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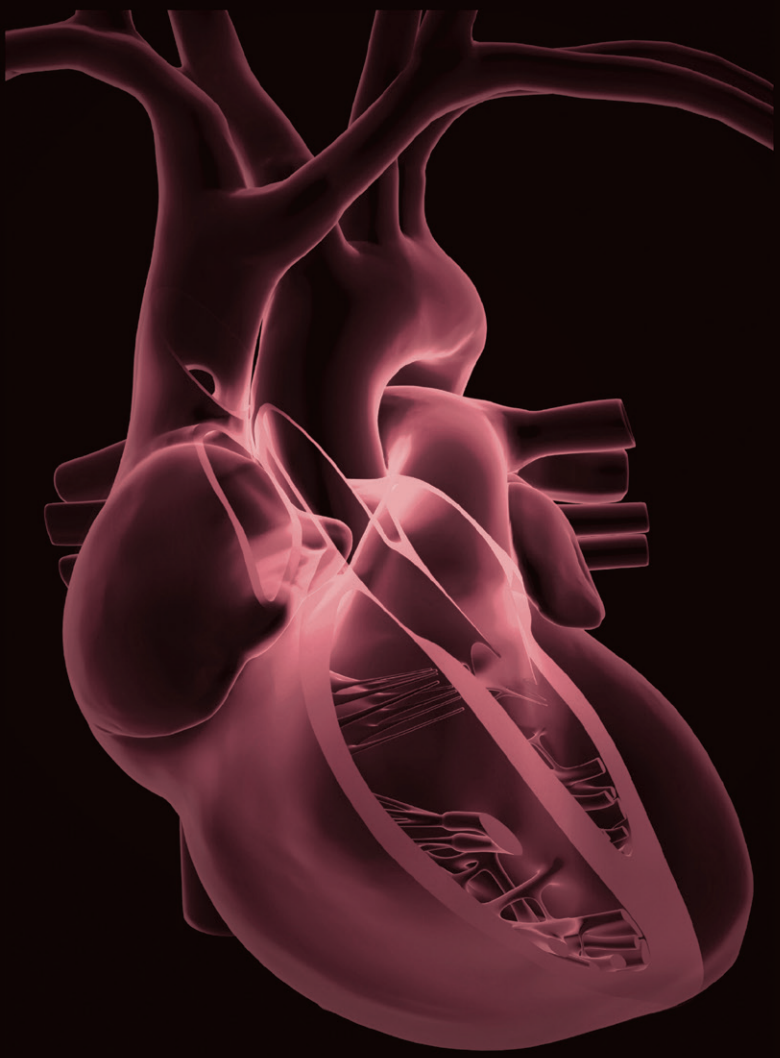
HQIP
Healthcare Quality Improvement Partnership



National Audit of Percutaneous Coronary Interventions

Annual Public Report

January 2014 - December 2014

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 **British Cardiovascular Society** is the voice for those working in cardiovascular health, science and disease management in the UK; we aim to promote and support both the healthcare professionals who work in cardiology and the patients for whom we want to encourage the best possible treatment. Our members are healthcare professionals, working in the field of cardiovascular health.

The National Audit of Percutaneous Coronary Interventions is commissioned by the **Healthcare Quality Improvement Partnership (HQIP)** as part of the National Clinical Audit Programme (NCA). 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 holds the contract to manage and develop the NCA Programme, comprising more than 30 clinical audits that cover care provided to people with a wide range of medical, surgical and mental health conditions. The programme is funded by NHS England, the Welsh Government and, with some individual audits, also funded by the Health Department of the Scottish Government, DHSSPS Northern Ireland and the Channel Islands.

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.

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This report is available online at 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 clinically led by the British Cardiovascular Intervention Society (BCIS) and is managed by the National Institute for Cardiovascular Outcomes Research (NICOR) 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, Wales 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.

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National Audit of Percutaneous Coronary Interventions

January 2014 - December 2014

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 Interventions**. The full report is available for download at **www.BCIS.org.uk.**

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

Contents

List of figures and tables

Executive summary

The audit of **percutaneous coronary intervention (PCI)** is continuous audit that collects information about all percutaneous coronary intervention procedures performed in all NHS hospitals and the majority of private hospitals in the UK. It focuses not only on procedures where percutaneous coronary intervention is deemed to have taken place (i.e. any coronary device such as a guide wire approaches, probes or crosses one or more coronary lesions, with the intention of performing a coronary intervention), the audit also collects information about the use of diagnostic interventional procedures such as pressure wire measurement, or the use of intracoronary imaging where no PCI ensues.

The audit shows a reassuring picture of PCI quality in the UK. Over the last 3 or 4 years percutaneous coronary intervention (PCI) activity in the UK has matured, as the proportion of differing clinical syndromes (case mix) treated has stabilized. From 2013 to 2014 there was only a 3% increase in total PCI activity, bringing the total to 96,143 procedures, which represents a rate of 1,488 per million population (pmp). The percentage of patients treated for an acute coronary syndrome has levelled off at about 65%, though with considerable variance between centres. Primary PCI is established across most of the UK as the default treatment for ST elevation MI and represents about 27% of all PCI activity. For most regions in the UK this represents a rate of between 300 and 500 pmp. There are 69 PCI hospitals in the UK to whom ambulances bring patients with STEMI to be treated by primary PCI.

Case ascertainment and data quality have improved but some centres stand out as not meeting the minimum data standards. This is particularly an issue for patients being treated in the context of an acute coronary syndrome. Some participating hospitals need to improve their compliance with the national audit project. Hospitals should also ensure they use the nationally agreed variable definitions when completing the datasets.

Risk adjusted analysis of both operator and hospitals are available to the public. The analysis has not shown any outliers at the 3 standard deviation level (see public reports)[1].

Low volume PCI hospitals

There are a number of NHS and private centres that do not conform to the national guidance of performing a minimum of 400 PCIs per annum[2].

Urgent and emergency PCI

Most centres achieve satisfactory 'door-to-balloon' times for the emergency treatment of STEMI (90% of patients treated within 90 minutes, and 77% within 60 minutes). There is evidence that some centres have improved whilst for others there is definite room for improvement. The recommended standards are not met for many patients requiring an inter-hospital transfer for treatment. Although 85% receive treatment within 150 minutes of a call for help, only 49% meet this target where transfer between hospitals is involved.

However the timeliness of treatment of patients with NSTEMI is generally poor. The median delay to treatment is 69 hours, and as the NICE recommendation is for treatment within 72 hours, over half of all patients are waiting too long for treatment. This is an avoidable cause of prolonged length of stay and increased treatment cost. Only 54% of patients having PCI for NSTEMI receive it within 72 hours (as recommended by NICE). Delays are worse for patients who have to be transferred from another hospital for their PCI. There is considerable variance – those with poor times could learn from centres that provide a more rapid service.

Out of hospital cardiac arrest

The optimal management of patients who are successfully resuscitated following cardiopulmonary arrest in the community remains uncertain. Evidence[3] suggests that 80% of patients suffer cardiac arrest at home and 20% in public places. Improved outcomes occur with early resuscitation in the community and the early use of a defibrillator. Guidelines recommend that patients be considered for emergency or urgent angiography and PCI where appropriate. The PCI audit dataset was enlarged to try to capture more information about these patients, and the initial results are presented in this audit. About half of all patients treated by PCI having sustained an out of hospital arrest are self-ventilating by the time they arrive in the catheter lab. The other half needed mechanical ventilatory support, and this amounted to a total of 1,473 patients in 2014. The majority (79%) of these patients presented with ST elevation on their post cardioversion ECG. There was however enormous variability between PCI centres, with these cases representing more than 5% of all PCI activity for some, and almost 0% for others. Although this probably reflects variation in protocol driven investigations for these patients, international guidance supports the treatment of these patients and all centres need to develop a clinical protocol. Of patients having PCI following out of hospital arrest, those needing ventilation had a 30 day mortality of 48% compared with 7% for those who are self-ventilating. Network protocols to enable rapid treatment in the community (before a patient gets to hospital) are likely to improve outcomes.

1. https://www.nhs.uk/Service-Search/consultants/performanceindicators/1024
2. http://heart.bmj.com/content/101/Suppl_3/1.full
3. file://ad.ucl.ac.uk/home/rmhklga/Documents/OHCA_consensus_paper.pdf

Radial arterial access

PCI using radial access rather than the traditional femoral artery access is associated with reduced complications in both observational datasets and randomised trials. PCI operators in the UK have continued to switch to using the radial artery as the default strategy, and in 2014 radial access was used in 75.3% of all procedures; there have been continuous increases in the use of this technique over the last few years. Operators and centres with low radial access rates should review practice.

New stent technology

Current stents are metallic and most also deliver an anti-proliferative drug (drug eluting stents) incorporated into a plastic coating on the stent. These stents remain as permanent intracoronary implants. Newer generation stents have produced better results than earlier drug-eluting stents in recent trials. In addition, there are a number of theoretical advantages to stents where the plastic coating disappears over time as well as for stents that having performed their function of scaffolding a narrowed artery, are then completely resorbed, leaving only native coronary artery tissue behind. The potential advantages of completely bio-resorbable stents need to be weighed against safety concerns. There is evidence of a shift towards using the new generation drug-eluting stents but there is considerable variance between centres. We intend to track the outcomes of the patients treated with the different stents using new variables in the dataset for next year.

Conformance with data completeness

There have been year-on-year improvements in conformance with the data completeness of key fields, but there are still a number of hospitals where the quality of the data received is sub-optimal.

Every year the audit produces an extensive list of analyses relating to various quality indicators and recommendations for a good practice with a comparative data for the participating hospitals as well as comparisons amongst the UK countries. **The full list of analyses can be found on the BCIS website**.

Recommendations

Commissioners and provider Chief Executives

We recommend that:

- PCI activity at individual hospitals reaches the minimum of 400 procedures per year
- Trusts, Strategic Clinical networks and Commissioners work to improve treatment times for patients receiving urgent and emergency care, especially when an inter-hospital transfer is required
- Current service configuration is reviewed for emergency cases with ST elevation MI (a) in hospitals that perform less well than the centres who provide the fastest treatment and (b) for patients where transfer between hospitals is involved
- A review of the clinical pathways for patients with NSTEMI undergoing PCI is undertaken to ensure patients receive timely treatment. This is especially important for those who have to be transferred from one hospital to another for treatment
- There are sufficient resources allocated to support national clinical audit activity

Medical directors and clinical leads

We recommend that:

- Hospitals review their use of radial artery access for PCI and plan the appropriate training to ensure this route is used as the default access route whenever possible
- Hospitals should use those stent technologies that have been shown to provide better outcomes for patients
- All Trusts provide appropriate support to the clinical audit teams. Our data show that a higher level of clinical engagement with the clinical audit team is associated with better data completeness and data quality. Each clinical audit should have a dedicated clinical lead assigned to support this activity
- All operators engage with the national audit programme and their local clinical audit team and to ensure timely submission of accurate data to NICOR
- All operators regularly review their outcomes via the NICOR PCI Operator Outcomes tool for their in-hospital complication rates and other relevant clinical measures
- Clinical and audit teams comply with completion of the new dataset items on cardiac arrest and new stent technology fields in addition to the existing data fields

Clinical audit teams

Everyone who is responsible or in some way involved in PCI audit data collection and submission should:

- Submit their data regularly, at least on a quarterly basis. More contemporaneous data allow more relevant analyses.
- Check that the data submitted to NICOR are accurate and that the reports on your data are consistent with your submitted data; this is especially relevant to those hospitals that use third party software for data submission
- Engage with the reports that are sent to the hospitals on a quarterly basis to check case ascertainment rates and data completeness especially for fields defined in the NICOR Minimum Data Standard. Data completeness should be at a minimum level of 90% but as high as possible
- Regularly review the audit reports sent to the hospital by the NAPCI team to ensure the hospital's performance meets NICE quality standards and recommendations for good practice (see section 1.4 of this report)

1 Introduction

1.1 Coronary heart disease

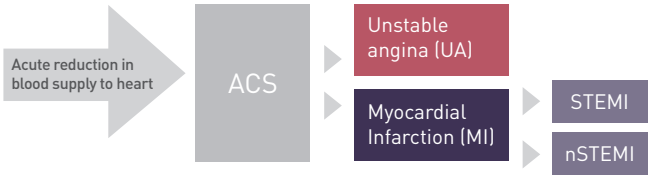
Coronary heart disease (CHD) is the largest cause of death and disability in the United Kingdom. CHD causes around 73,000[5] deaths in the UK each year and around one in five men and one in seven women will die from the disease.

Coronary heart disease is usually caused by **atherosclerosis** which is a process where the walls of the arteries develop fatty deposits called atheroma. Atherosclerosis manifests itself in a number of conditions of which the two conditions below are relevant to this audit:

Stable angina is a symptom that occurs 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 Syndromes (ACS) occur when there is a sudden or recent reduction in the blood supply to the heart and include **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 these syndromes can be distinguished with an **electrocardiogram (ECG)** and blood tests.

Figure 1: Types of acute coronary syndrome



A myocardial infarction (heart attack) occurs when a coronary artery becomes 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.

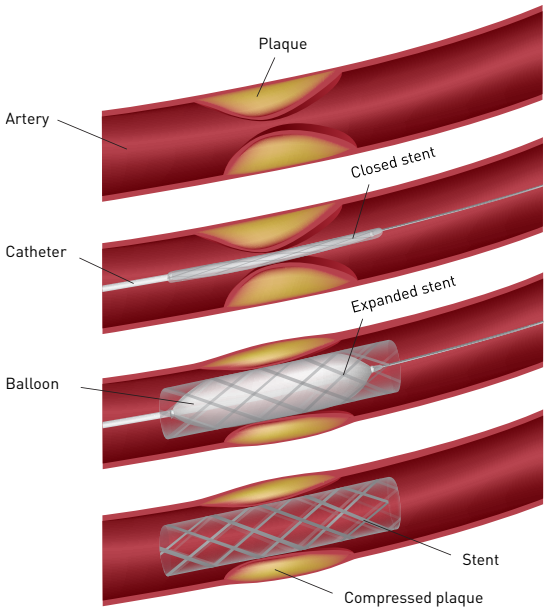
Sometimes the artery becomes partially blocked or only blocked temporarily. The ECG usually does not show ST segment elevation. Shortage of blood supply to the affected heart muscle is less severe or intermittent and may not lead to myocardial necrosis. If it does not then the syndrome is called unstable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

1.2 Percutaneous coronary procedures

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 and it is less invasive than the coronary artery bypass grafting. During the procedure, a small balloon is inserted which, when inflated widens the artery. In most cases a 'stent' - metal mesh scaffold - is implanted to keep the artery wall open.

The PCI procedure



5. http://www.nhs.uk/Conditions/Coronary-heart-disease/Pages/Introduction.aspx

1.3 Guidelines and quality standards

The National Institute for Health and Clinical Excellence (NICE) recommends that PCI is used to manage stable angina[6 7] and acute coronary syndromes[8 9] in three ways:

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

To achieve this NICE have published the following statements:

Quality	Detail
NICE quality standard [QS68] **Quality statement 3**	Coronary **angiography** and PCI is performed within 72 hours for patients with NSTEMI or unstable angina.
NICE quality standard [QS68]**Quality statement 4**	Coronary angiography and PCI for adults with NSTEMI or unstable angina who are clinically unstable as soon as possible or within 24 hours from becoming clinically unstable.
NICE quality standard [QS68] **Quality statement 5**	Adults who are unconscious after cardiac arrest caused by suspected acute **ST segment elevation myocardial infarction (STEMI)** are not excluded from having coronary angiography (with follow–on primary percutaneous coronary intervention [PCI] if indicated).
NICE technology appraisal guidance 71 **Sections 1.1 and 1.5**	Drug-eluting stents for the treatment of coronary artery disease where indicated for patients with small arteries and long lesions.

In addition to NICE guidelines, the British Cardiovascular Intervention Society has published updated recommendations for good practice in 2015[10] of which key recommendations are:

Recommendation	Detail
Institutional facilities	Each **PCI hospital** undertaking emergency PCI cases should have at least two cardiac dedicated catheter laboratories.
Institutional volume	Minimum case volume for a PCI hospital is 400 procedures per year. Minimum of three interventional cardiologists per hospital. Hospitals providing a primary PCI service should perform a minimum of 100 PPCI procedures each year.
Operators volume of cases	Every operator should perform a minimum of 150 cases within a two year period. Operators performing primary PCI procedures should undertake a minimum of 50 elective or emergency cases per year within the primary PCI hospital.
Monitoring institutional standards	All PCI hospitals are expected to collect comprehensive and accurate data that relate to the interventional treatment they provide for their patients. Regular departmental discussions should include individual case presentations for all unexpected mortality and morbidity. BCIS will provide operators with a detailed breakdown of their own PCI activity that includes **risk-adjusted** outcome analysis.

Other standards/ recommendations	Detail
Data from a number of randomized trials and multiple registries[11]	There is increasing evidence that arterial access via the radial route is associated with a reduction in bleeding complications

6. https://www.nice.org.uk/guidance/cg126/chapter/guidance#investigation-and-revascularisation
7. https://www.nice.org.uk/guidance/qs21
8. https://www.nice.org.uk/guidance/cg167/chapter/recommendations
9. http://www.nice.org.uk/guidance/QS68
10. http://heart.bmj.com/content/101/Suppl_3/1.abstract?etoc
11. J Am Coll Cardiol. 2014;63(10):973-975.doi:10.1016/j.jacc.2013.09.066

1.4 National Audit of Percutaneous Coronary Interventions (NAPCI)

1.4.1 The role of the audit

Clinical audit is the process of monitoring the care and treatment of patients against agreed national and international standards, 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. The audit has collected patient level data nationwide since 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 and their coverage, number of PCI procedures per centre and population, number of operators in each centre, etc.)
- Appropriateness of 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/survival

1.4.2 Project governance

The audit is managed by the National Institute of Cardiovascular Outcomes Research (based at University College London) and is clinically led by the British Cardiovascular Intervention Society.

The British Cardiovascular Interventional Society provides intellectual and clinical leadership of the audit. In 2014 the BCIS Data Monitoring and Audit Group has expanded its membership to include patient representatives, participating hospitals and representatives from the MHRA, a regulatory body. The audit is referred to as the National Audit of Percutaneous Coronary Interventions (NAPCI).The Steering Group meets three times a year (see appendix 4 for its membership).

The Steering Group's remit is to:

- Provide leadership on the aims and delivery of the project, dependent on allocation of resources, in collaboration with the British Cardiovascular Intervention Society and to ensure the agreed reports are published
- Ensure that the project is aligned with the evolving needs within the clinical specialty
- Review 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 is not meeting those standards
- Review applications to use the audit data for research or other quality improvement programmes outside of NICOR
- Review the dataset for potential changes to ensure it remains up to date in the context of an evolving evidence base

The NAPCI audit is commissioned by the Healthcare Quality Improvement Partnership (HQIP). HQIP holds commissioning and funding responsibility for this and several other national clinical audits.

1.4.3 Methodology

NAPCI is a continuous audit and collects information about all percutaneous coronary intervention procedures performed in all NHS hospitals and the majority of private hospitals (more information about the participation can be found in section 2.1) in the UK (England, Wales, Scotland and Northern Ireland). The data are collected at the hospital level, including in the instances where more than one participating hospital is part of the same trust.

In addition to percutaneous coronary intervention (deemed to have taken place if any coronary device such as a guide wire approaches, probes or crosses one or more **coronary lesions**, with the intention of performing a coronary intervention), the audit also collects information about the use of diagnostic interventional procedures such as pressure wire measurement, or the use of intracoronary imaging where no PCI ensues. There have been concerns about the overuse of PCI in patients with stable coronary disease. Trial results[12] have shown improved outcomes with appropriate use of adjunctive technologies such as pressure wire assessment of lesions and the use of intravascular ultrasound.

Data can be either entered manually via a dedicated interface (web-based application) or imported from existing hospital clinical information 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 ID and password.

In addition to clinical data, the audit also collects patient identifiable information to allow for the datasets to be

12. http://eurheartj.oxfordjournals.org/content/ehj/35/37/2541.full.pdf

linked with external datasets such as the Office for National Statistics for mortality analysis. NICOR has permission from the Confidentiality Advisory Group[13] to collect and store this information without patient consent.

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. In addition, NICOR staff recognise that confidentiality is an obligation and regularly undergo information governance training to ensure understanding of the duty of confidentiality, how it relates to patient information and the data that are held and handled at NICOR.

1.4.4 Data quality, data completeness & case ascertainment

External data validation is not possible. We intend to explore the suitability of HES data in this regard. Currently, case ascertainment rates are based on the self-reported data via an annual survey that requests information about total number of cases performed. Each participating hospital is also encouraged to undertake a systematic validation of case ascertainment rates, data completeness and the quality of data that they submit to NICOR. Hospitals are sent automated reports from NICOR on a quarterly and monthly basis that provides feedback on data completeness as well as aggregate data of relevant clinical indicators.

In addition, the audit has defined a minimum data standard[14] that comprises those fields most important in the analysis of key quality indicators and the analysis of risk adjusted outcomes. Hospitals are required to meet a minimum of 90% data completeness for these fields. The results of data completeness for the fields in question are available in appendix 2.

1.4.5 How we analysed the data

Data held within the secure storage environment at NICOR were extracted and provided to the information analyst. Because the analyst did not need to access personal identifiers for this work, personal identifiers in these data were replaced with codes prior to distribution.

The data provided by hospitals do not always adhere to the technical standards of the audit. The data are first processed to reduce the effect of deviation from the audit's standards and to maximise their usability for analysis. Analysis proceeds on cleaned data.

The data cleaning and analysis processes described in this report were performed in the R statistical programming language (version 3.2.2, released on 14 August 2015). R is today the sixth most popular programming language in the world, well above its competitors Matlab (ranked 10th) and SAS (26th). NICOR's Analysis Team standardised around the use of R across all national audit work in 2011. The PCI audit benefits from this standardisation as code snippets, data structures and analysis frameworks are shared among team members, resulting in more sophisticated analysis and presentation in shorter time frames.

The PCI data cleaning and analysis processes use the R package pmgr, written and maintained by NICOR's Senior Information Analyst. Data that do not fit the standards for each field are transformed when possible to make them usable for analysis. On rare occasions, multiple copies of records for the same procedure are found to be duplicated and so stored twice or more in the database. Duplicate records are identified and removed prior to analysis.

Most of the analyses available in this report are descriptive statistics. They are calculated using standard modules within the R programming framework. Tables and graphics are also prepared within R, and then exported for inclusion in this report. **Funnel plot** methodology is used to determine whether results from individual centres are within agreed boundaries. A more detailed explanation about the statistical methodology is available on request.

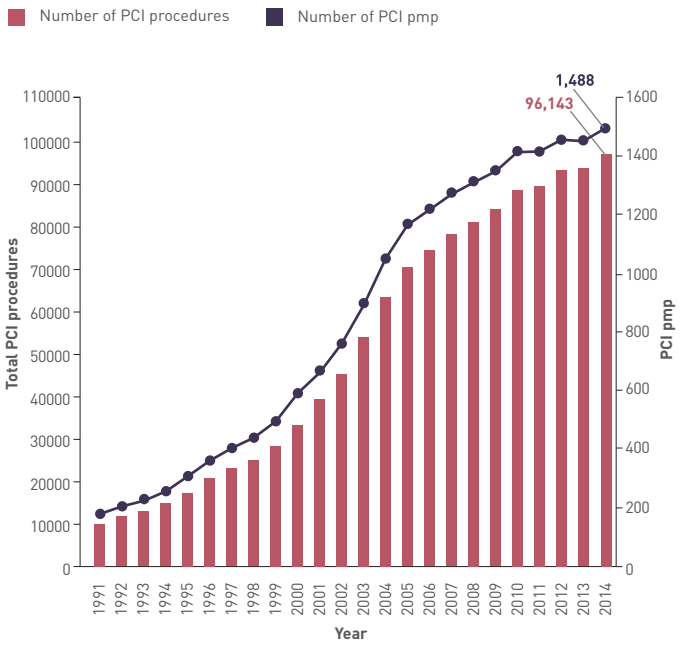
13. http://www.hra.nhs.uk/research-community/applying-for-approvals/confidentiality-advisory-group-cag/

14. http://www.ucl.ac.uk/nicor/audits/adultpercutaneous/datasets

2.1 PCI activity and structure

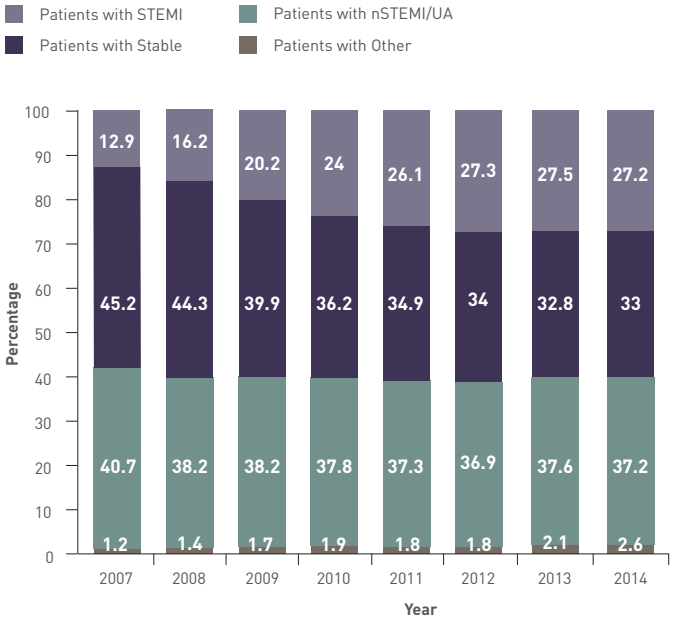
The optimal rate of PCI per million population (pmp) is difficult to judge and is dependent on many factors, including the varying characteristics of populations in different countries. While the rate of PCI pmp in the UK has, historically, been considerably lower than most other European countries, there have been steady increases in activity. A total of 96,143 PCIs were performed from January to December 2014 compared with 92, 589 in 2013. This represents rate of 1,488 PCI pmp in 2014 compared to 1,444 pmp in 2013 (see Figure 2 for temporal trends).

Figure 2: Temporal trends of PCI numbers and per million population rates (pmp)



Primary PCI is established across most of the UK as the default treatment for ST elevation MI and represents about 27% of all PCI activity (see Figure 3), and for most regions in the UK represents a rate of between 300 and 500 pmp (Figures 4a & 4b) which is comparable to the rates in other European countries[15]. There are 69 PCI centres in the UK to whom ambulances bring patients with STEMI to be treated by primary PCI.

Figure 3: Proportion of different indications for all PCIs performed each year



15. Eur Heart J. 2014 Aug 1;35(29):1957-70. doi:10.1093/eurheartj/eht529. Epub 2014 Jan 12.

Figure 4a: Rate of primary PCI pmp by each Local Area Network over the last 5 years

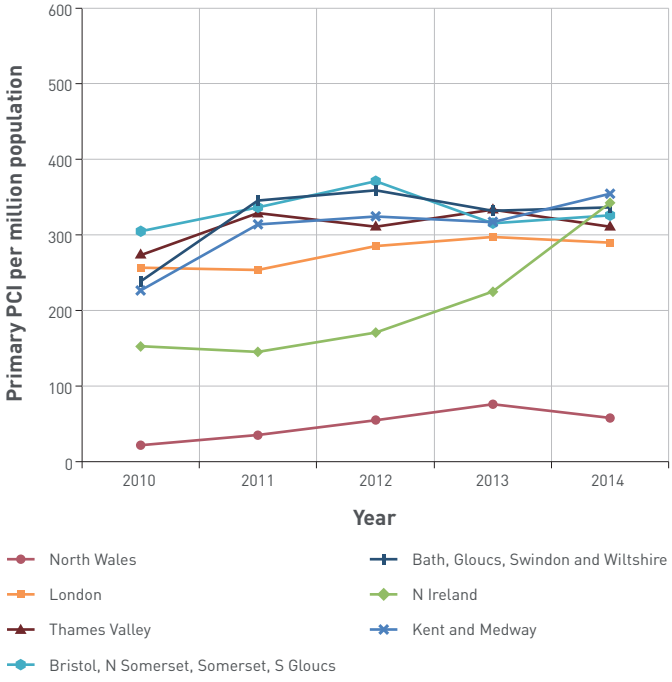


Figure 4c: Rate of primary PCI pmp by each Local Area Network over the last 5 years

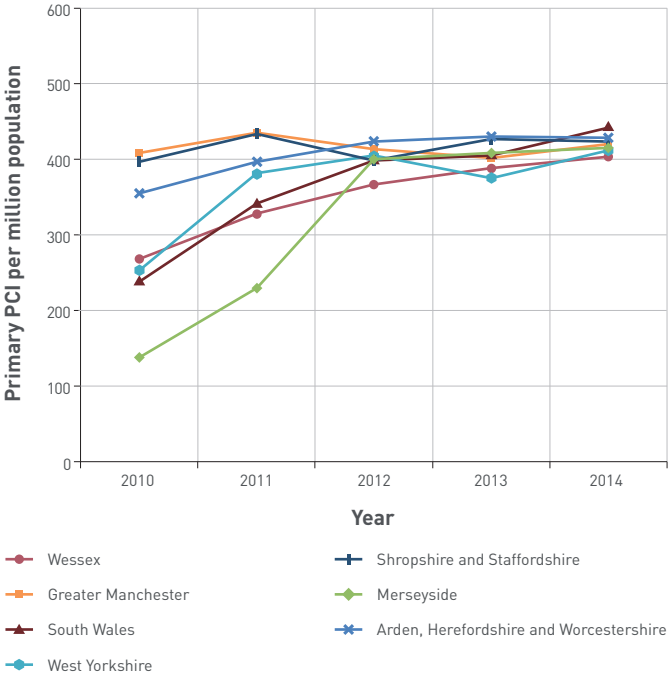


Figure 4b: Rate of primary PCI pmp by each Local Area Network over the last 5 years

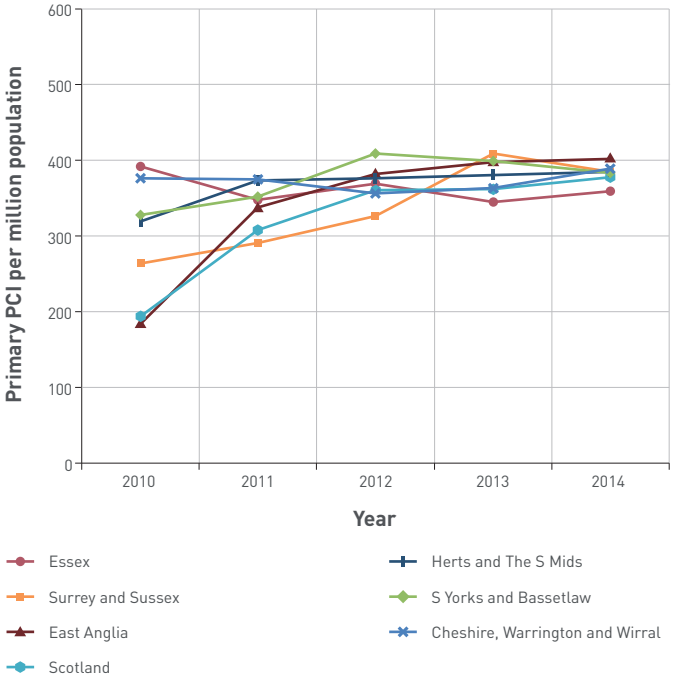
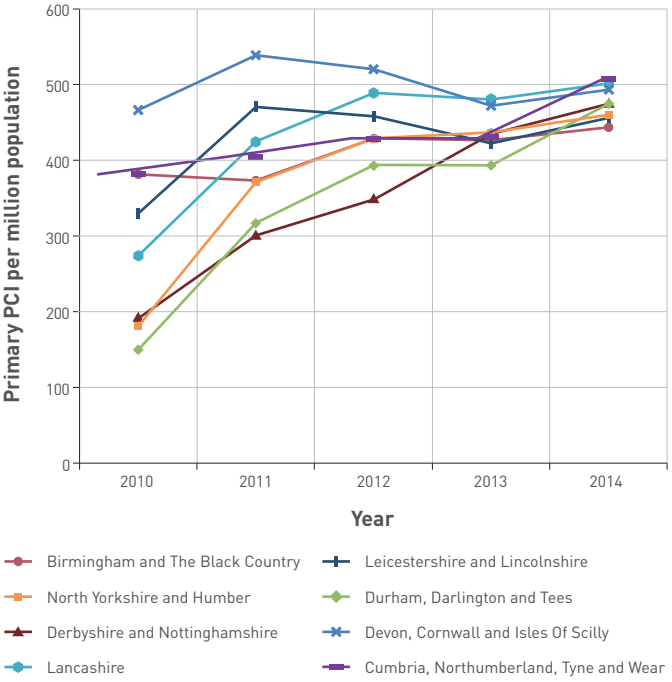


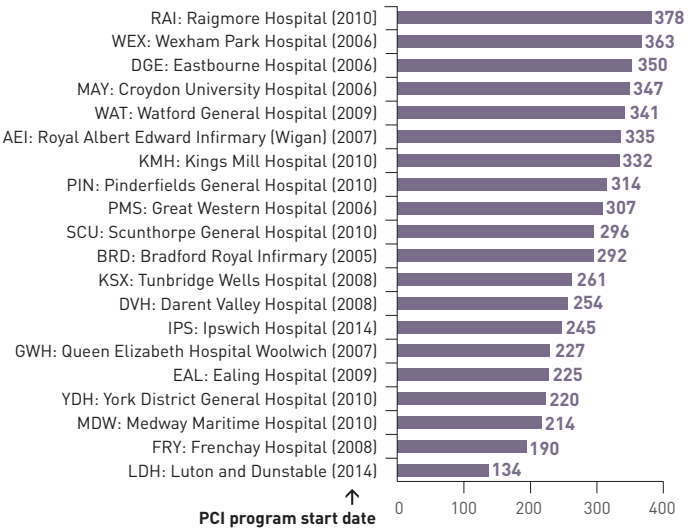
Figure 4d: Rate of primary PCI pmp by each Local Area Network over the last 5 years



16. http://heart.bmj.com/content/101/Suppl_3/1.abstract?etoc

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'[16] recommend that centres undertake at least 400 PCI procedures each year. In 2014, 20% of NHS PCI centres performed 400 or fewer cases compared with 22% in 2013. Nevertheless all but 2 NHS centres performed over 200 cases (Figure 5). 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.

Figure 5: Hospitals that performed less than 400 PCIs in 2014 with a year the PCI activity started



BCIS also recommends that every operator should perform a minimum of 150 cases within a two year period. The information about the individual operator PCI activity is available on the BCIS website.

There are several possible reasons why operators may be recorded with a low procedural volume. It may genuinely reflect their practice. They may have only been appointed as a consultant part way through the year in question. They may have suspended their work due to pregnancy, or by taking a sabbatical.

2.2 Patient demographics

Patients that are treated by PCI have a mean age of 65 on average, 75% are male. Female patients treated with PCI tend to be slightly older with an average age of 69 years.

Patient outcomes are often influenced by other factors in addition to the care provided and some of those characteristics are presented in Table 1. Smoking is one of the risk factors that affects patient outcomes. The British Heart Foundation reports that smokers are almost twice as likely to have a heart attack compared with those that never smoked as smoking damages the lining of the arteries predisposing to the build-up of atheroma resulting in narrowed arteries, and also increases the likelihood of blood clotting in the arteries. There appears to be a small reduction in the patients who are current smokers and the rate of those that never smoked has increased slightly.

The rate of patients who have previously had PCI is steadily increasing as this treatment becomes more prevalent. The rate of patients with diabetes has also increased over the last few years.

Table 1: Summary of patient demographics (mean) between 2007 and 2014

	2007	2008	2009	2010	2011	2012	2013	2014
Age (mean)	63.6	63.8	64.2	64.3	64.6	64.8	64.9	65.1
Sex (male)	73.8%	74%	74.1%	74.2%	74.1%	74.1%	74.2%	74.3%
Diabetic	17.5%	18.2%	18.3%	18.7%	19.1%	20.2%	20.8%	21%
Previous CABG	8.6%	9.2%	8.7%	8.6%	8%	8.3%	8.6%	8.4%
Previous PCI	18.4%	20.6%	21.7%	22%	22.7%	23.5%	24.7%	25.6%
Previous MI	29.6%	30.1%	28.8%	28.2%	27.6%	26.8%	27.3%	27.4%
Current smoker	24%	24.2%	25.9%	26.4%	26.1%	25.4%	25.2%	24.4%
Ex-smoker	40.1%	40.7%	40%	38.7%	37.1%	36.8%	37.7%	37.3%
Never smoked	35.8%	35%	34.1%	34.9%	36.8%	37.8 %	37.1%	38.2%

2.3 Clinical practice

2.3.1 Urgent and emergency procedures

Emergency procedures are procedures which are most effective if they are performed as soon as possible after the patient becomes ill. Urgent procedures are procedures that are necessary over the next day or so, within this period of hospitalisation, but not needed immediately. Urgent and emergency treatment applies to patients with an acute coronary syndrome (see Table 2).

Table 2: Description of acute coronary syndromes

Acute coronary syndrome	ST segment elevation (STEMI)	ST-elevation usually indicates complete blockage of a coronary artery and, in most cases, warrants immediate treatment to re-open the artery. Also known as heart attack.
	Non-ST segment elevation (nSTEMI)	nSTEMI is another type of a heart attack but usually there is only partial occlusion of the coronary artery. Treatment with PCI is not usually needed immediately but is used over the next few days.
	Unstable Angina	Sometimes the artery becomes partially blocked or only blocked temporarily. The ECG may be abnormal but 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.

Patients with STEMI

Patients with STEMI are treated by an emergency procedure called primary PCI for which the NICE guideline[17] recommends that patients receive primary PCI within 90 minutes from arrival at the PCI hospital. This is measured as the **door-to-balloon time (DTB).** The European guideline[18] on the other hand recommends a shorter timeline with a door-to-balloon time of 60 minutes or less from arrival at the PCI hospital. In 2014 average percentage of patients being treated within 60 minutes from arrival at a PCI hospital was 77% compared with 90% within the 90 minute target (see Figures 6 and 7).

17. https://www.nice.org.uk/guidance/QS68/chapter/Quality-statement-6-Primary-PCI-for-acute-STEMI

18. http://eurheartj.oxfordjournals.org/content/ehj/35/37/2541.full.pdf

Figure 6: Percentage of patients who received primary PCI within 90 minutes from arrival at the PCI hospital. The blue line in the middle represents the national average which is 90%. (See Appendix 1 for hospital codes and their corresponding names.)

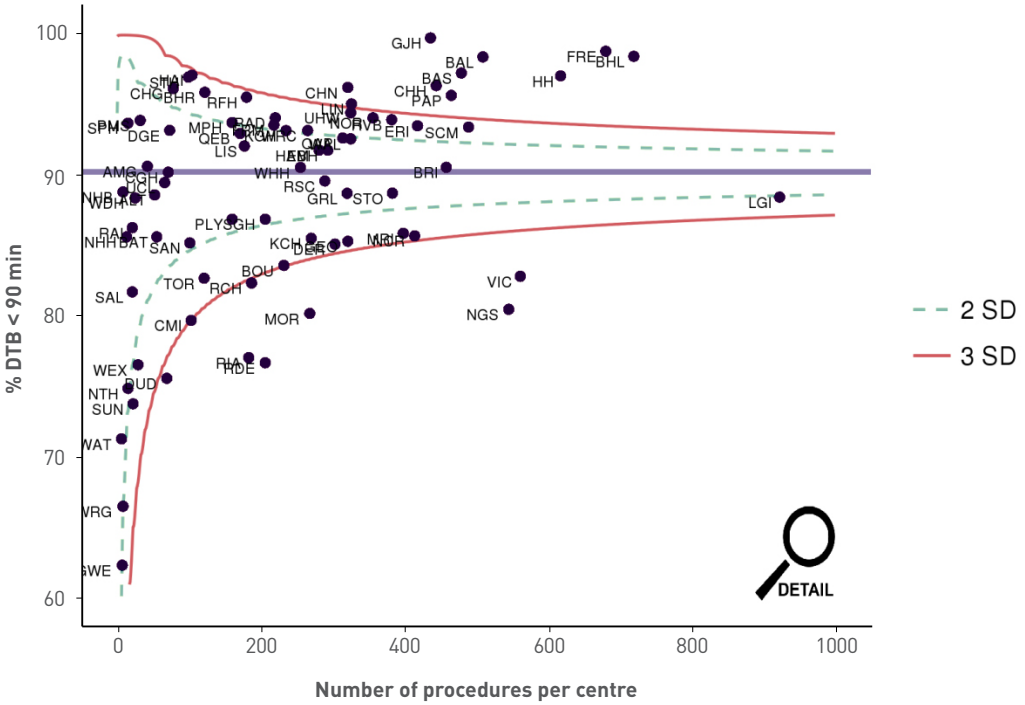
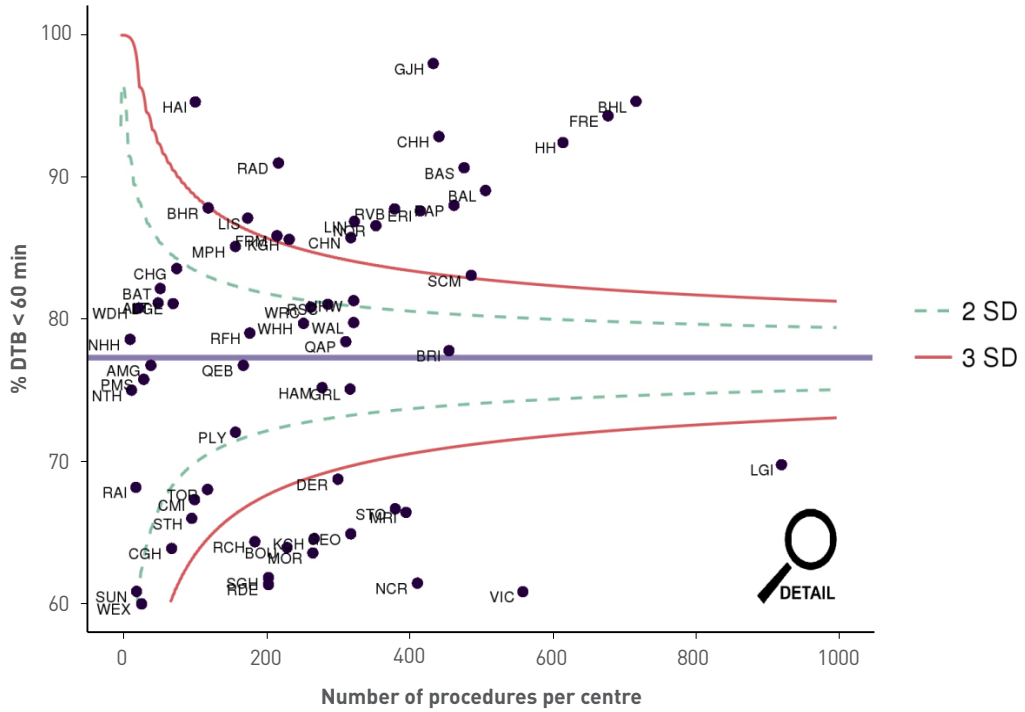


Figure 7: Percentage of patients who received primary PCI within 60 minutes from arrival at the PCI hospital. The blue line in the middle represents national average which is at 77 %. (See Appendix 1 for hospital codes and their corresponding names.)



There is room for improvement for a considerable number of hospitals for the DTB standard whether the NICE or European guidelines are used.

Patients with nSTEMI/unstable angina

Coronary angiography is a diagnostic procedure that is important in determining the extent and severity of the coronary disease. NICE guidelines[19] published in September 2014, recommend that once a diagnosis of NSTEMI is made, coronary angiography should be offered, when appropriate, within 72 hours of first admission. This may lead to revascularisation 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[20]. The audit tracks patients with UA/NSTEMI who end up being treated by PCI.

Figure 8 shows that only the average percentage of patients treated within the 72 hour timeline within centres is only 54%.

19. https://www.nice.org.uk/guidance/QS68 chapter/Quality-statement-3-Coronary-angiography-and-PCI-within-72-hours-for-NSTEMI-or-unstable-angina20.

20. http://www.gracescore.org/WebSite/About.aspx

Figure 8: Percentage of patients with nSTEMI who were treated with PCI within 72 hours from admission regardless of method of admission i.e. whether they were admitted directly to the PCI hospital or were admitted to a non-PCI hospital first.
Data for individual centres will vary depending on the proportion of patients admitted directly or transferred from another hospital. (See Appendix 1 for hospital codes and their corresponding names.)

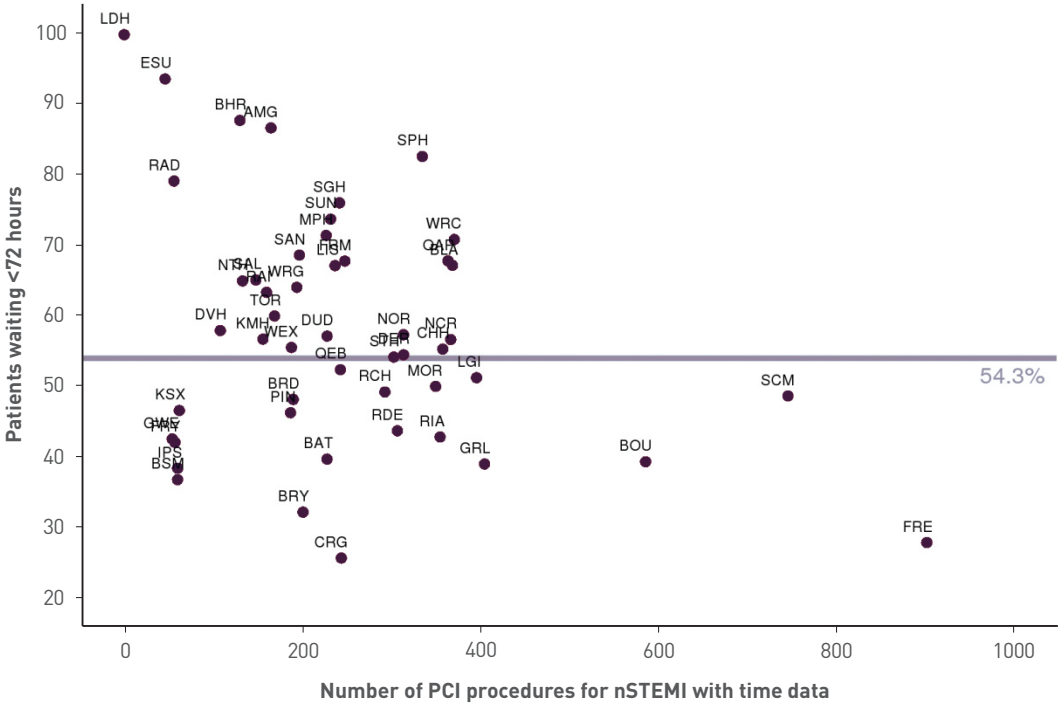
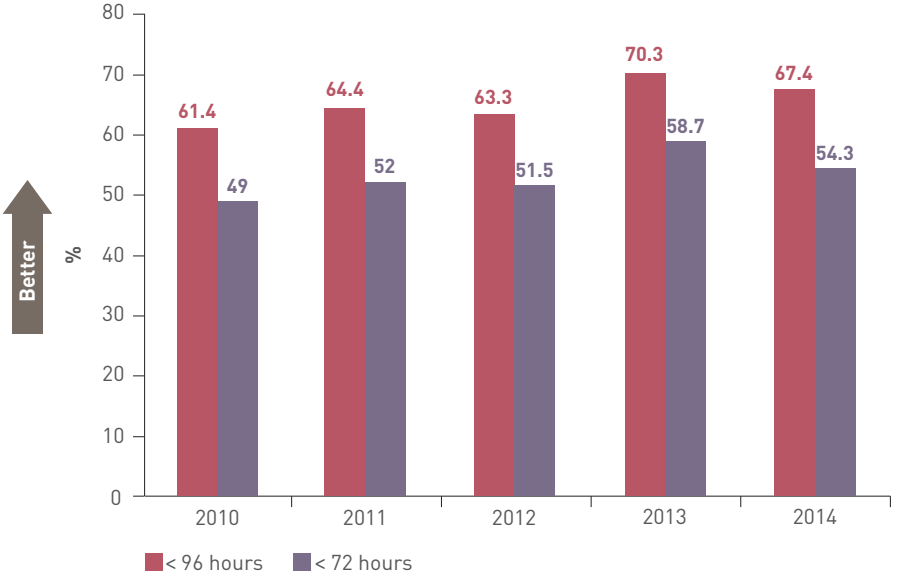


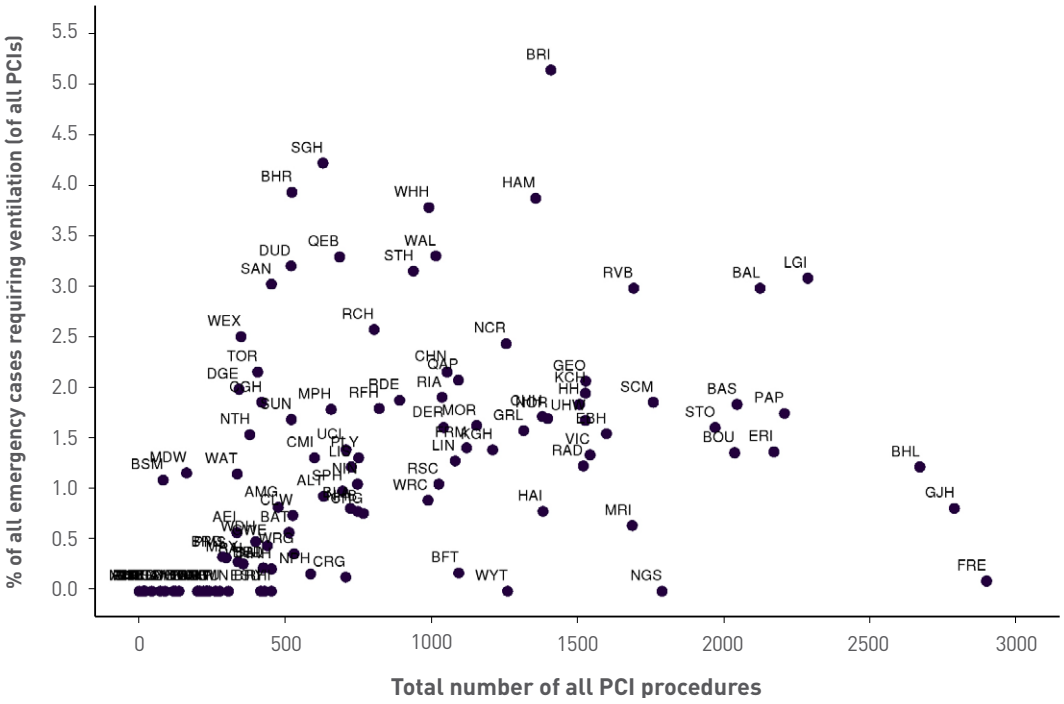
Figure 9: Percentage of patients with nSTEMI that received PCI within 96 hours compared with 72 hours from the time of admission to the first hospital with temporal trends over the last five years



It is not surprising that the method of admission plays a role in the delays that patients face for angiography and PCI. The audit data found that those who are admitted to a non-PCI hospital first and then are transferred wait 82 hours on average for their PCI compared to those that are admitted to the PCI hospital directly where the wait is on average 61 hours (Figure 9).

2.3.2 Out of hospital cardiac arrest

Figure 10: Percentage of patients who were ventilated before the procedure (the majority are patients who have sustained out of hospital cardiac arrest). (See appendix 1 for hospital codes and their corresponding names.)



The optimal management of patients who are successfully resuscitated following cardiopulmonary arrest in the community remains uncertain. The PCI audit dataset was enlarged to try to capture more information about these patients, and the initial results are presented in this audit. About half of all patients treated by PCI having sustained an out of hospital arrest are self-ventilating by the time they arrive in the catheter lab. The other half needed mechanical ventilatory support, and this amounted to a total of 1,473 patients in 2014. The majority (79%) of these patients presented with ST elevation on their post **cardioversion** ECG. There was however enormous variability between PCI hospitals, with these cases representing more than 5% of all PCI activity for some, and almost 0% for others (Figure 10). Although this probably reflects variation in protocol driven investigations for these patients, international guidance supports the treatment of these patients and all centres need to develop a clinical protocol. Of patients having PCI following out of hospital arrest, those needing ventilation had a 30 day mortality of 48% compared with 7% for those who are self-ventilating.

2.3.3 Radial arterial access

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. PCI using radial access rather than the traditional femoral artery access is associated with reduced complications in both observational datasets and randomised trials. PCI operators in the UK have continued to switch to using the radial artery as the default strategy, and in 2014 radial access was used in 75% (as can be seen in Figure 11) of all procedures; there have been continuous increases in the use of this technique over the last few years.

Figure 11: Temporal trends of use of radial artery as access route

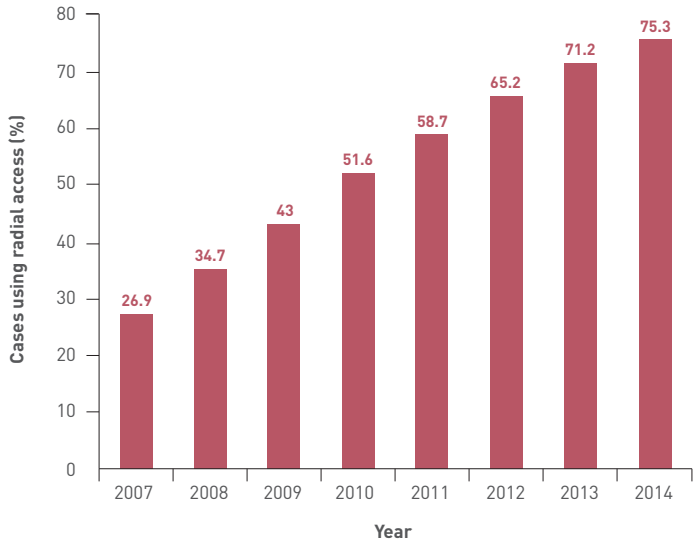
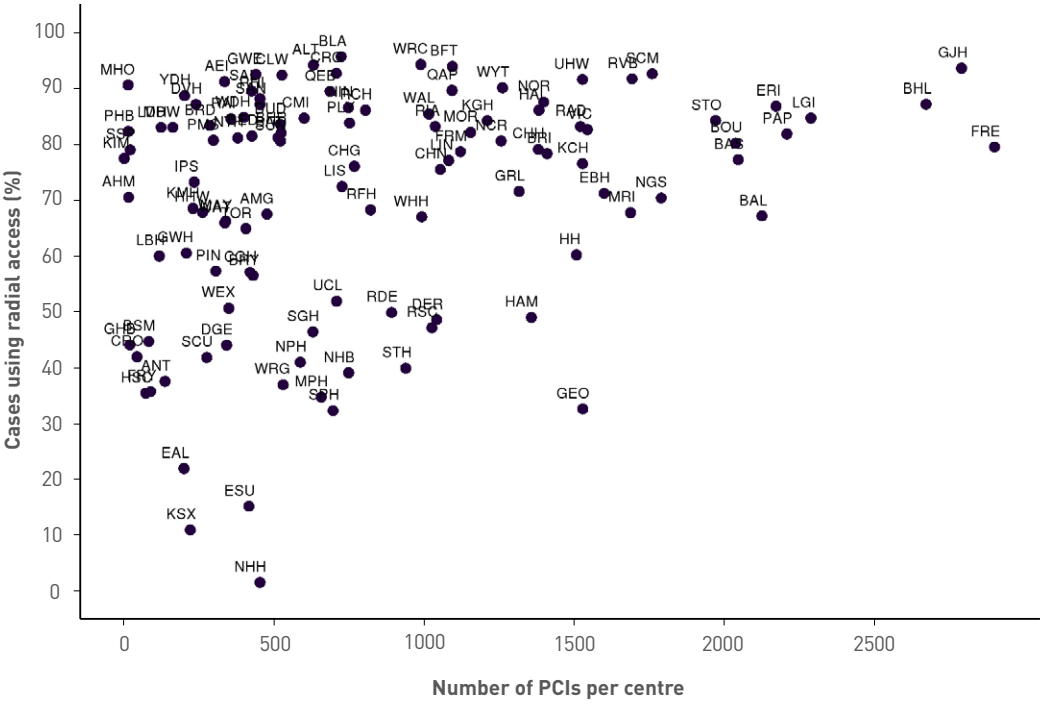


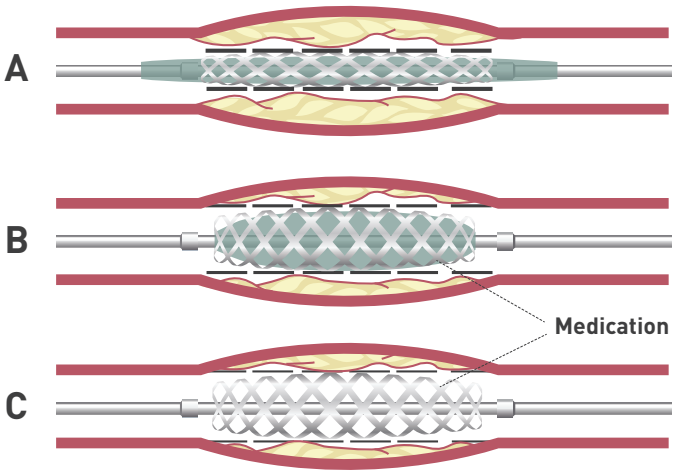
Figure 12: Percentage of patients where the radial artery access was used in individual hospitals. (See appendix 1 for hospital codes and their corresponding names.)



Although there has been an enormous increase in the use of this technique there is still a large variation in the use of this approach between different PCI centres (see Figure 12 and Table 4 in the appendix 3). The operator level data for radial access are available on the BCIS website.

2.3.4 New stent technology

The National Institute for Health and Care Excellence (NICE) recommends 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. There are some cases that do not need or cannot be treated with stents.



Drug eluting stents were developed to reduce the risk of treated arteries becoming re-narrowed. Data from multiple trials has confirmed that these devices are associated with improved outcomes, and that 'second generation' stents have better outcomes than first. The audit confirms a switch to second generation drug eluting stents. The only disadvantage of drug eluting stents is that a patient needs to be treated with anti-thrombotic drugs for longer than if they are treated with plain metal stents. Where a patient is at risk of bleeding, or needs an urgent operation, bare metal stents may be favoured.

While there has been a gradual increase in use of drug eluting stents since 2007, with 86% of cases being treated with drug eluting stents in 2014, there remains variance in their use across different centres and countries which may be explained by **case mix** and also financial pressures because drug eluting stents are more expensive (Figures 13 and 14).

Figure 13: Use of drug eluting stents in PCI

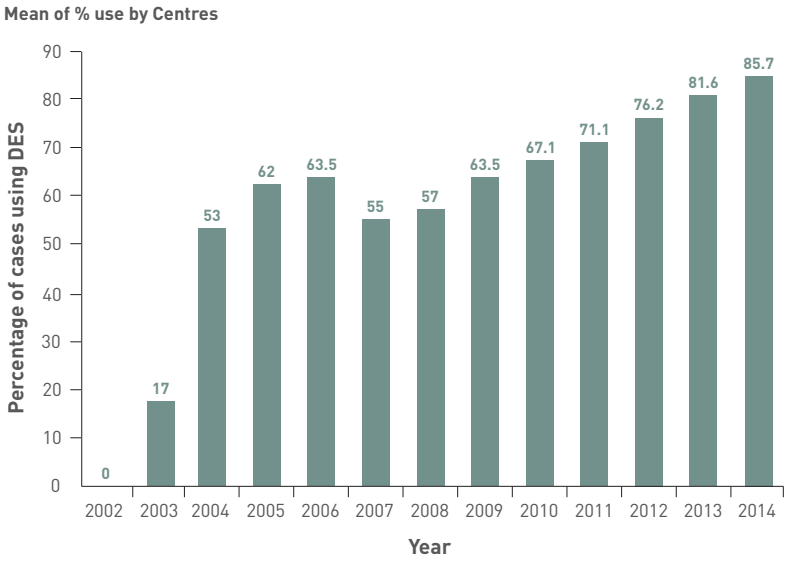
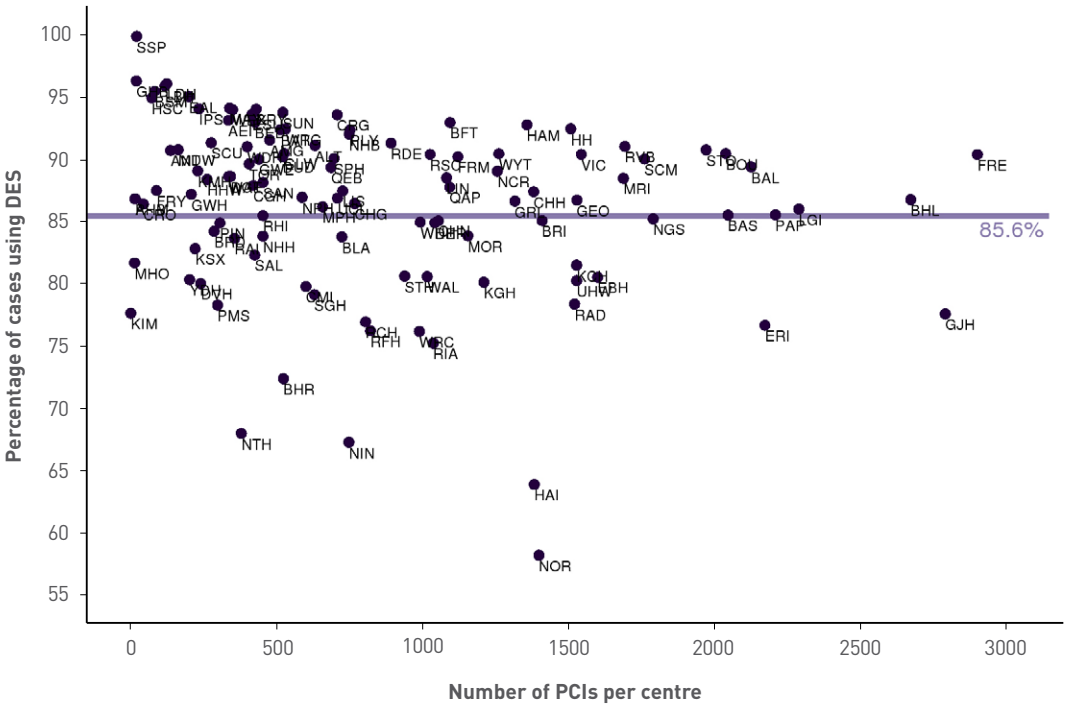


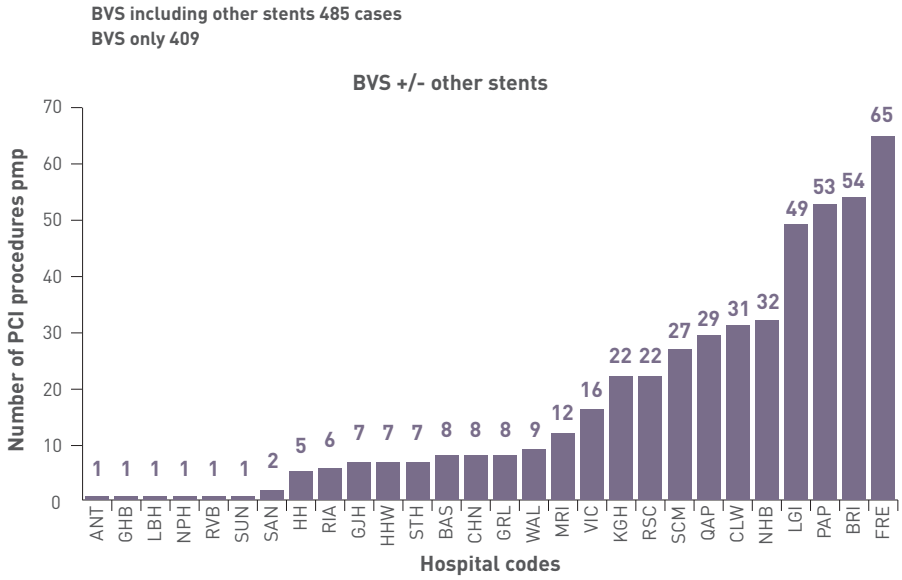
Figure 14: Use of drug eluting stents in PCI hospitals in the UK. (See Appendix 1 for hospital codes and their corresponding names.)



Recent trials demonstrate that newer generation drug-eluting stents are associated with slightly better outcomes for patients. There are a number of technological changes underway. Some stents are now designed where the plastic coating that contains the **anti-proliferative drugs** dissolve away over time. Other stents have been designed where the anti-proliferative drugs can be put on to the metallic stents without the need for a plastic coat.

Bio-absorbable vascular scaffolds (BVS) are another new technology. Once the artery has healed after a PCI, there should be no on-going need for a scaffold, though metal stents remain in position as permanent implants. The concept behind bio-absorbable vascular scaffolds is that they are eventually completely resorbed leaving no residual implanted material. Early data are encouraging, but the precise role for these devices has yet to be defined. In 2014, 485 cases were performed using these bio-absorbable devices (Figure 15). We will be following the longer term outcomes from these procedures in this audit.

Figure 15: Hospitals and their use of bio-absorbable vascular scaffolds (BVS) in PCI. (See Appendix 1 for hospital codes and their corresponding names.)



2.4 Patient outcomes

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 2014, the rate of requirement for emergency surgery remains very low at less than 0.06%. The incidence of stroke also remain low at less than 1% of all PCI procedures.

The overall rate of death in hospital following PCI has gradually increased over the years as sicker patients have been treated (particularly those with STEMI). The mortality of patients treated for similar clinical syndromes however has remained level. In the last 3 years case mix has become more stable because primary PCI had been almost fully implemented across the UK. As a result the overall in-hospital mortality has stabilised. 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 2014, in-hospital mortality following PCI for stable symptoms was 0.11%, following PCI for UA/NSTEMI was 0.7%, and for STEMI 5.3%. In the very sickest patients, who present with extremely damaged heart muscle, and are describes as being in cardiogenic shock, mortality was about 31%.

Nevertheless adverse outcomes will also depend on the quality of care given and the timeliness of treatment. 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 which is known as the Consultant Outcome Publication. Outcomes are analysed using risk adjustment techniques to account for differences in case mix.

For the third year running, the audit shows that PCI practice with regard to the complication rates i.e. freedom from **MACCE** rates following PCI meets the expected standard.

In addition this year 30-day **survival after a procedure** was analysed at both the operator and the hospital level. This analysis made use of the records of deaths in England and Wales held by the Office of National Statistics. Again the findings are reassuring in that the survival rates for all operators and PCI centres in the UK are within the expected standards.

You can check individual hospital or specific operator outcome results on the BCIS website.

3 Use of audit data

3.1 National reporting

The audit and its dataset were designed in a way that allows reporting at the national level and inter-hospital comparisons. In the table there are examples of various activities and purposes for which audit data had been used to date:

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.
British Cardiovascular Intervention Society	PCI centre and Individual PCI Consultant operator outcome reports [21] Comprehensive analysis of annual audit data from 1992 to present [22]
Transparency of data	Data underpinning some of the summary reports are published on **data.gov.uk** website.
Quality accounts	Department of Health Quality Accounts 2014/15: 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.
NHS England Service Level Markers	Clinical Service Quality Markers is a programme of work that aims to provide better, more accessible information for patients - an 'at a glance' indication of how well services are performing and meeting patients' needs. The intention is to develop composite measures that are based on multiple data items, whilst relying on existing data collections and indicators. The first phase of the project includes the following clinical areas; cancer, cardiac (myocardial infarction), mental health (psychosis and dementia) and musculoskeletal.
NICE Clinical Guidelines	The audit data support the NICE clinical guideline consultation process when required.

3.2 Local reporting and activity

3.2.1 Aggregate data available to participating hospitals

Hospitals that participate in the audit are sent reports with aggregate figures relating to the relevant quality standards on a regular basis. The reports specified in the table below allow hospitals to review their clinical practice on a regular basis and to validate data completeness and data quality of the submitted data. Many have reported using the information from these reports in their local service review or a delay breach meetings where the clinical practice is reviewed against the quality standards.

Hospital performance	'Aggregate reports' are generated by the data submitted to NICOR and distributed monthly to all PCI centres.
	'Delays reports' 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 MACCE and 30-day survival post procedure provide information on the number of actual events compared with predicted events.
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 systematically.

21.http://www.bcis.org.uk/pages/page_box_contents.asp?pageid=774&navcatid=157

22.http://www.bcis.org.uk/documents/BCIS_Audit_2014_07102015_for_web.pdf

3.2.2 Case studies about local use of clinical audit data

Although the dataset was developed to allow for the national reporting, it also serves to facilitate a local review of the quality of care provided by the hospital and individual operators. This section presents some examples of how North Wales Cardiac Centre and University Hospital of North Staffordshire have engaged with their audit data to understand the level of care and services provided to their local population.

North Wales Cardiac Centre

Dr Paul Das	Consultant Interventional Cardiologist, North Wales Cardiac Centre
Ms Catrin Hanks	Manager, North Wales Cardiac Network

A local PCI service was conceived when the first dedicated cardiac catheter laboratory in North Wales opened at Glan Clwyd Hospital in 2006. At that time, North Wales Cardiac Network comprised three independent NHS Trusts, which were amalgamated as a single Local Health Board in 2009. Betsi Cadwaladr University Health Board serves a population of 700 000 spread out over nearly 2500 square miles, including remote rural and coastal communities. Patients were travelling up to 100 miles for PCI in Liverpool and Manchester, and PCI rates were less than 800 per million, some 30% below the UK average. The main driver towards local PCI was to improve access to revascularisation. Another priority of the Health Board has been to repatriate clinical services from North West England, and it was considered important to offer patients a service with the availability of Welsh-speaking staff.

PCI began immediately after the BCIS site visit in February 2009, with three experienced consultant interventionists working in a single laboratory. It was originally envisaged that the service would provide mainly elective PCI, but it soon became clear that there was a large demand for inpatient PCI. In the first year, we performed 450 cases, of which 200 were for acute coronary syndromes. After that, PCI volume stabilised at between 500 and 550 cases per year, with a 65:35 split between acute and elective.

Because of the geographical distance from neighbouring PCI centres and the existing experience of the operators, we were keen to establish a comprehensive local service. Therefore pressure wire and intravascular ultrasound were available from the start, enabling challenging cases such as left main stem and bifurcations to be undertaken. Rotablation was introduced in 2010 and an optical coherence tomography module was acquired in 2013. Each of these developments was supported by a programme of staff training including courses, on-site proctoring, industry support and local audit. A fourth interventionist was appointed in 2014.

The unit is developing expertise in two particular areas: chronic total occlusions and bio-absorbable vascular scaffolds. The CTO programme has expanded over the last three years to include a full range of hybrid and retrograde techniques. In this we have been supported by industry and colleagues from Liverpool Heart and Chest hospital. All operators have gained experience with BVS; we have participated in the Absorb UK Registry as the fifth highest recruiting centre.

The main barrier to further service development was lack of capacity, resulting in unacceptable delays to inpatient treatment. In 2013, following a great deal of work by the Cardiac Network, the Health Board and Welsh Assembly Government agreed to fund a second catheter laboratory. This was supported by a generous charitable donation from the Livesey Foundation in North Wales. We took the opportunity to redesign the service to better serve the needs of both inpatients and ambulant **elective patients**. The unit reopened as North Wales Cardiac Centre in August 2014, boasting a dedicated emergency entrance and a day case lounge. Again, Liverpool Heart and Chest Hospital kindly shared their own experience and ideas with us. We now perform 15-20 PCIs each week and aim to treat stable inpatients within one working day following referral. Over 90% of cases are trans-radial, with nearly all elective patients and 50% of inpatients discharged on the same day.

Although local primary PCI was an early ambition, Wales as a whole has lagged behind the rest of the UK in this respect and it has proved difficult to staff an on-call service. An official weekday PPCI programme was finally launched in June 2015, in collaboration with the Welsh Ambulance Service. This covers the entire region, with air ambulance transfers from as far south as Powys and Ceredigion. A fifth interventionist is joining the unit in autumn 2015, and we hope to expand to a full 24/7 service in 2016. This will be supported by a team of dedicated specialist cardiac nurses.

Originally, data were collected on the CVIS database and uploaded to BCIS. This provided comprehensive data for local audit and enabled us to rank highly in levels of data completeness. A Centricity Cardio Workflow database was introduced when the new centre opened in 2014. This has the advantage of linking images to reports, and facilitates image export. The transition has not been entirely smooth, and we appointed a dedicated audit officer in 2015 to co-ordinate this process and ensure that our internal audit is robust and complete.

From the start, we were aware that offering patients local PCI alone was not enough. The service had to be not only convenient but also of similar scope and quality to the high standard already available in Liverpool and Manchester. The annual Consultant Outcomes Publication of risk-adjusted operator and unit outcomes has enabled us to monitor and demonstrate this, and provided a template for internal audit to improve the service. The PCI Audit has been an invaluable resource, providing reliable data to predict and plan our activity and to benchmark our performance against other units.

University Hospital of North Staffordshire

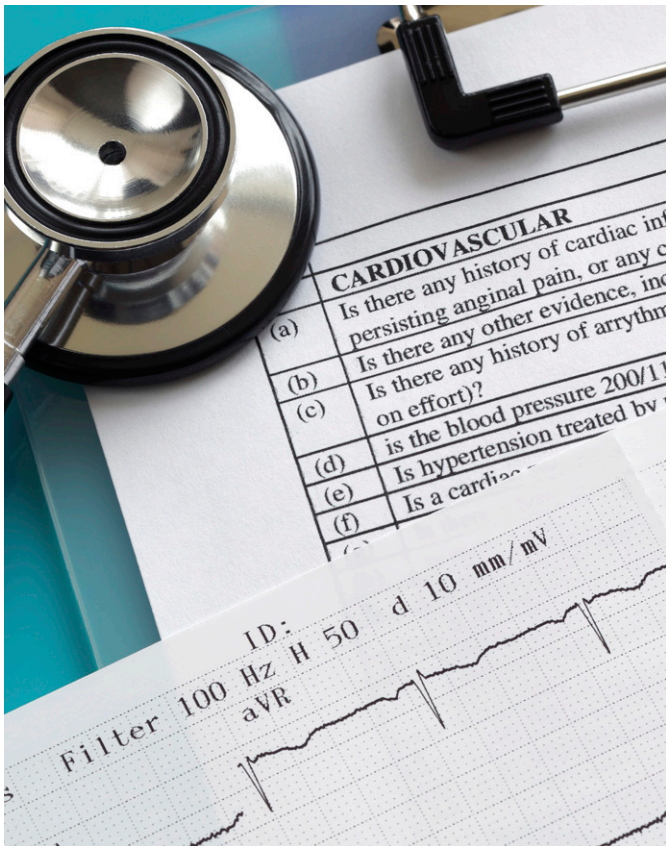
Dr Adrian Large	Consultant Cardiologist and Audit Clinical Lead, University Hospital of North Staffordshire
Adrian Shufflebotham	Cardiology Information Analyst, University Hospital of North Staffordshire

The cardiology service at the University Hospital of the North Midlands (UHNM) offers adult tertiary cardiac care for a population of between 1.5 and 2 million. The unit has taken part in the BCIS PCI national audit since 2006 and data on the unit's overall activity are presented and discussed yearly at a meeting open to all clinical staff. A primary PCI service for acute ST-elevation MI was introduced in early 2007 and currently the unit undertakes more than 2000 PCI cases per year. In the last 10-years the unit has grown exponentially in all areas and during this period PCI clinical audit data, collected as part of the BCIS national audit programme, have been regularly used to support critical review of practice, promote learning and drive improvements in quality of care and outcomes for our patients with ischaemic heart disease.

The improvements brought about by systematic audit have been numerous. Some are very well defined and very specific, for example benchmarking our door-to-balloon times in primary PCI allowed us to identify room for improvement in cases sent from neighbouring district hospitals. This has led to a program of work undertaken jointly with the ambulance service and neighbouring colleagues to streamline patient pathways. Other benefits, which are at least partially attributable to rigorous clinical audit, are less well-defined but no less valuable. A culture of openness to peer review has developed which allows frank but constructive debate about individual operator practices and outcomes. A tacit agreement seems to have been reached that our goal is to provide the best quality care for all patients passing through the PCI service using any and all means available, including the forsaking of individual operator egos when necessary. This attitude nurtures effective teamwork and collaboration between operators, particularly on challenging cases.

Furthermore, pathways of care have been standardised based on sound evidence to reduce the risk of human error and minimise idiosyncratic practices.

We believe that our taking part in the National Audit of Percutaneous Coronary Interventions has served our patients very well to date, and we look to the future with enthusiasm tainted by a modicum of concern. Clinical audit will become an increasingly important part of assuring heart disease patients of high-quality care but it will only be of value If it is conducted rigorously, is fully supported and suitably resourced. There are no signs of patient numbers decreasing and treatment options are becoming ever more complex. Rigorous audit is resource hungry and whether or not the NHS will have afforded truly meaningful, widespread clinical audit over the next 10 years remains to be seen.



4 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 and timeliness of submission of data to NICOR.

In 2016/17 we plan to...

Improve the variety of reports available to individual PCI Consultant Operators to allow them to monitor their practice and outcomes

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

Promote transparency: We will continue to publish process and outcome data for all PCI Consultant Operators in the UK on the BCIS website. In 2014, all PCI consultant risk adjusted MACCE rates were within the expected range which is extremely reassuring and shows that in the UK a safe and high quality service is being delivered. We will continue to identify areas where there is scope for improvements in both processes and outcomes

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: http://www.ucl.ac.uk/nicor

Appendix 1 List of participating hospitals & codes

NICOR code	Hospital name	Type	Country
AEI	Royal Albert Edward Infirmary (Wigan)	NHS	England
AHM	BMI Alexandra Hospital	Private	England
ALT	Altnagelvin Hospital	NHS	Northern Ireland
AMG	Wycombe Hospital	NHS	England
ANT	St Anthony's Hospital	Private	England
BAL	London Chest Hospital, Barts Health NHS Trust	NHS	England
BAS	Basildon and Thurrock University Hospitals, Essex Cardiothoracic Centre	NHS	England
BAT	Royal United Hospital Bath	NHS	England
BED	Bedford Hospital	NHS	England
BFT	Belfast Trust City Hospital	NHS	Northern Ireland
BHL	Liverpool Cardiothoracic Centre	NHS	England
BHR	Royal Berkshire and Battle Hospital	NHS	England
BLA	Royal Blackburn Hospital	NHS	England
BMI	BMI Meriden Hospital	Private	England
BOU	Royal Bournemouth Hospital	NHS	England
BRD	Bradford Royal Infirmary	NHS	England
BRI	Bristol Royal Infirmary	NHS	England
BRY	Acute Pennine Trust Fairfield	NHS	England
BSM	Southmead Hospital	NHS	England
CGH	Conquest Hospital	NHS	England
CHG	Cheltenham General Hospital	NHS	England
CHH	Castle Hill Hospital (Hull and East Yorkshire NHS Trust)	NHS	England
CHN	Nottingham City Hospital	NHS	England
CLW	North Wales Cardiac Centre	NHS	Wales
CMI	Cumberland Infirmary	NHS	England
CRG	Craigavon Hospital	NHS	Northern Ireland
CRO	Cromwell Hospital	Private	England
DER	Royal Derby Hospital (formerly Derbyshire Royal Infirmary)	NHS	England
DGE	Eastbourne Hospital	NHS	England
DUD	Birmingham City Hospital	NHS	England
DVH	Darent Valley Hospital	NHS	England
EAL	Ealing Hospital	NHS	England
EBH	Birmingham Heartlands Hospital	NHS	England
ERI	Edinburgh Heart Centre	NHS	Scotland
ESU	East Surrey Hospital, Surrey and Sussex NHS trust	NHS	England
FRE	Freeman Hospital	NHS	England
FRM	Frimley Park Hospital	NHS	England
GEO	St George's Hospital	NHS	England
GHB	Spire Hospital Bristol	Private	England

NICOR code	Hospital name	Type	Country
GJH	Golden Jubilee National Hospital (formerly HCI)	NHS	Scotland
GRL	Glenfield Hospital	NHS	England
GWE	Royal Gwent Hospital	NHS	Wales
GWH	Queen Elizabeth Hospital Woolwich	NHS	England
HAI	Hairmyres Hospital	NHS	Scotland
HAM	Hammersmith Hospital	NHS	England
HBP	Spire Hospital Hull and East Riding	Private	England
HH	Royal Brompton Hospital and Harefield NHS Trust, Harefield site	NHS	England
HHW	Wellington Hospital	Private	England
HSC	Harley Street Clinic	Private	England
IND	London Independent Hospital	Private	England
KCH	Kings College Hospital	NHS	England
KGH	Kettering General Hospital	NHS	England
KMH	Kings Mill Hospital	NHS	England
KSX	Tunbridge Wells Hospital	NHS	England
LBH	London Bridge Hospital	Private	England
LEB	Spire Hospital Leeds	Private	England
LGI	Yorkshire Heart Centre (Leeds General Infirmary)	NHS	England
LIN	Lincoln County Hospital	NHS	England
LIS	Lister Hospital	NHS	England
LNH	Leeds Nuffield Hospital	Private	England
MAY	Croydon University Hospital	NHS	England
MDW	Medway Maritime Hospital	NHS	England
MHO	Manor Hospital Oxford	Private	England
MOR	Morriston Hospital	NHS	Wales
MPH	Musgrove Park Hospital	NHS	England
MRI	Manchester Royal Infirmary	NHS	England
NCR	New Cross Hospital	NHS	England
NGS	Northern General Hospital	NHS	England
NHB	Royal Brompton Hospital and Harefield NHS Trust, Brompton site	NHS	England
NHH	Basingstoke and North Hampshire Hospital	NHS	England
NIN	Ninewells Hospital	NHS	Scotland
NOR	Norfolk and Norwich University Hospital	NHS	England
NPH	Northwick Park Hospital	NHS	England
NTH	Northampton General Hospital	NHS	England
PAP	Papworth Hospital	NHS	England
PHB	BMI Priory Hospital	Private	England
PHN	BMI Park Hospital	Private	England
PIN	Pinderfields General Hospital	NHS	England
PLY	Derriford Hospital, Southwest Cardiothoracic Centre	NHS	England
PMS	Great Western Hospital, Wiltshire Cardiac Centre	NHS	England
QAP	Queen Alexandra Hospital	NHS	England

NICOR code	Hospital name	Type	Country
QEB	Queen Elizabeth Hospital, Birmingham	NHS	England
RAD	John Radcliffe Hospital	NHS	England
RAI	Raigmore Hospital	NHS	Scotland
RCH	Royal Cornwall Hospital	NHS	England
RDE	Royal Devon & Exeter Hospital	NHS	England
RFH	Royal Free Hospital	NHS	England
RHH	Ross Hall Hospital	Private	Scotland
RHI	Calderdale Royal Hospital	NHS	England
RIA	Aberdeen Royal Infirmary	NHS	Scotland
RSC	Royal Sussex County Hospital	NHS	England
RVB	Royal Victoria Hospital	NHS	Northern Ireland
SAL	Salisbury District Hospital	NHS	England
SAN	Sandwell General Hospital	NHS	England
SCM	James Cook University Hospital	NHS	England
SCU	Scunthorpe General Hospital	NHS	England
SGH	Southampton General Hospital	NHS	England
SPH	St Peter's Hospital	NHS	England
SSP	Spire Shawfair Park Hospital	Private	Scotland
STH	St Thomas' Hospital	NHS	England
STO	City General Hospital (University Hospital of North Staffordshire)	NHS	England
SUN	Sunderland Royal Hospital	NHS	England
TOR	Torbay Hospital	NHS	England
UCL	Heart Hospital (UCLH)	NHS	England
UHW	University Hospital of Wales	NHS	Wales
VIC	Blackpool Victoria Hospital	NHS	England
WAL	Walsgrave Hospital (University Hospital Coventry)	NHS	England
WAT	Watford General Hospital	NHS	England
WDH	Dorset County Hospital	NHS	England
WEX	Wexham Park Hospital	NHS	England
WHH	William Harvey Hospital, East Kent Hospitals NHS Trust	NHS	England
WRC	Worcester Royal Hospital	NHS	England
WRG	Worthing Hospital	NHS	England
WYT	Wythenshawe Hospital	NHS	England
YDH	York District General Hospital	NHS	England

Appendix 2 Data completeness

Key

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

Pink - less than 50%; Light Pink - more than 50% but less than 90%; White - more than 90%; 0 = missing data

Hospital name	Hospital code	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	Patient location at the time of STEMI
Aberdeen Royal Infirmary	RIA	100	100	99.23	100	100	100	94.25	99.9	100	100	100	n/a	99.9	99.52	94.58
Acute Pennine Trust Fairfield	BRY	100	100	99.57	98.56	100	100	99.79	99.79	99.79	100	100	100	23.08	35.04	100
Altnagelvin Hospital	ALT	100	98.29	94.57	99.22	100	100	96.57	98.71	86.57	94.43	100	n/a	42.14	45.71	81.11
Barts and the London	BAL	99.22	96.85	97.95	99.36	100	100	97.85	98.86	94.11	97.9	94.42	97.85	0	59.15	0
Basildon Hospital	BAS	100	100	88.14	99.45	99.85	100	85.49	97.31	99.62	99.83	99.56	99.49	90.83	40.3	98.92
Basingstoke and North Hampshire Hospital	NHH	100	99.78	100	0.36	100	100	90.93	79.27	0.22	99.57	0.43	99.35	61.77	41.68	85.71
Bedford Hospital	BED	100	100	92.65	100	100	100	100	100	100	100	100	100	100	100	100
Belfast City Hospital	BFT	100	100	100	100	100	100	71.58	100	100	100	100	n/a	13.93	95.44	50
Birmingham City Hospital	DUD	100	99.83	99.66	100	100	100	95.98	98.66	100	100	99.81	98.83	81.74	55.28	96.88
Birmingham Heartlands Hospital	EBH	100	100	95.89	99.82	100	100	97.97	88.88	99.88	98.84	99.94	99.71	67.23	82.74	97.95
Blackpool Victoria Hospital	VIC	99.89	99.94	98.93	99.53	99.48	100	99.94	100	98.6	100	91.81	98.93	97.87	97.25	88.54
BMI The Alexandra Hospital	AHM	98.68	100	38.16	0	100	100	59.21	61.84	6.58	97.37	100	0	0	0	100
Bradford Royal Infirmary	BRD	100	99.7	100	100	100	100	100	100	95.55	95.55	95.58	97.92	100	99.11	100
Bristol Royal Infirmary	BRI	100	100	92.99	95.13	99.08	100	94.69	97.41	99.8	99.93	99.72	99.18	94.96	97.14	97.97
Calderdale Royal Hospital	RHI	100	100	94.08	100	99.13	100	90.06	99.37	99.79	98.94	100	99.58	97.89	97.04	0
Castle Hill Hospital	CHH	100	100	99.27	100	100	100	100	100	100	100	100	99.14	100	98.94	98.99
Cheltenham General Hospital	CHG	100	99.5	100	100	100	100	99.88	99.75	99.88	99.88	100	99.88	99.88	97.02	100
Conquest Hospital	CGH	100	100	100	100	100	100	100	99.54	100	100	100	100	99.54	89.56	100
Craigavon Area Hospital	CRG	100	100	100	100	100	100	100	100	99.49	99.87	99.86	n/a	100	99.87	100

Hospital name	Hospital code	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	Patient location at the time of STEMI
Cromwell Hospital	CRO	100	100	91.67	100	100	100	93.33	93.33	100	100	100	0	65	73.33	100
Croydon University Hospital	MAY	100	100	98.38	100	100	100	99.77	99.77	100	100	100	99.77	99.31	94	100
Cumberland Infirmary	CMI	99.85	100	89.94	100	99.84	100	89.32	92.57	97.99	97.83	93.42	96.75	86.22	67.49	77.4
Darent Valley Hospital	DVH	100	100	97.45	100	100	100	84.31	99.27	93.07	95.62	100	99.64	99.27	97.81	83.33
Derriford Hospital	PLY	100	100	99.74	100	100	100	100	100	100	100	99.87	99.6	97.36	94.86	100
Dorset County Hospital	WDH	100	99.35	85.16	100	99.26	100	93.33	97.63	94.19	93.98	97.79	90.32	76.13	96.56	93.75
Ealing Hospital	EAL	100	100	100	83.65	100	100	96.15	71.63	98.56	98.56	100	99.52	85.1	81.73	50
East Surrey Hospital	ESU	96.46	100	96.23	62.45	100	100	62.5	70.28	96.23	99.53	96.23	100	8.96	29.72	33.33
Eastbourne DGH	DGE	100	100	100	100	100	100	100	100	100	100	100	99.72	99.72	90.14	100
Freeman Hospital	FRE	100	99.9	97.66	98.78	100	100	97.72	98.11	100	100	100	99.35	96.65	95.54	95.87
Frenchay Hospital	FRY	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Frimley Park Hospital	FRM	100	100	100	100	100	100	100	100	100	100	100	99.52	40.89	39.38	99.3
Glenfield Hospital	GRL	99.93	100	99.37	100	100	100	99.02	99.3	100	100	100	99.79	98.25	99.3	100
Golden Jubilee Hospital	GJH	100	100	95.54	100	100	100	95.11	97.51	98.66	98.94	98.43	n/a	0.34	93.2	66.46
Hairmyres Hospital	HAI	100	100	99.93	11.37	100	100	47.55	63.17	14.82	20.29	97.05	n/a	0	46.47	31.62
Hammersmith Hospital	HAM	100	100	100	99.66	99.49	100	99.41	99.71	99.41	100	99.19	97.21	98.02	91.73	99.76
Harefield Hospital	HH	100	100	98.55	99.57	100	100	94.53	97.17	99.14	99.93	97.49	93.3	8.43	3.56	94.28
Harley Street Clinic	HSC	100	100	95.28	100	100	100	95.28	96.23	100	100	100	0	3.77	99.06	100
James Cook University Hospital	SCM	100	100	99.68	100	100	100	100	99.79	100	100	99.94	99.89	100	99.68	100
John Radcliffe Hospital	RAD	100	100	99.75	100	100	100	100	90.39	99.38	99.94	99.87	98.48	98.27	49.6	71.03
Kettering General Hospital	KGH	100	100	99.73	100	100	100	100	100	100	100	100	99.59	80.96	90.45	85.67
KIMS Hospital Kent*	KIM	100	100	100	0	100	100	100	100	100	100	100	0	100	100	100
King's College Hospital	KCH	100	99.94	95	99.88	99.54	100	93.58	96.63	60.35	100	99.28	96.74	60.67	36.08	99.72
Kings Mill Hospital	KMH	100	100	100	82.46	87.39	100	95.87	97.52	91.32	90.91	100	96.69	89.26	98.76	100
Leeds General Infirmary	LGI	100	100	97.07	100	100	100	96.15	97.99	99.66	99.96	99.52	99.54	93.38	95.81	99.09
Lincoln County Hospital	LIN	100	100	69.97	99.88	99.54	100	60.15	85.15	100	100	41.6	99.83	98.15	99.33	83.96
Lister Hospital	LIS	100	96.17	98.33	99.79	100	100	98.68	99.28	100	100	100	99.88	99.52	99.52	100

Hospital name	Hospital code	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	Patient location at the time of STEMI
Liverpool Heart and Chest Hospital	BHL	100	99.12	100	100	100	100	100	99.96	97.18	97.25	99.89	99.4	93.58	87.58	95.02
London Bridge Hospital	LBH	100	100	100	100	100	100	100	100	99.46	100	100	6.67	55.98	100	100
Luton & Dunstable Hospital	LDH	100	100	95.49	100	100	100	92.48	100	99.25	100	100	100	100	74.44	100
Manchester Royal Infirmary	MRI	100	100	100	100	100	100	81.87	85.18	100	100	100	90.99	100	7.92	81.94
Manor Hospital, Oxford	MHO	100	37.5	100	100	100	100	100	100	37.5	29.17	95.45	0	100	100	100
Medway Maritime Hospital	MDW	100	100	100	98.85	100	100	95.35	97.67	98.84	99.42	99.42	97.09	2.91	7.56	90.91
Morriston Hospital	MOR	100	99.76	97.59	97.53	100	100	96.55	98.23	99.84	100	98.88	99.76	87.08	97.51	95.79
Musgrove Park Hospital	MPH	99.46	99.59	100	100	100	100	99.86	99.86	99.05	98.51	99.85	98.64	95.92	99.73	99.46
New Cross Hospital	NCR	100	99.85	100	99.89	100	100	100	100	100	100	100	100	95.83	97.81	100
Ninewells Hospital	NIN	100	100	99.87	100	100	100	100	100	93.77	100	99.74	n/a	0	4.5	0
Norfolk and Norwich University Hospital	NOR	100	100	99.5	99.4	99.72	100	93.2	99.75	100	100	99.86	99.63	68.56	88.96	99.51
North Wales Cardiac Centre	CLW	100	100	94.27	99.47	100	100	97.13	98.57	77.96	81.36	99.25	94.08	63.98	74.01	96.43
Northampton General Hospital	NTH	100	99.75	99.75	99.14	100	100	98.75	99.5	99	100	99.48	99	93.02	99.75	92.86
Northern General Hospital	NGS	100	100	84.72	92.49	100	100	89.33	93.79	100	99.67	94.93	99.67	0	0	95.74
Northwick Park Hospital	NPH	100	100	99.86	100	100	100	99.72	99.86	99.86	100	99.5	97.63	99.72	97.08	94.12
Nottingham City Hospital	CHN	100	99.91	83.26	100	100	100	66.61	85.81	99.47	99.47	99.43	99.74	71.1	46.96	95.78
Papworth Hospital	PAP	99.96	100	100	100	100	100	100	99.96	100	99.96	100	100	65.92	91.61	97.71
Pinderfields General Hospital	PIN	100	100	100	100	100	100	100	100	100	100	100	100	100	99.68	100
Priory Hospital	PHB	100	100	100	0	100	100	95.65	100	34.78	43.48	95.65	4.35	65.22	86.96	100
Queen Alexandra Hospital	QAP	98.93	99.59	100	100	100	100	99.92	99.75	100	99.92	100	97.11	98.19	82.14	99.23
Queen Elizabeth Hospital Woolwich	GWH	100	99.54	98.62	48.28	99.54	100	87.56	83.87	95.85	95.85	100	99.54	95.39	100	50
Queen Elizabeth Hospital, Edgbaston	QEB	100	100	100	100	100	100	100	100	100	100	100	99.5	99.87	99.87	100
Raigmore Hospital	RAI	100	100	95.99	100	100	100	99.47	98.93	100	100	100	n/a	100	100	100
Royal Albert Edward Infirmary	AEI	100	98.69	99.21	98.8	97.67	100	94.75	94.23	98.16	97.9	99.71	98.16	92.91	92.65	0
Royal Berkshire Hospital	BHR	100	100	100	100	100	100	100	100	99.63	99.63	99.81	99.25	64.42	55.62	46.32
Royal Blackburn Hospital	BLA	100	100	99.86	100	97.4	100	98.91	96.06	91.85	92.66	99.86	96.6	20.11	89.81	91.67

Hospital name	Hospital code	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	Patient location at the time of STEMI
Royal Bournemouth General Hospital	BOU	100	100	69.77	99.91	100	100	86.06	95.43	44.26	93.25	99.85	99.63	74.45	84.12	93.75
Royal Brompton Hospital	NHB	99.87	100	100	98.95	100	100	98.42	98.94	100	100	97.09	95.44	93.8	93.4	82.35
Royal Cornwall Hospital	RCH	100	100	99.88	100	100	100	97.42	97.3	100	100	100	100	99.14	70.67	99.56
Royal Derby Hospital	DER	100	100	91.44	99.46	100	100	95.4	96.96	93.38	99.72	99.62	97.88	36.52	95.86	97.65
Royal Devon & Exeter Hospital	RDE	100	100	100	100	100	100	100	100	99.89	99.89	100	99.67	98.44	99.44	99.64
Royal Free Hospital	RFH	100	100	0.11	100	100	100	100	100	100	100	100	97.7	45.46	34.92	90.48
Royal Gwent Hospital	GWE	100	100	99.16	96.94	100	100	99.37	99.16	98.32	98.53	97.09	95.17	43.07	98.32	90.91
Royal Infirmary of Edinburgh	ERI	100	100	68.24	100	100	100	86.57	97.62	62.37	62.74	99.91	n/a	5.87	4.63	71.48
Royal Sussex County Hospital	RSC	100	100	94.91	99.17	100	100	93.67	98.27	99.9	100	98.35	99.9	16.6	85.12	98.21
Royal United Hospital Bath	BAT	100	100	73.7	99.71	100	100	90.9	97.69	95.09	95.23	99.81	100	57.51	66.76	81.82
Royal Victoria Hospital	RVB	100	100	61.18	100	100	100	82.36	93.57	98.81	98.75	99.71	n/a	32.07	96.73	97.28
Salisbury District Hospital	SAL	100	100	100	100	100	100	97.07	99.63	99.82	100	100	98.72	94.32	97.99	100
Sandwell General Hospital	SAN	99.8	100	100	100	100	100	97.85	99.22	100	100	99.35	99.41	92.19	91.6	99.2
Scunthorpe General Hospital	SCU	100	100	59.88	98.46	100	100	83.28	84.19	86.63	88.75	99.65	100	95.74	96.96	100
Southampton General Hospital	SGH	99.43	99.86	100	100	100	100	99.57	99.57	99.57	99.72	100	94.11	99.57	99.57	99.63
Southmead Hospital**	BSM	100	100	100	100	100	100	100	100	100	100	100	98.96	100	100	100
Spire Bristol	GHB	100	96.67	66.67	0	100	100	76.67	93.33	100	96.67	85.71	43.33	70	83.33	100
Spire Shawfair Park Hospital	SSP	100	96.77	90.32	100	100	100	96.77	96.77	87.1	90.32	89.66	0	9.68	83.87	100
St Anthony's Hospital	ANT	100	100	99.38	0	100	100	99.38	100	100	100	100	50	99.38	99.38	100
St George's Hospital	GEO	100	99.74	95.02	91	99.93	100	94.51	98.91	95.98	96.04	99.87	94.33	89.78	58.49	88.45
St Peter's Hospital	SPH	99.39	99.88	100	100	100	100	100	100	99.88	100	100	99.02	96.46	49.08	100
St Thomas Hospital	STH	100	100	99.91	100	100	100	100	99.16	100	100	99.89	98.57	98.7	100	100
Sunderland Royal Hospital	SUN	100	100	98.44	99.67	99.62	100	99.83	99.48	85.76	83.68	81.47	99.48	90.45	74.13	58.97
The Great Western Hospital	PMS	100	100	100	100	100	100	100	100	100	100	100	100	99.67	99.35	90.7
The Ipswich Hospital	IPS	100	100	95.57	100	100	100	100	100	79.34	89.3	100	99.63	94.46	98.89	100
Torbay Hospital	TOR	100	100	99.77	99.12	100	100	99.08	99.77	100	100	99.76	100	98.39	96.79	96.2

Hospital name	Hospital code	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	Patient location at the time of STEMI
Tunbridge Wells Hospital	KSX	100	100	100	100	100	100	100	79.75	97.93	97.93	100	97.93	85.95	90.5	100
University College Hospital	UCL	100	100	99.38	100	100	100	98.89	99.26	99.38	99.75	100	96.47	82.14	81.4	92.8
University Hospital Coventry	WAL	99.9	100	94.47	99.74	100	100	95.44	98.16	95.25	99.13	98.34	98.25	1.26	57.61	94.42
University Hospital of North Staffordshire	STO	99.39	99.76	99.95	100	99.95	100	87.79	98.4	98.44	99.34	100	99.34	37.25	58.7	98.97
University Hospital of Wales	UHW	100	99.94	96.7	99.12	99.8	100	96.58	98.75	96.01	98.26	96.74	79.2	30.95	98.19	83.55
Watford General Hospital	WAT	100	100	100	97.96	100	100	99.14	99.43	26.65	26.36	100	97.99	61.89	81.95	75
Wellington Hospital North	HHW	100	100	99.4	100	100	100	96.08	97.59	99.7	100	100	2.26	9.04	100	100
Wexham Park Hospital	WEX	100	100	100	100	100	100	100	100	99.76	100	100	96.61	21.26	100	7.32
William Harvey Hospital	WHH	100	100	89.77	98.25	99.9	100	91.33	93.27	95.81	96.69	97.2	96.27	96.39	95.03	97.98
Worcestershire Royal Hospital	WRC	98.77	99.53	100	100	100	100	97.83	100	99.34	99.24	99.9	98.96	97.83	99.05	100
Worthing Hospital	WRG	100	99.85	99.24	100	100	100	93.77	99.39	99.09	99.54	100	100	87.08	76.14	100
Wycombe Hospital	AMG	100	100	93.04	99.15	100	100	93.81	94	99.23	99.42	100	99.81	94.39	92.26	92.16
Wythenshawe Hospital	WYT	100	100	100	100	100	100	100	100	100	100	100	100	100	84.68	100
York District Hospital	YDH	100	100	100	97.42	93.33	100	99.1	96.4	90.09	90.09	100	99.55	100	27.93	100

**Services from Frenchay Hospital (FRY) were moved to Southmead Hospital (BSM)

Appendix 3 Arterial access

Hospital name	2013			2014	
	Hospital code	Number of records eligible for this analysis	Percentage of procedures where right or left radial artery was used for access	Number of records eligible for this analysis	Percentage of procedures where right or left radial artery was used for access
		n	%	n	%
National average	**Overall**	**90163**	**71.20**	**93143**	**75.30**
Aberdeen Royal Infirmary	RIA	1072	81.72	1044	83.52
Acute Pennine Trust Fairfield	BRY	473	61.73	438	56.85
Altnagelvin Hospital	ALT	474	92.19	581	94.49
Bart's Heart Centre	BAL	2251	68.86	2126	67.50
Basildon Hospital	BAS	2132	75.70	2050	77.56
Basingstoke and North Hampshire Hospital	NHH	455	1.98	461	1.95
Bedford Hospital	BED	385	71.43	434	81.80
Belfast City Hospital	BFT	1034	92.94	1075	94.23
Birmingham City Hospital	DUD	475	80.21	528	83.90
Birmingham Heartlands Hospital	EBH	1531	72.18	1598	71.53
Blackpool Victoria Hospital	VIC	1531	81.52	1541	82.93
BMI The Alexandra Hospital	AHM	38	44.74	24	70.83
Bradford Royal Infirmary	BRD	260	81.92	294	83.67
Bristol Royal Infirmary	BRI	1369	76.92	1413	78.63
Calderdale Royal Hospital	RHI	459	83.66	460	88.48
Castle Hill Hospital	CHH	1503	74.92	1354	79.39
Cheltenham General Hospital	CHG	664	72.59	775	76.39
Conquest Hospital	CGH	419	59.19	425	57.41
Craigavon Area Hospital	CRG	818	92.42	713	92.99
Cromwell Hospital	CRO	58	29.31	52	42.31

Hospital name	2013			2014	
	Hospital code	Number of records eligible for this analysis	Percentage of procedures where right or left radial artery was used for access	Number of records eligible for this analysis	Percentage of procedures where right or left radial artery was used for access
		n	%	n	%
Croydon University Hospital	MAY	358	51.12	347	66.57
Cumberland Infirmary	CMI	486	81.69	607	85.01
Darent Valley Hospital	DVH	260	90.38	247	87.45
Derriford Hospital	PLY	743	84.52	755	84.11
Dorset County Hospital	WDH	374	85.03	397	85.14
Ealing Hospital	EAL	196	15.82	206	22.33
East Surrey Hospital	ESU	371	1.62	424	15.57
Eastbourne DGH	DGE	334	32.04	347	44.38
Freeman Hospital	FRE	2869	79.78	2900	79.83
Frenchay Hospital**	FRY	204	33.33	97	36.08
Frimley Park Hospital	FRM	998	60.92	1128	78.99
Glenfield Hospital	GRL	1472	73.37	1320	71.89
Golden Jubilee Hospital	GJH	2604	92.43	2795	93.92
Hairmyres Hospital	HAI	1246	86.44	1369	86.41
Hammersmith Hospital	HAM	1346	38.34	1360	49.34
Harefield Hospital	HH	1516	56.93	1512	60.52
Harley Street Clinic	HSC	102	30.39	81	35.80
James Cook University Hospital	SCM	1697	90.87	1766	92.92
John Radcliffe Hospital	RAD	1620	77.16	1515	83.50
Kettering General Hospital	KGH	1148	72.56	1216	84.54
KIMS Hospital Kent*	KIM	n/a	n/a	9	77.78
King's College Hospital	KCH	1211	73.74	1336	76.87
Kings Mill Hospital	KMH	288	53.82	138	68.84
Leeds General Infirmary	LGI	2201	81.33	2288	85.01
Lincoln County Hospital	LIN	951	66.25	1076	77.42
Lister Hospital	LIS	583	69.81	734	72.75

Hospital name	2013			2014	
	Hospital code	Number of records eligible for this analysis	Percentage of procedures where right or left radial artery was used for access	Number of records eligible for this analysis	Percentage of procedures where right or left radial artery was used for access
		n	%	n	%
Liverpool Heart and Chest Hospital	BHL	2700	85.93	2652	87.48
London Bridge Hospital	LBH	154	37.66	126	60.32
Luton & Dunstable Hospital*	LDH	n/a	n/a	132	83.33
Manchester Royal Infirmary	MRI	1417	63.09	1689	68.09
Manor Hospital, Oxford	MHO	n/a	n/a	22	90.91
Medway Maritime Hospital	MDW	110	71.82	168	83.33
Morriston Hospital	MOR	1238	81.99	1133	82.44
Musgrove Park Hospital	MPH	658	35.41	664	35.09
New Cross Hospital	NCR	1337	81.38	1263	80.92
Ninewells Hospital	NIN	695	84.89	754	86.87
Norfolk and Norwich University Hospital	NOR	1359	85.43	1401	87.87
North Wales Cardiac Centre	CLW	513	80.12	533	92.68
Northampton General Hospital	NTH	438	81.05	383	81.46
Northern General Hospital	NGS	1437	55.74	1737	70.70
Northwick Park Hospital	NPH	542	21.40	588	41.33
Nottingham City Hospital	CHN	1076	71.84	1054	75.81
Papworth Hospital	PAP	2088	74.52	2214	82.16
Pinderfields General Hospital	PIN	308	52.27	314	57.64
Priory Hospital	PHB	32	90.62	23	82.61
Queen Alexandra Hospital	QAP	1122	86.90	1096	89.96
Queen Elizabeth Hospital Woolwich	GWH	232	68.10	212	60.85
Queen Elizabeth Hospital, Edgbaston	QEB	766	85.51	694	89.77
Raigmore Hospital	RAI	318	84.28	364	84.89
Royal Albert Edward Infirmary	AEI	366	92.62	342	91.52

Hospital name	2013			2014	
	Hospital code	Number of records eligible for this analysis	Percentage of procedures where right or left radial artery was used for access	Number of records eligible for this analysis	Percentage of procedures where right or left radial artery was used for access
		n	%	n	%
Royal Berkshire Hospital	BHR	300	88.67	390	82.31
Royal Blackburn Hospital	BLA	662	94.41	725	96
Royal Bournemouth General Hospital	BOU	1911	79.12	2044	80.53
Royal Brompton Hospital	NHB	762	20.34	753	39.44
Royal Cornwall Hospital	RCH	856	82.48	810	86.42
Royal Derby Hospital	DER	803	49.07	1048	48.95
Royal Devon & Exeter Hospital	RDE	898	19.82	898	50.22
Royal Free Hospital	RFH	693	59.45	745	68.59
Royal Gwent Hospital	GWE	571	91.42	446	92.83
Royal Infirmary of Edinburgh	ERI	1916	87.11	1653	87.11
Royal Sussex County Hospital	RSC	998	34.77	1023	47.51
Royal United Hospital Bath	BAT	533	75.42	519	81.50
Royal Victoria Hospital	RVB	1384	92.49	1682	92.03
Salisbury District Hospital	SAL	355	87.61	433	89.84
Sandwell General Hospital	SAN	367	80.93	461	87.42
Scunthorpe General Hospital	SCU	277	27.44	282	42.20
Southampton General Hospital	SGH	608	43.26	637	46.78
Southmead Hospital**	BSM	n/a	n/a	91	45.05
Spire Bristol	GHB	18	61.11	27	44.44
Spire Shawfair Park Hospital	SSP	30	63.33	29	79.31
St Anthony's Hospital	ANT	124	23.39	145	37.93
St George's Hospital	GEO	1626	31.18	1528	32.98
St Peter's Hospital	SPH	632	34.49	704	32.67
St Thomas Hospital	STH	864	29.17	946	40.27
Sunderland Royal Hospital	SUN	349	83.95	529	80.91

Hospital name	2013			2014	
	Hospital code	Number of records eligible for this analysis	Percentage of procedures where right or left radial artery was used for access	Number of records eligible for this analysis	Percentage of procedures where right or left radial artery was used for access
		n	%	n	%
The Great Western Hospital	PMS	398	82.91	306	81.05
The Ipswich Hospital*	IPS	n/a	n/a	242	73.55
Torbay Hospital	TOR	407	62.90	414	65.22
Tunbridge Wells Hospital	KSX	301	6.98	229	11.35
University College Hospital	UCL	788	37.56	714	52.24
University Hospital Coventry	WAL	1029	85.71	1023	85.73
University Hospital of North Staffordshire	STO	1779	79.82	1965	84.58
University Hospital of Wales	UHW	1445	93.77	1532	91.91
Watford General Hospital	WAT	238	63.45	240	66.25
Wellington Hospital North	HHW	250	57.6	270	68.15
Wexham Park Hospital	WEX	299	50.5	355	50.99
William Harvey Hospital	WHH	879	66.21	977	67.35
Worcestershire Royal Hospital	WRC	953	92.97	996	94.58
Worthing Hospital	WRG	503	29.62	536	37.31
Wycombe Hospital	AMG	496	61.49	482	67.84
Wythenshawe Hospital	WYT	1158	80.57	1191	90.43
York District Hospital	YDH	217	81.11	209	89

*n/a = no data as the hospital only started performing PCI in 2014

**Services from Frenchay Hospital (FRY) were moved to Southmead Hospital (BSM)

Appendix 4 Membership of NAPCI steering group/data monitoring group

Name	Role	Organisation
Dr Peter Ludman	Chairman, NAPCI Clinical Lead, BCIS Audit Lead; Consultant Cardiologist	University Hospitals Birmingham NHS Foundation Trust
Dr Mark de Belder	Consultant Cardiologist	South Tees Hospitals NHS Foundation Trust
Dr Rod Stables	Consultant Cardiologist; Research Lead for Interventional Cardiology Institute of Cardiovascular Medicine and Science (Liverpool)	Liverpool Heart and Chest Hospital NHS Foundation Trust
Dr Rob Henderson	Consultant Cardiologist	Nottingham University Hospitals NHS Trust
Professor Adrian Banning	Consultant Cardiologist, BCIS Honorary Secretary	Oxford Radcliffe Hospitals NHS Trust
Lucia Gavalova	Committee Secretary, NAPCI Project Manager, NICOR	National Institute for Cardiovascular Outcomes Research (NICOR)
Dr Tim Gilbert	Consultant Cardiologist	Norfolk and Norwich University Hospitals NHS Foundation Trust
Dr Andrew Wragg	Consultant Cardiologist	Barts Health NHS Trust
Professor Simon Redwood	President of BCIS; Consultant Cardiologist	Guys and St Thomas NHS Foundation Trust
Professor Nick Curzen	Consultant Cardiologist	University Hospital Southampton NHS Foundation Trust
Dr Darragh O'Neill	Information Analyst, NICOR	National Institute for Cardiovascular Outcomes Research (NICOR)
Andrew Donald	Database Developer, NICOR	National Institute for Cardiovascular Outcomes Research (NICOR)
Ronald van Leeven	MINAP Project Manager, NICOR	National Institute for Cardiovascular Outcomes Research (NICOR)
Dr Clive Weston	MINAP Clinical Lead	Abertawe Bro Morgannwg University Health Board
Dr David Hildick Smith	BCIS Honorary Treasurer	Brighton and Sussex University Hospitals NHS Trust
Dr Adam de Belder	BCIS Clinical Standards Group Chair	Brighton and Sussex University Hospitals NHS Trust
Sheila Jamieson	Centre Database Manager/Clinical Effectiveness (Freeman Hospital)	The Newcastle Upon Tyne Hospitals NHS Foundation Trust
Alexander McLaren	Senior Medical Device Specialist, MHRA Representative	Medicines & Healthcare Products Regulatory Agency
James Ian Neill	Patient Representative	Retired
Keith Wilson	Patient Representative	Liverpool Heart and Chest Hospital NHS Foundation Trust

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 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). Narrowing and complete blockages within the arteries can be identified during the angiography and this allows decisions to be made regarding treatment. Often an angiogram is an immediate precursor to PCI and stent implantation or to coronary artery bypass grafting.
Atherosclerosis		A process where the walls of the arteries develop fatty deposits called atheroma.
Cardioversion		Process by which the heart is restored to normal rhythm by using an externally applied electric shock.
Case mix		Different types of patients treated by a hospital or an operator
Coronary heart disease	CHD	A group of diseases that includes stable and unstable angina, myocardial infarction, and sudden coronary death. It is a results of the narrowing or blockage of the coronary arteries, usually caused by atherosclerosis
Coronary lesions		Is a tearing on the internal walls of the artery that can be stable and unstable.
Door-to-balloon time	DTB	The interval between the ambulance arriving at a PCI hospital and the performance of primary PCI.
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.
Electrocardiogram	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		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-balloon time.
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

Major Adverse Cardiac and Cerebrovascular Events	MACCE	MACCE is a selection of events that can happen to patients and includes all-cause death, stroke, MI and repeat revascularisation.
Myocardial infarction		Death of the cells of an area of the heart muscle (myocardium) as a result of oxygen deprivation, which in turn is caused by obstruction of the blood supply; commonly referred to as a heart attack.
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 is not required.
Operator		An interventional cardiologist performing PCI and other catheter based procedures
Outlier		An observation that lies an abnormal distance from other values in a random sample from a population. In a sense, this definition leaves it up to the analyst (or a consensus process) to decide what will be considered abnormal. Before abnormal observations can be singled out, it is necessary to characterize normal observations.
Primary PCI	pPCI	A technique to re-open the blocked coronary artery responsible for the heart attack in patients with STEMI. It has to be performed as soon as possible after the STEMI is diagnosed to prevent loss of a heart muscle.
PCI hospital		It is a hospital equipped with catheter laboratories and trained staff to perform percutaneous coronary interventions.
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.
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.
Survival post procedure		An interval to look at a rate of patients who survived after they had a procedure. This can be before and/or after discharge from the hospital.
Unstable angina	UA	A condition in which your heart doesn't get enough blood flow and oxygen. It is a type of acute coronary syndrome and may lead to a heart attack.

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