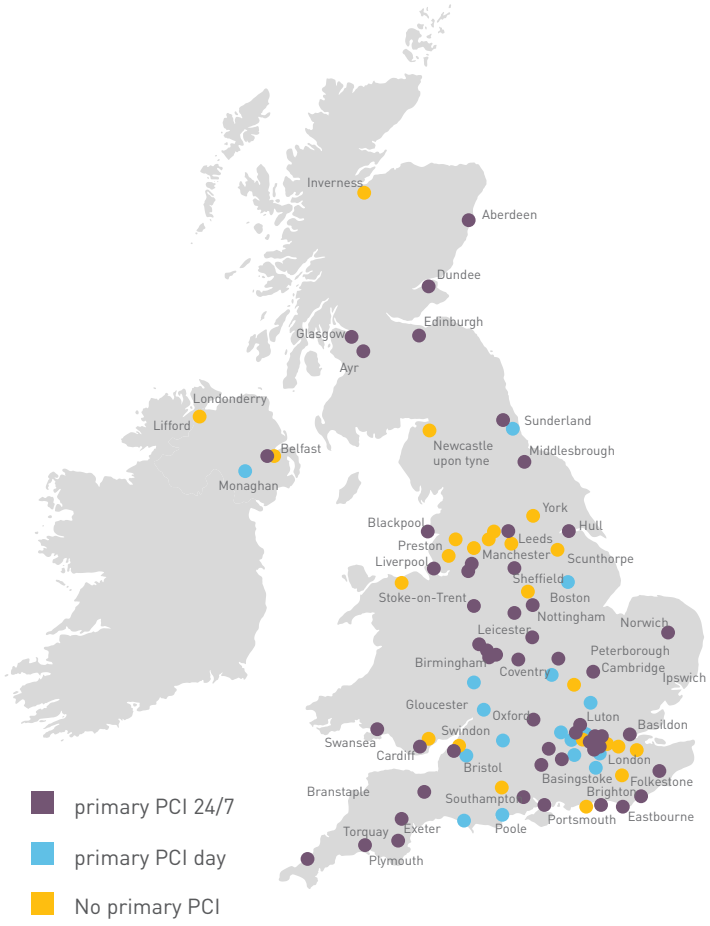
The number of hospitals performing PCI has increased this year and there has been a fall in the number of sites performing angiography only. In 2011, in the United Kingdom there were a total of 117 PCI centres, and 61 centres performing angiography only.

An increase in availability of service

Primary PCI is an emergency treatment that needs to be available at all times. In 2007, only 50% of hospitals offered primary PCI as a treatment for STEMI during working hours. In 2011, over 70% provided a working hours service. In 2007, 30% of PCI centres offered this service at all hours every day. In 2011 this has almost doubled and almost 60% of centres now offer a 24/7 service.

A map showing the distribution of this activity across the UK is given in Figure 9.

Fig 9. PCI centres and their provision of primary PCI therapy across the UK



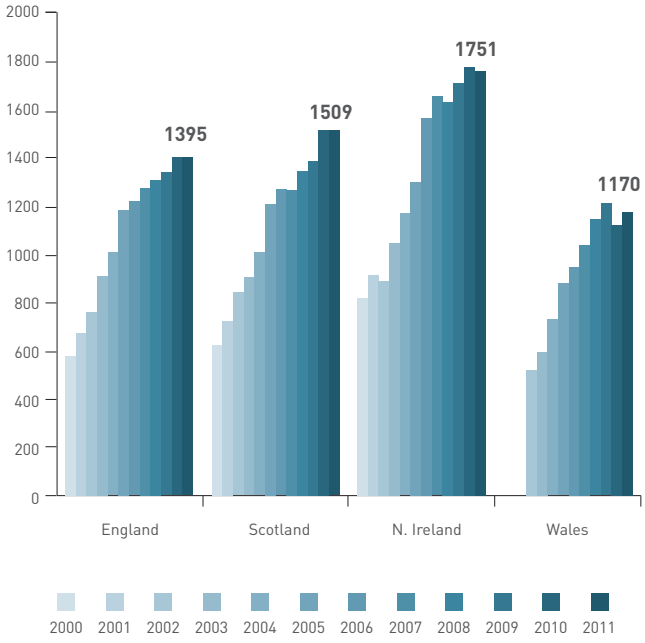
An increase in number of patients treated

Increasing the number of patients treated by each centre has also helped to improve access. Increasing volume has an additional benefit. There is increasing evidence from the UK (BCIS data) and other countries that patients treated in higher volume centres have improved outcomes, particularly centres that perform at least 400 procedures per year. The BCIS and BCS 'Recommendations for good practice and training'(5) recommend that centres undertake at least 400 PCI procedures each year. In 2011, the majority of units perform considerably more than 400 cases per year. Only 29% of units perform less than 400 cases and in the majority of cases this is because the unit is new, and undertaking a gradually increasing volume of work. Details of number of cases performed by centres are available in the full analyses (www.bcis.org.uk).

Variation in access across the UK

Whilst overall access to PCI and primary PCI has improved, there remain large differences in PCI rates between the countries of the United Kingdom, with the lowest in Wales at 1,170 pmp, with the highest provision in Northern Ireland at 1751 pmp (Figure 10).

Fig 10. PCI activity per million population in the UK countries

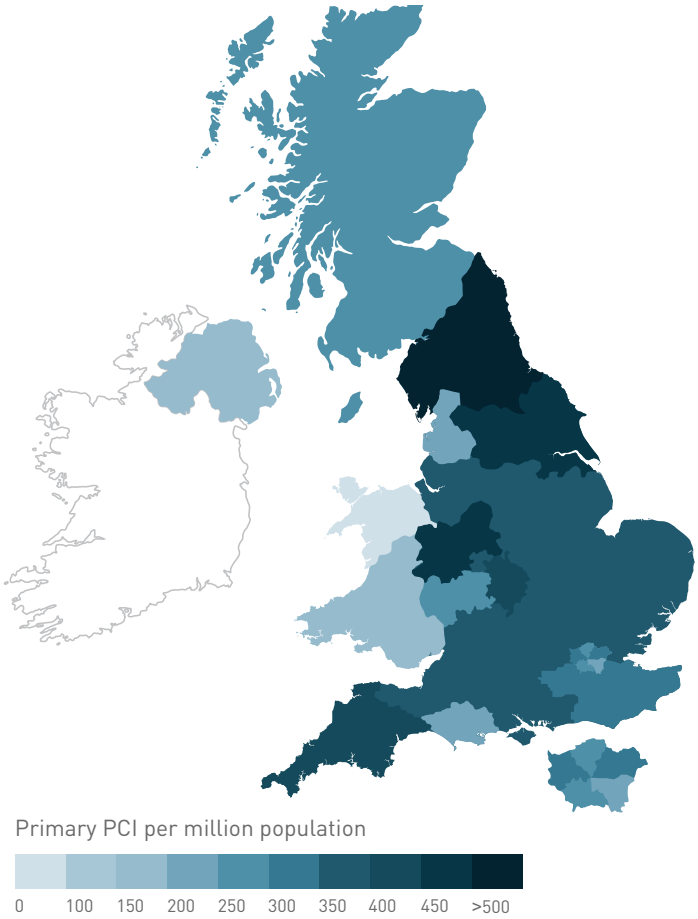


As with overall PCI rates, there are differences in the provision of primary PCI between the UK countries, with N. Ireland having the lowest rates per million population (Figure 11).

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

Within England and Wales there are also differences between cardiac networks and countries (Figure 12).

Fig 12. Rates of primary PCI for STEMI, per million population by Cardiac Networks and countries of the UK



2.4 Care and treatment of patients

Primary PCI and delays to treatment 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 PCI centre (door-to-balloon time) and within 150 minutes of a patient's call for professional help (call-to-balloon time) (Figure 13).

Fig 13. Two procedural measures associated with better outcomes for patients

In the treatment of STEMI by primary PCI, any delay in the performance of primary PCI is associated with a worse outcome for the patient. There are 2 important procedural measures:

- **The time the patient calls for professional help to the time of primary PCI treatment (call-to-balloon time) measures the entire process of care.**
- **The time a patient arrives at a PCI centre to the time of primary PCI treatment (door-to-balloon time) which assesses how quickly the PCI unit can perform primary PCI.**

In 2011, 80% of all patients were treated within 150 minutes of calling for professional help and 92% treated within 90 minutes of arriving at the PCI centre.

However, how the patient gets to the PCI centre can cause delays. There are two routes into a PCI centre for heart attack patients:

Direct admission
The patient is brought directly to the PCI centre usually by ambulance. In 2011, 77.5 % of patients who received primary PCI were direct admissions to the centre.

Interhospital transfer (IHT)
The patient is transferred from a hospital not capable of performing PCI to the PCI centre that performs the PCI. In 2011 22.5% 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 (Figure 14).

Call-to-balloon (CTB): 89% of patients admitted directly to a PCI centre were treated within 150 minutes. Only 51% of patients who were transferred from another hospital to the PCI centre were treated within 150 minutes of calling for help.

Door-to-balloon time (DTB): is an indication of how quickly the PCI centre can perform PCI when the patient is in the PCI centre.

A strategy to avoid interhospital transfers would result in quicker and therefore better treatment. In 2011, this would have saved approximately 50 minutes of delay (Figure 15).

There have been important improvements in CTB time delays by the majority of PCI centres. In 2011, there is little difference in **door-to-balloon** times for either admission

Fig 14. Percentage of STEMI patients treated by Primary PCI within target time by admission route

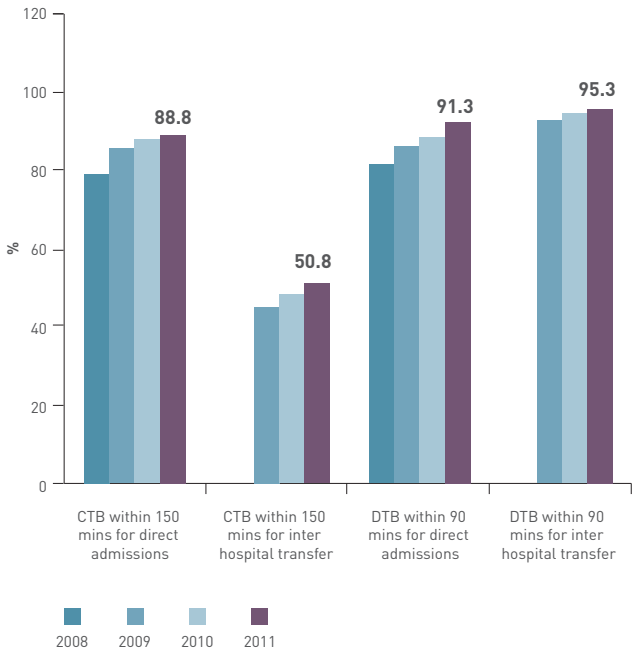
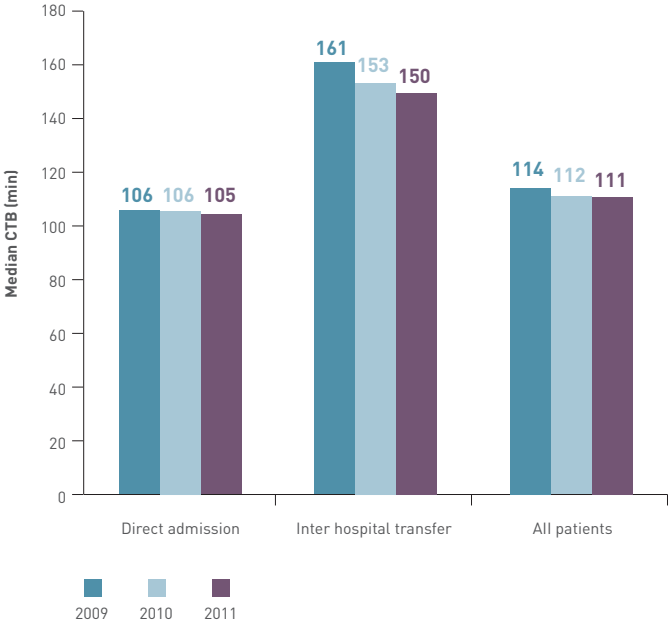


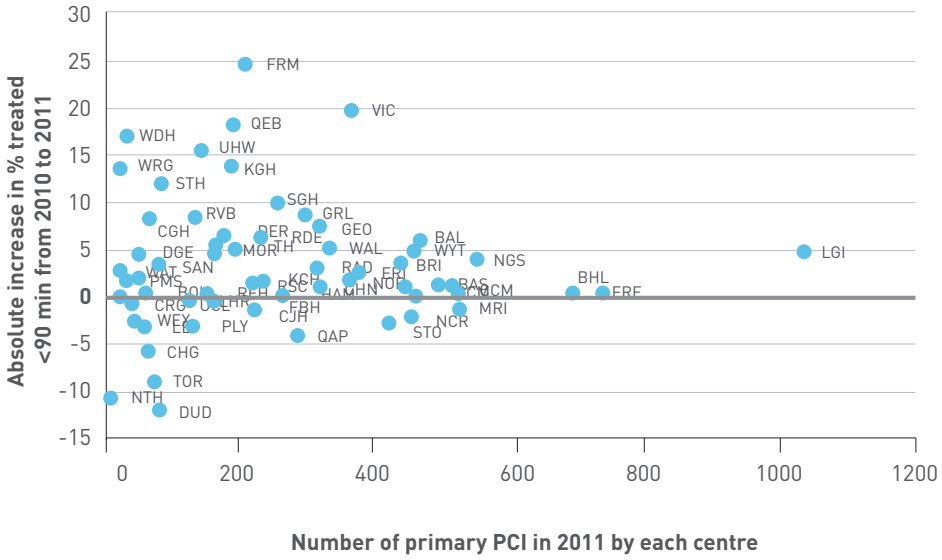
Fig 15. Median Call to Balloon (CTB) times by direct admission (Direct) or by inter-hospital transfer (IHT)



route. This shows that the process of care from arrival at the PCI centre to treatment now works well. Figure 16 shows the improvement in door to balloon times between 2010 and 2011 by each centre according to the overall volume of their activity. Clearly those centres already performing well may not need to improve as much. Figure 17 shows the degree of improvement according to how well a unit was performing in 2010. It is very encouraging to see that those centres who had the most room for improvement (on the left of the graph) have indeed improved the most.

More details regarding the analyses of delays are provided in the full analysis available in the BCIS web site. Enlarged versions of these graphics are also available for download.

Fig 16. Improvement in time delays to treat patients by primary PCI against overall PCI activity of each centre



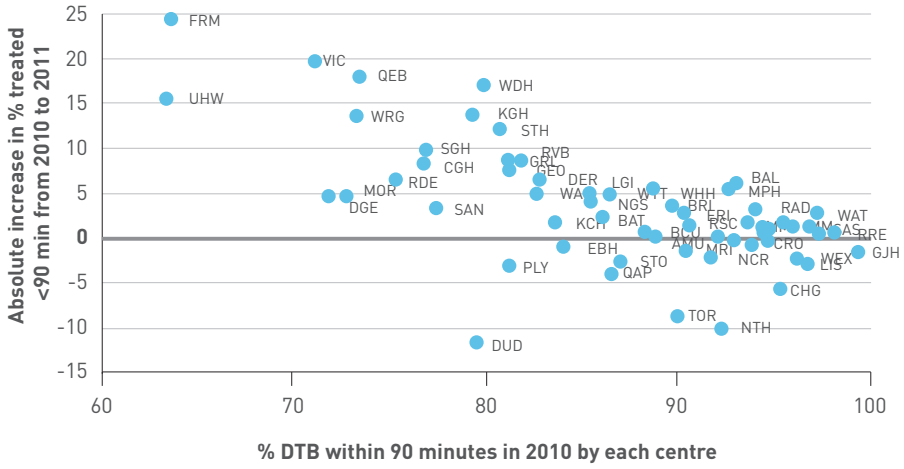


Fig 17. Improvement in time delays to treat patients by primary PCI against performance of each unit in 2010

The percentage of cases treated within target times by each PCI centre are presented in Figure 18 and Figure 19.

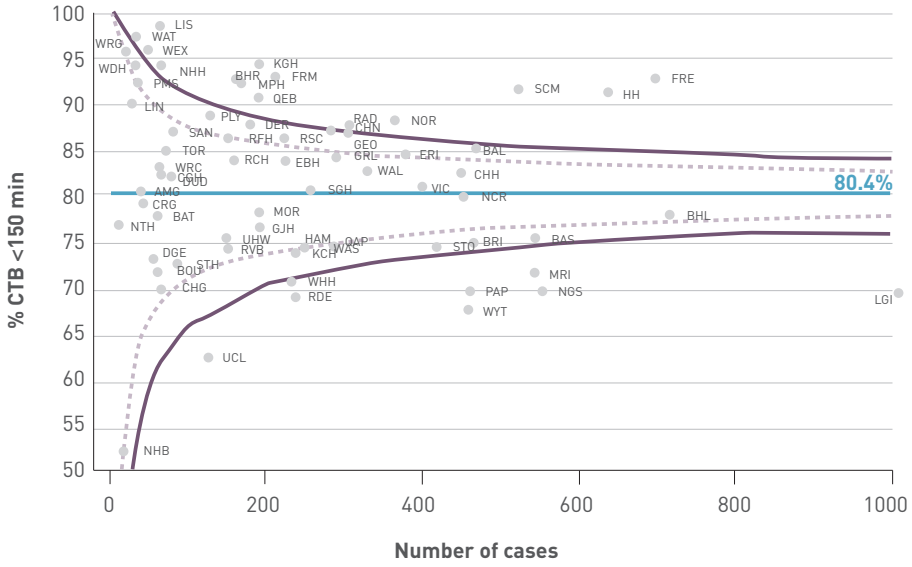


Fig 18. Call-to-balloon time: percentage of patients treated within 150 minutes of calling for help.

- <150min
- 3 standard deviation
- 2 standard deviation
- Mean

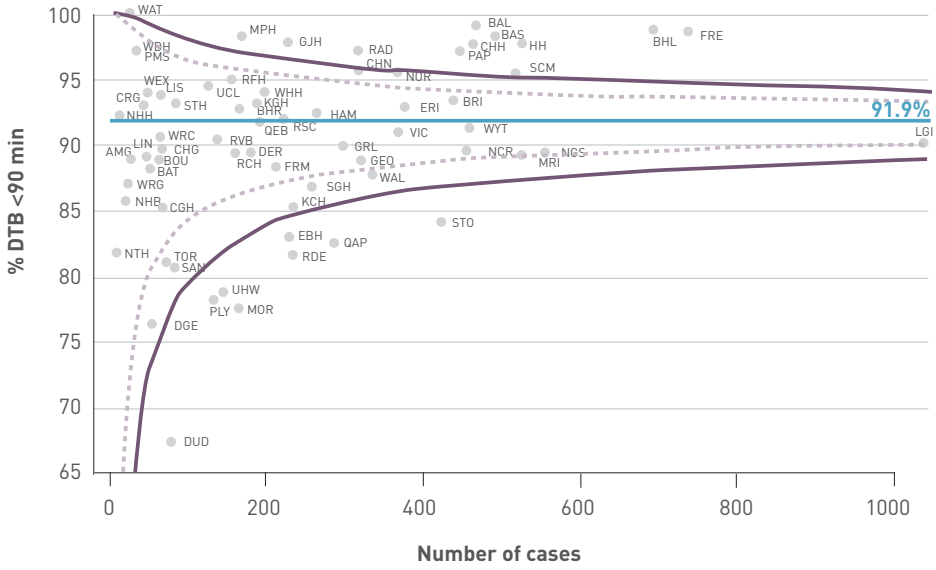


Fig 19. Door-to-balloon time: percentage of patients treated within 90 minutes of arriving at a PCI centre.

- <90min
- 3 standard deviation
- 2 standard deviation
- Mean

2.5 Improved access to evidence based treatment and guidelines

Drug eluting stents

The National Institute for Health and Clinical Excellence (NICE)[3] 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 do now involve stent insertion (92%) suggesting that this aspect of good practice is being met.

There has been a gradual increase in the percentage of patients treated with drug eluting stents now that initial concerns about long term safety are better understood, which reached 71.1% in 2011.

The use of drug eluting stents appears to be approximately what might have been predicted if units were following recommendations from current NICE guidelines (Figure 20) though there are very large differences between the countries of the UK (Figure 21).

Fig 20. Use of drug eluting stents in PCI

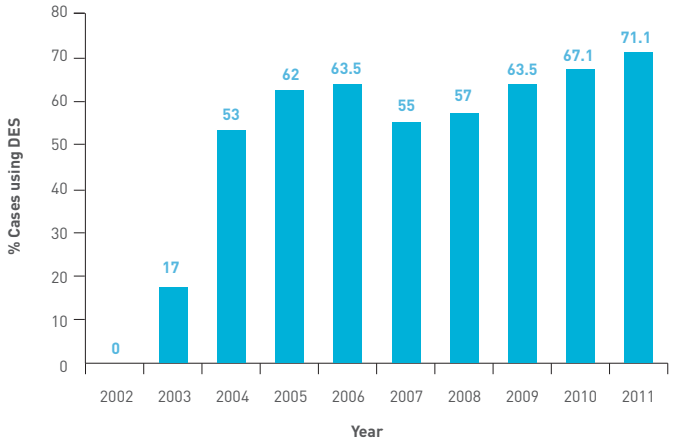
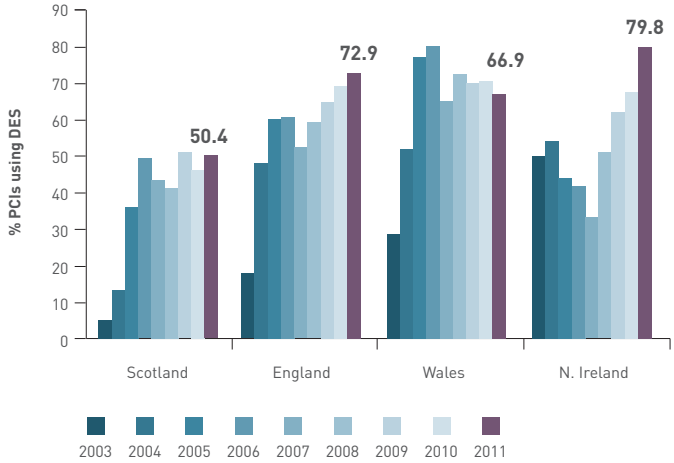


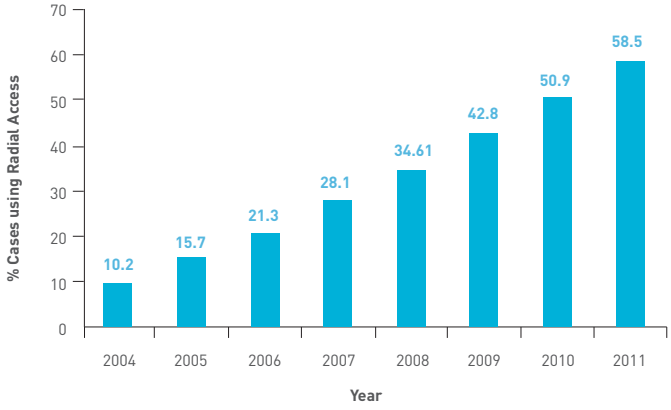
Fig 21. Drug eluting stent use by countries of the UK



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 reached 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 the 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 smaller radial artery in the wrist. Robust data shows this is associated with a reduction in complication rate; 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 (Figure 22). There is a large variation in the use of this approach between different PCI centres (Figure 23). This has had a positive impact and complication rates have reduced in the last five years (Figure 24).

Fig 22. The increasing use of the radial artery as access site for PCI



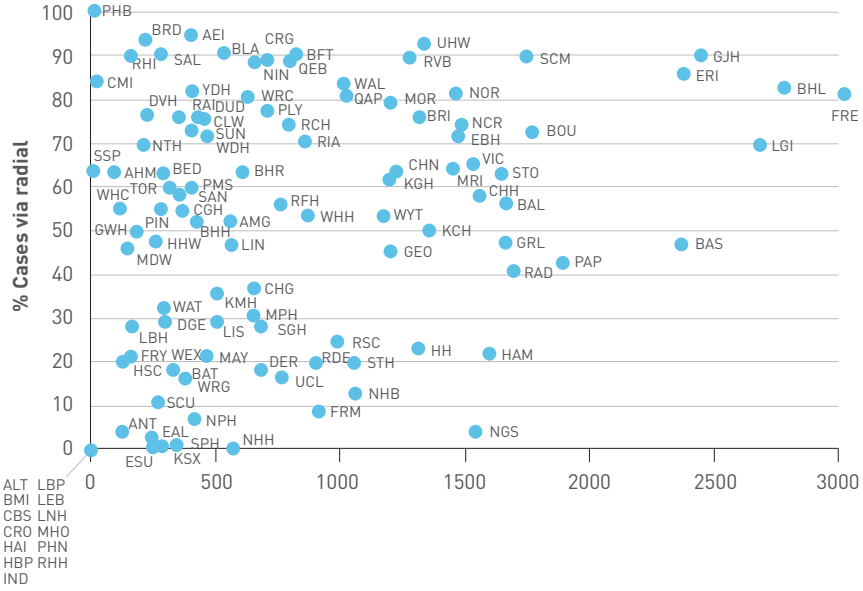
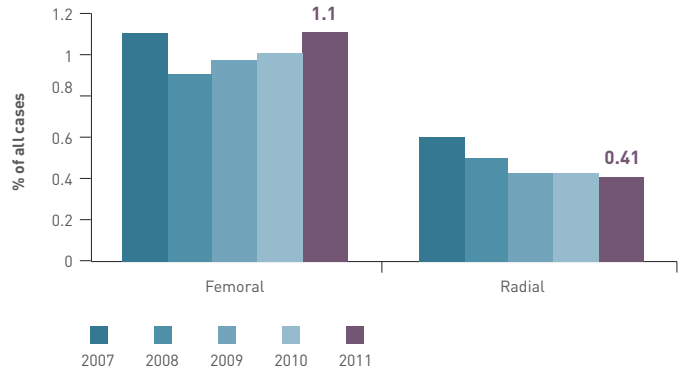


Fig 23. Variation in the use of radial arterial access by PCI centre

Fig 24. Access site complication rates for PCI using femoral access versus radial access



2.6 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 bypass surgery

This may be needed to treat a complication. In 2011, the need for emergency coronary artery bypass graft (CABG) remains very low at less than 1%.

Stroke:

The incidence of stroke also remains low at less than 1% of all PCI procedures.

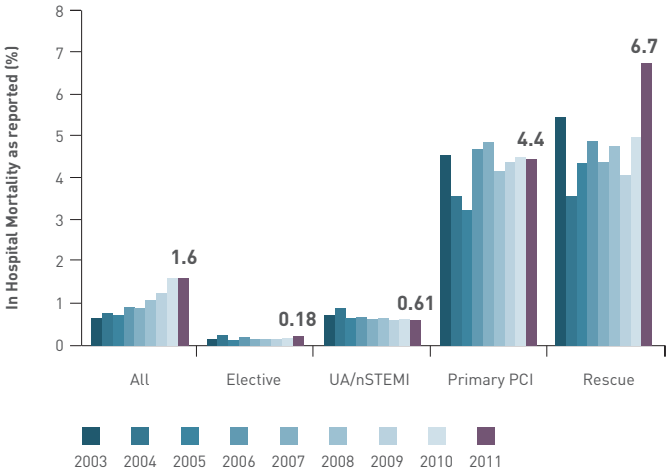
Mortality:

The overall rate of death in hospital following PCI has gradually increased over the past few years. In 2007, in-hospital mortality rates were 0.89% compared to 1.6% in 2011.

This may reflect more accurate data entry. It may also be due to the increasing proportion of sicker patients undergoing PCI.

If we look at the in hospital mortality for specific groups of patients, the mortality rates for patient undergoing elective, unstable angina (UA) and primary PCI have remained stable. In contrast, the mortality rates for **rescue PCI** have increased (Figure 25). The increase in overall mortality is due to an increasing proportion of sicker patients treated by PCI. This change in case mix is due to the increasing use of primary PCI to treat STEMI which has more than doubled in the last few years (see Section 2.3).

Fig 25. Risk of death following PCI by syndrome



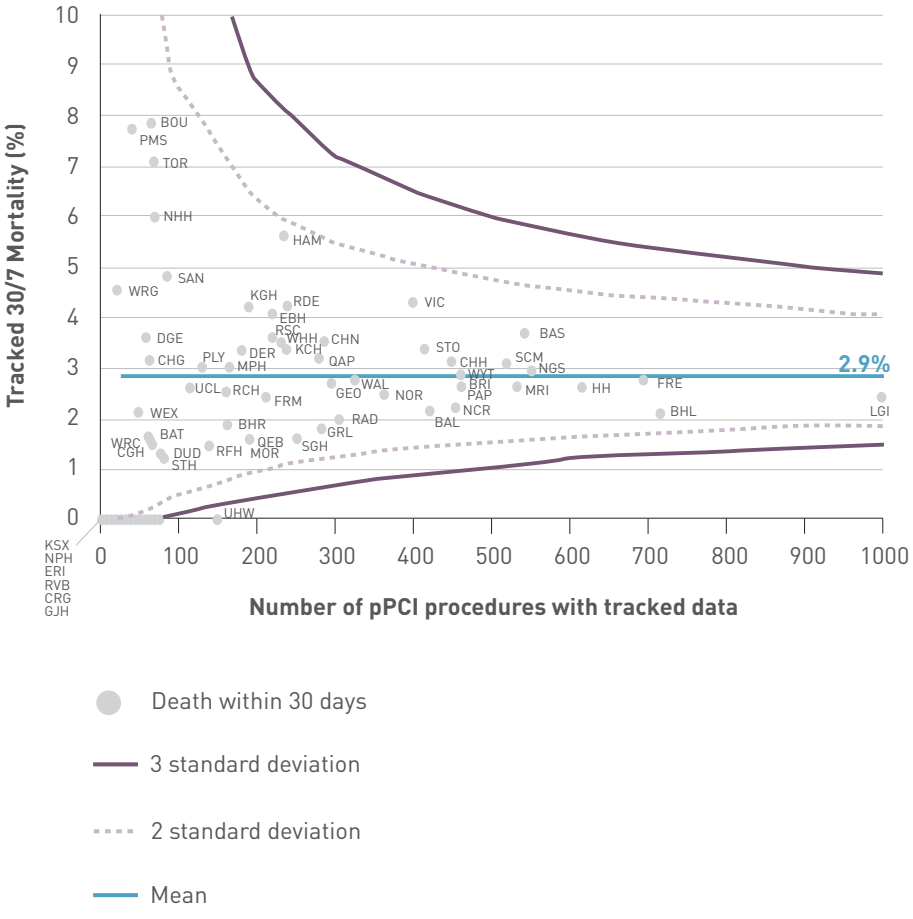
This figure clearly demonstrates the importance of **risk adjustment** in the assessment of outcome to help avoid misleading conclusions. This is further highlighted when the mortality rates of individual hospitals are compared. Results need to be interpreted with caution. Accuracy of the results depends

on a number of factors including the **statistical model** [10] **used** and the accuracy of data entry. Not only must a patient's **risk factors** be correctly recorded, but also any complications after the procedure must be recorded correctly. More detailed findings are available at the BCIS website (www.BCIS.org.uk).

Using Office of National Statistics mortality data:
To attempt to avoid under reporting of adverse outcomes we plan to use a mortality only model, and link to ONS tracked mortality to validate outcomes. Mortality tracking has been used in this audit to assess the outcomes of relatively similar groups of patients.

For example, the validated 30 day mortality of patients treated by a primary PCI is shown in Figure 26. In this figure each unit is represented by a point on the graph according to the total number of the primary PCI procedures performed against their 30 day mortality. Patients presenting in **cardiogenic shock** or needing ventilation are excluded from this analysis. No unit has mortality above the 2 or 3 standard deviation (SD) line, suggesting that no unit's outcomes are statistically worse than the average.

Fig 26. Independently validated 30 day mortality following primary PCI



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 are readily available.

Improve IT systems

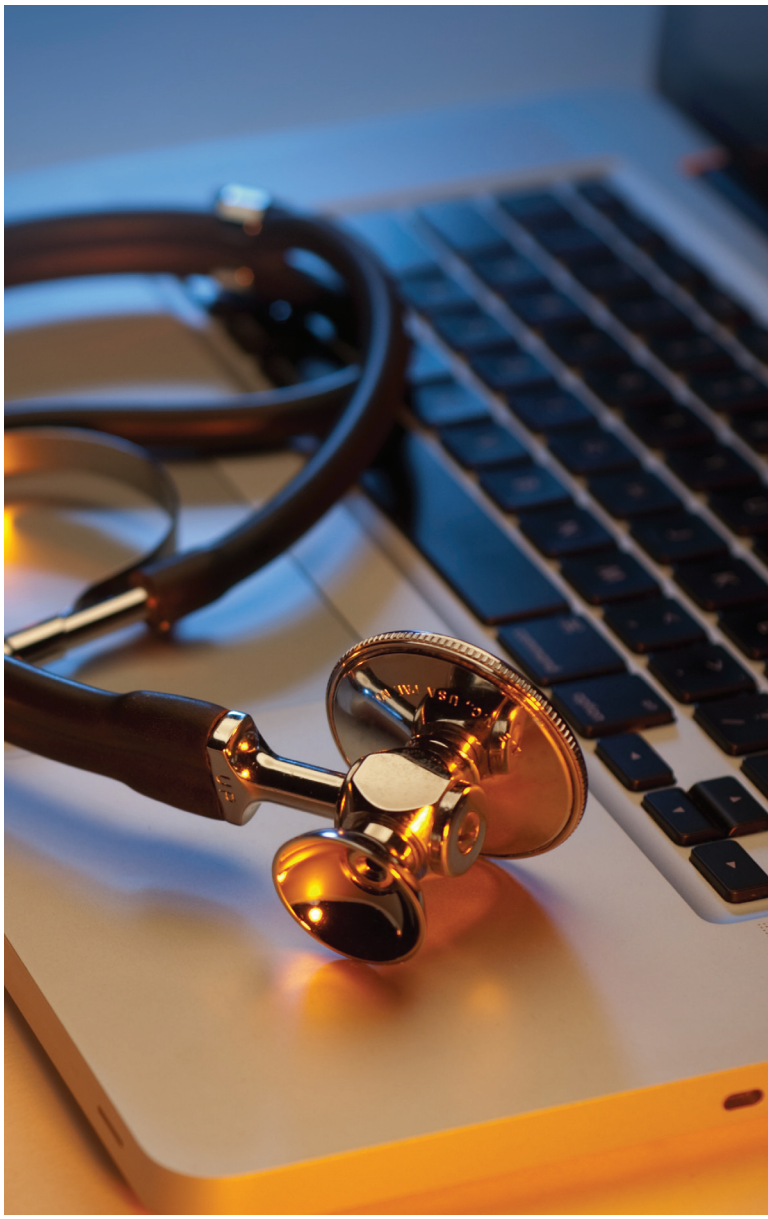
Earlier this year NICOR began a major project to upgrade its data collection and management systems. The current Lotus Notes software has become increasingly unwieldy as the NICOR databases have grown in size and complexity. A new platform will substantially improve NICOR's ability to derive high-quality results from the PCI database to inform hospitals. Cardiac Networks and patients regarding the provision of cardiac care. The first step in this project involved a transfer of all data from the Information Centre for Health and Social Care onto secure NICOR servers. The transition was not easy, and it led to some delays in accessing the PCI database. Despite these difficulties, participating hospitals submitted their data in time, making possible the timely publication of this report. We would like to thank everyone for their effort and patience during the migration. The new IT platform will be rolled out in stages throughout 2013, with the national audit of PCI scheduled for autumn 2013.

Improve reporting

We plan to develop software to generate personalised **funnel plots** for individual cardiologists to use for **revalidation purposes**.

Improve data quality by encouraging the use of consistent definitions to improve the accuracy of data. We will also strengthen the link with the heart attack audit as both audits collect data on primary PCI. Work includes aligning the two datasets, definitions and analysis to enhance the completeness of the description and measurement of patient care.

Improve analysis by developing the risk adjustment model to avoid 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. Plans are also in place to try to validate reported MACCE through Hospital Episode Statistic data (HES).



4 Research Use of PCI Audit Data

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

Audit and research are two distinct activities with different purposes. Research is used to establish good practice and is designed so that results can be generalised to similar groups. Research generates new knowledge. Data is 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 data for non experimental research. Findings are based on 'real world' patients and not restricted to trial criteria.

The national PCI audit collects data on all PCI procedures in the UK and now has nearly 600,000 records in the database. The data are a valuable research resource especially as they can be linked with external databases. Linkage to databases such as the Office of National Statistics 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), **reintervention** and process of care.

The BCIS Data Monitoring and Audit Group (Appendix 2 for membership) is responsible for reviewing and assessing the audit data and reviewing applications to use the dataset for research. A full list of approved studies is also available via the website. Figure 25 provides a summary of the type of research undertaken so far.

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

The mechanism for applying to use these data for research are available on the NICOR web site (http://www.ucl.ac.uk/nicor).

Patient outcomes A good number of the research studies look at differences in patient outcomes. The aim is to identify common factors that may have a negative or positive effect on outcomes such as reintervention, stroke and death. Studies focus on looking at patients grouped by illness, ethnicity, procedure or PCI Centre. Examples include:

- Comparing the PCI access site (e.g. femoral vs radial atery) and neurological complications
- The outcomes for South Asian patients following PCI procedures.
- Looking at the clinical outcomes in patients with **cardiogenic shock**.
- The use of drug eluting stents for groups of patients who need rotational atherectomy. This is a type of interventional procedure to help open coronary arteries blocked with heavily calcified material which is more common in the elderly, and restore blood flow to the heart. Often a drug eluting stent is inserted to improve the results.
- Comparing patient outcomes for ACS syndromes between different hospitals and explaining any differences.

Review changing clinical practice including a study looking at whether clinical practice changed following publication of clinical trial findings that showed PCI may be deferred in patients with stable disease as long as medical therapy is optimised and maintained.

Linking audit data with other national datasets provides valuable information about the patient pathway and the cost effectiveness of certain treatments. One study will look at the health gains of cardiac rehabilitation by linking the national PCI audit data with other national heart disease audits, national cost data and cardiac rehabilitation audit data.

5 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 PCI 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 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 PCI.
Cardiac catheter laboratory		The cardiac catheter laboratory is where the angiogram and PCI are performed.
Cardiogenic shock		Cardiogenic shock occurs when the heart fails to pump effectively.
Case mix		The type or mix of patients treated by a hospital including age and sex of patients.
Coronary Heart Disease	CHD	The narrowing or blockage of the coronary arteries, usually caused by atherosclerosis.
Coronary artery bypass grafting	CABG	Coronary artery bypass grafting (CABG) is a type of surgery used to improve blood flow to the heart. It is used to treat people with severe coronary heart disease.
Door-to-balloon time	DTB	The interval between the ambulance arriving at a hospital and the performance of primary PCI.
Drug eluting stents		These are coronary stents placed into coronary arteries that slowly release a drug to stop cell growth.
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.
Elective		An elective PCI is one scheduled in advance because it does not involve a medical emergency.
Funnel plots		Funnel plots were first introduced in 1984 as a means of estimating bias in 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. 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%. 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.

Hospital Episode Statistics	HES	Hospital Episode Statistics (HES) 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. http://www.hesonline.nhs.uk.
Heart attack		The term applied to the symptoms, usually but not always involving chest pain, which develop when a clot (thrombus) develops within a heart artery as a result of spontaneous damage to the inner lining of the artery (plaque rupture). The heart muscle supplied by the blocked artery suffers permanent damage if the blood supply is not restored quickly. The damage to heart muscle carries a risk of sudden death, and heart failure in people who survive.
Heart Attack Centre		A hospital that provides a primary PCI service to patients with ST elevation Myocardial Infarction.
Major Adverse Cardiac and Cerebrovascular Events	MACCE	MACCE is a selection of events that can happen after PCI and includes all causes of death, stroke, heart attack and emergency coronary artery bypass surgery.
Myocardial Infarction		A heart attack in which heart muscle damage is confirmed by blood testing and ECG charges.
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	Office of National Statistics is the UK's largest independent producer of official statistics and the recognised national statistical institute of the UK. http://www.ons.gov.uk.
Percutaneous coronary intervention	PCI	A technique to re-open the blocked coronary artery. A fine catheter (tube) is passed, under local anaesthetic, from an artery in the leg or arm into the blocked heart artery. A thin wire is then passed through the catheter and across the blockage, allowing the artery to be re-opened by temporary inflation of a balloon which tracks over this wire. Once the artery has been reopened and widened by a balloon, it is usually scaffolded by the implantation of a small expandable metal tube (stent) which is passed into the artery and deployed with an angioplasty balloon. The umbrella term that encompasses both balloon dilatation (angioplasty) and stent insertion (stenting) is 'percutaneous coronary intervention' (PCI).
Primary percutaneous coronary intervention	primary PCI	When PCI is used in the treatment if a patient presenting with myocardial infarction associated with an ECG showing ST segment elevation.
Radial artery		One of the arteries that passes through the wrist to provide blood supply to the hand.
Re-infarction		The development of evidence of re-occlusion (further blockage) of, or development 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.
Rescue PCI		Patients with a heart attack are treated either with primary PCI or with thrombolysis. When thrombolysis fails, rescue PCI is performed.
Revalidation		This is an appraisal process to provide reassurance to patients, the public, employers and other healthcare professionals that cardiologists are up-to-date and fit to practice.
Revascularisation		Interventions that improve the blood supply to the heart, including PCI or coronary artery bypass grafting.
Risk adjustment		Risk adjustment 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 major complications than others.

Risk factors		A risk factor is something associated with an increased risk to a patient. For example, the development of coronary heart disease is influenced by the following risk factors: increasing age, family history, smoking and obesity.
Stable elective patients		An elective procedure or surgery 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.
Statistical model		A statistical model is a formal mathematical way of representing a real world situation that allows predictions to made.
ST elevation myocardial infarction	STEMI	A heart attack characterised by a specific abnormal appearance of ST segment elevation on the ECG thought to be indicative of complete blockage of a coronary artery. Reperfusion therapy with thrombolysis or PCI has been shown to be very beneficial in the treatment of this condition.
Statistical model		A statistical model is a formal mathematical way of representing a real world situation that allows predictions to made.
Thrombolysis		Thrombolysis is the breakdown of blood clots by drug treatment. Drugs are often referred to as 'clot busters'.
Unstable angina		The symptoms of unstable angina are the same as those of stable angina, but they do not follow the usual pattern. For example, in unstable angina the symptoms can develop without any angina triggers being present, can persist at rest, last longer than 5 minutes.

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Data Completeness English NHS Hospitals	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
AEI. Royal Albert Edward Infirmary	99.8	99.8	99.3	89.5	96	96	98.3	96.9	88.5	91.6	100	96.2
AMG. Wycombe Hospital	100	100	83.8	99.1	100	100	97.1	98.1	62.4	62.9	100	100.9
BAL. Barts and the London	100	99.2	91.7	95.2	99.3	99.3	92.7	93.4	93.1	93	91.5	95.4
BAS. Basildon Hospital	100	100	98.1	98.2	100	100	74.6	99.4	100	99.8	100	99.9
BAT. Royal United Hospital Bath	100	100	**47.8**	99.6	100	100	83.3	81.8	77.7	77.7	100	99.4
BED. Bedford Hospital	100	100	70.9	100	100	100	94.1	70.6	57.1	85.8	100	99.7
BHH. Rochdale Infirmary	100	100	100	100	100	100	100	100	99.3	100	99.8	100
BHL. Liverpool Heart and Chest Hospital	100	100	100	100	100	100	99.9	99.9	97	97.2	100	100.1
BHR. Royal Berkshire Hospital	100	99.8	99.8	99.8	100	100	100	99.5	100	100	100	99.4
BLA. Royal Blackburn Hospital	100	100	100	100	98.7	99.3	99.3	99.4	98.7	99.6	100	99.8
BOU. Royal Bournemouth General Hospital	100	100	92.1	100	100	100	94.7	97.2	98.5	99.9	100	100
BRD. Bradford Royal Infirmary	100	99.6	100	100	100	99.1	99.6	100	100	100	99.6	99.2
BRI. Bristol Royal Infirmary	100	99.8	95	97.9	99.9	99.6	98.3	98.8	99.7	99.7	99.8	99.2
CGH. Conquest Hospital	100	100	100	100	100	100	100	100	100	100	100	100

Key: Data completeness less than 90% Data completeness less than 50%

Data Completeness English NHS Hospitals	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
CHG. Cheltenham General Hospital	100	99.9	90.7	100	100	97.7	99.9	100	99.7	99.7	97.7	100
CHH. Castle Hill Hospital	100	100	98.7	100	100	100	100	100	100	100	100	99.9
CHN. Nottingham City Hospital	100	100	85.1	100	99.9	100	84.9	94.1	100	100	100	99.8
CMI. Cumberland Infirmary	100	100	88	100	92	100	76	88	100	96	100	88
DER. Royal Derby Hospital	100	100	93.6	99.6	98.5	99.9	98.7	99.1	97.4	98.1	99	99.7
DGE. Eastbourne DGH	100	100	100	100	100	100	100	100	100	100	100	100
DUD. Birmingham City Hospital	100	100	100	100	100	100	100	100	100	100	100	99.4
DVH. Darent Valley Hospital	100	100	98.1	99.3	100	100	91.7	99.6	99.2	99.6	100	100.4
EAL. Ealing Hospital	100	98.4	100	97.1	100	97.6	96	73.4	99.6	97.2	100	100
EBH. Birmingham Heartlands Hospital	100	100	95.1	97.5	100	96.4	91	93.7	99.9	99.6	99.7	99.5
ESU. East Surrey Hospital	100	100	100	80.7	99.6	100	58.4	69.6	100	100	100	100
FRE. Freeman Hospital	100	100	97.6	99.5	100	98.8	95.5	97.9	100	100	80.9	99.8
FRM. Frimley Park Hospital	100	100	100	100	100	100	100	100	100	100	100	99.6
FRY. Frenchay Hospital	100	100	100	100	100	100	100	100	100	100	100	100
GEO. St George's Hospital	100	100	94.7	98.7	100	99.9	98.5	99.3	99.9	99.8	99.9	99.2
GRL. Glenfield Hospital	100	100	94.4	100	100	100	93.9	91	99.9	99.9	99.8	99.8

GWH. Queen Elizabeth Hospital, Woolwich	100	99.5	100	46.2	99.5	97.8	96.2	94.6	98.4	98.4	100	98.9
HAM. Hammersmith Hospital	100	100	100	99.2	97.4	97.8	98.7	95.6	99.2	100	100	102.6
HH. Harefield Hospital	100	99.8	97.2	99.3	99.9	97.2	92.4	96.2	99.8	99.5	99.9	99.5
KCH. King's College Hospital	100	99.4	98.6	99.5	99.8	97.9	97.1	98.6	99.8	99.8	100	99.4
KGH. Kettering General Hospital	100	100	98.8	100	100	100	100	100	100	100	100	99.9
KMH. Kings Mill Hospital	100	99.8	100	99.7	98.6	99.6	99	98	99	99.6	100	100
KSX. Tunbridge Wells Hospital	100	99.3	93	99.2	100	100	99.7	85.2	66.4	67.4	100	99
LGI. Leeds General Infirmary	99.9	90.4	89.3	94.1	99.7	98.8	90.1	90.9	96.7	97.1	93.7	99
LIN. Lincoln County Hospital	100	100	100	96.9	99.8	99.1	87.4	84.6	100	99.3	100	100
LIS. Lister Hospital	100	95.2	99	100	100	100	99.5	100	100	100	100	99.8
MAY. Croydon University Hospital	100	100	97.1	95.2	100	100	96.2	91.5	99.6	100	99.6	99.8
MDW. Medway Maritime Hospital	99.3	100	100	79.8	100	98	94.7	95.4	98.7	98	100	96
MPH. Musgrove Park Hospital	100	99.9	87.3	100	100	97.9	93.7	99.9	99.5	96.7	97.9	99.7
MRI. Manchester Royal Infirmary	100	100	100	99.9	100	99.5	90.4	95.3	99.8	99.5	62.8	96.1
NCR. New Cross Hospital	100	100	99.6	100	100	100	99.9	99.9	100	100	100	100.1
NGS. Northern General Hospital	100	99.9	95.3	100	100	100	98.2	97.4	99.6	99.7	99.9	99.9

Key: Data completeness less than 90% Data completeness less than 50%

Data Completeness English NHS Hospitals	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
NHB. Royal Brompton Hospital	100	100	98.8	93.3	100	99.4	95	98	99.3	99.3	95.9	95
NHH. Basingstoke and North Hampshire Hospital	100	100	100	96.8	100	100	97.7	59	100	100	100	99.5
NOR. Norfolk & Norwich University Hospital	100	100	98.4	100	100	99.7	97.7	99.5	98.3	100	98.4	100.1
NPH. Northwick Park Hospital	100	99.5	100	0.7	98.1	85.4	46.8	57.6	53.7	85	99.8	88.4
NTH. Northampton General Hospital	100	100	100	100	99.1	99.1	98.6	98.6	97.7	99.1	100	100
PAP. Papworth Hospital	100	100	67.5	100	100	100	92.2	99.9	99.9	99.6	100	100.1
PIN. Pinderfields General Hospital	100	100	100	99.6	100	100	98.9	85.3	100	99.6	100	100
PLY. Derriford Hospital	100	100	98.7	99.4	100	99.9	98	99.4	100	100	99.9	100.1
PMS. The Great Western Hospital	100	100	99.3	100	99.3	100	100	99.5	100	100	100	100
QAP. Queen Alexandra Hospital	100	99.9	99.9	100	99.9	99.8	99.5	99.4	99.9	99.7	99.9	100.7
QEB. Queen Elizabeth Hospital Edgbaston	100	100	100	100	100	100	100	100	100	100	100	99.9
RAD. John Radcliffe Hospital	100	100	100	100	100	100	99.9	84.3	100	99.9	100	95.2
RCH. Royal Cornwall Hospital	100	100	99.7	100	100	100	94.7	99.7	100	100	100	100.1
RDE. Royal Devon & Exeter Hospital	100	100	100	100	100	99.6	100	100	100	100	100	99.8

RFH. Royal Free Hospital	100	100	100	100	100	96.9	100	100	100	100	100	99.7
RHI. Calderdale Royal Hospital	100	100	55.1	98.2	99.4	97	100	98.8	100	100	100	99.4
RSC. Royal Sussex County Hospital	100	100	95.3	100	100	99.9	92.1	96.9	100	99.9	96.3	99.6
SAL. Salisbury District Hospital	100	100	60.9	100	100	100	92.7	72.3	98.6	100	100	100
SAN. Sandwell General Hospital	100	99.2	100	100	100	95.1	100	100	100	100	100	100
SCM. James Cook University Hospital	100	100	99.5	100	100	100	98.9	99.5	100	100	100	100.1
SCU. Scunthorpe General Hospital	100	100	83.8	100	100	100	94.2	74.2	78.6	91.6	100	100
SGH. Southampton General Hospital	100	99.7	100	100	100	98.8	99.2	99.4	99.7	99.9	95.3	100.9
SPH. St Peter's Hospital	100	99.7	100	100	100	100	100	100	100	100	100	99.4
STH. St Thomas' Hospital	100	100	99.8	100	100	100	99.5	98	100	100	100	96.7
STO. University Hospital of North Staffordshire	99.6	97.8	99.8	100	100	97.8	89.8	98.1	98.2	99.1	69	99.8
SUN. Sunderland Royal Hospital	100	100	99.8	100	100	99.5	100	100	92.5	97.6	97.8	96.4
TOR. Torbay Hospital	100	100	100	99.6	100	98.8	100	100	100	100	100	99.4
UCL. University College Hospital	100	100	98	99.8	100	100	98.6	98.4	98.5	99	100	97.7
VIC. Blackpool Victoria Hospital	100	99.7	100	99.7	99.9	95.6	99.9	99.9	97.4	100	99.9	99.3
WAL. University Hospital Coventry	100	100	94.9	100	100	99.9	93.5	97.5	98.8	99.4	99.2	99.5

Key: Data completeness less than 90% Data completeness less than 50%

WAT. Watford General Hospital	100	100	100	100	100	100	100	100	99	99.3	100	100
WDH. Dorset County Hospital	100	99.8	89.4	100	100	99.4	99.8	99.8	99.1	99.2	99.4	100
WEX. Wexham Park Hospital	100	100	100	100	100	100	100	100	100	100	100	99.7
WHC. Whipps Cross University Hospital	100	100	90.2	100	100	100	99.2	66.7	99.2	100	100	100
WHH. William Harvey Hospital	100	100	74	98.9	99.8	99.1	80.2	89.7	82.4	88.7	88.5	98.9
WRC. Worcestershire Royal Hospital	100	100	99.7	100	100	99.2	100	100	100	100	98.1	100
WRG. Worthing Hospital	100	99.7	81.6	100	100	100	95.3	98.7	98.4	99	100	100
WYT. Wythenshawe Hospital	100	100	100	100	100	100	100	100	100	100	100	100
YDH. York District Hospital	100	100	60.9	98.4	99.5	99.5	98.1	97.6	96.9	96.9	98.3	99.1

Data Completeness English Private Hospitals	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
LBH. London Bridge Hospital	100	100	100	100	100	100	94.1	100	100	100	99.4	73.4
HHW. Wellington Hospital	100	100	93.6	100	100	99.6	83.8	98.1	100	100	99.2	80.4
HSC. Harley Street Clinic	100	100	77.8	100	100	98.5	77.8	95.6	100	99.3	97.7	78.2
ANT. St Anthony's Hospital	100	100	93.5	n/a	100	99.3	98.6	95.7	84.2	79.9	78.4	64
PHB. BMI Priory Hospital	85.7	100	100	100	100	100	85.7	100	28.6	28.6	100	71.4
AHM. BMI Alexandra Hospital	100	99.1	9.6	0	100	100	13.9	19.1	24.3	83.5	56.2	98
BMI. BMI Meriden Hospital	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
CBS. BUPA Hospital Southampton	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
CRO. Cromwell Hospital	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
HBP. BUPA Hospital, Hull & East Riding	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IND. London Independent Hospital	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
LBP. Leicester BUPA Hospital	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
LEB. BUPA Hospital Leeds	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Key: Data completeness less than 90% Data completeness less than 50%

LNH. Leeds Nuffield Hospital	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MHO. Manor Hospital	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
PHN. BMI Park Hospital	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Data Completeness for Scottish NHS Hospitals	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
NIN. Ninewells Hospital	100	100	99.7	100	100	100	100	100	99.1	100	99.7	n/a
GJH. Golden Jubilee Hospital	100	100	99.7	100	100	100	99.6	99.6	96.3	100	97.8	n/a
RIA. Aberdeen Royal Infirmary	100	100	97.3	99.8	100	100	96.9	96.9	92.3	100	97.2	n/a
RAI. Raigmore Hospital	100	100	97.5	100	100	100	97.7	97.5	93.8	100	88.1	n/a
ERI. Royal infirmary of Edinburgh	100	100	67.1	100	100	100	88.5	95.2	100	100	100	98.4
HAI. Hairmyres Hospital	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Data Completeness for Scottish Private Hospitals	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
SSP. Spire Shawfair Park Hospital	100	100	64.7	n/a	100	100	88.2	100	76.5	100	100	n/a
RHH. Ross Hall Hospital	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Data Completeness for Northern Ireland Hospitals	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
CRG. Craigavon Area Hospital	100	99.7	99.5	100	100	99.7	96.4	99.1	99	99.6	100	100
RVB. Royal Victoria Hospital	100	100	78.9	100	99.9	100	85.4	94	98.9	99	100	99.9
BFT. Belfast City Hospital	100	100	85.4	99.7	100	100	45.7	69.7	100	100	100	57.2
ALT. Altnagelvin Hospital	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Data Completeness for Welsh Hospitals	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
CLW. Glan Clwyd Hospital	100	98.9	96.2	100	100	100	99.8	99.6	97	98.7	100	98.3
UHW. University Hospital of Wales	100	99.9	93.5	96.9	100	99.9	98.7	99	95.3	99	98.3	98.9
MOR. Morriston Hospital	100	99.8	91.7	99.5	99.9	97.6	91.9	96.1	77.4	96.2	91.9	99.7

Key: Data completeness less than 90% Data completeness less than 50%

Appendix 2 BCIS Data Monitoring and Audit Group

Name	Role	Organisation
Peter Ludman (Chair)	Consultant Cardiologist (BCIS audit lead)	Queen Elizabeth Hospital Edgbaston Birmingham
Mark de Belder	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
Emmanouil Lazaridis	Senior Information Analyst	NICOR
NICOR project team in attendance:		
Tracy Whittaker	Project Manager	NICOR
Lynne Walker	Programme Manager	NICOR