NICOR

NCAP

NATIONAL CARDIAC AUDIT PROGRAMME

ANNUAL REPORT 2018

Towards healthier hearts: driving improvement from real-world evidence

British Cardiovascular Society

BHRS British Heart Rhythm Society

BCIS

UCLPartners
Academic Health Science Partnership

NHS
Barts Health
NHS Trust

National Cardiac Audit Programme (NCAP) annual report 2018 (2016/17 data)

Towards healthier hearts: driving improvement from real-world evidence

Towards healthier hearts: a patient's perspective

Fourteen years ago I underwent a coronary bypass, which prevented me suffering a heart attack. I was one of a small number for whom the operation could be performed by using a robot and graft between the ribs, enabling such a quick recovery that I was able to resume playing a full round of golf on a hilly course a month later. Although I am a non-smoker and not overweight I had worked very long hours and been lazy about exercise, so there were lifestyle lessons for me!

While attending cardiac rehabilitation I was asked to join a heart committee as a patient representative. Those were the early days of patient engagement, so it was a vague proposition, but I thought my care had been so good that I should put something back. Since then the patient role has expanded enormously and the culture is one of encouraging participation because patients are the experts on what they have experienced: what was good and what could be better.

Having engaged with the NHS on a large variety of projects, including the Myocardial Ischaemia National Audit Project (MINAP), I have always been impressed by the total commitment of NHS professionals to continuous improvement in outcomes for patients. Those collecting data in hospitals, analysts and clinicians are all part of a team effort to gather information that can help improve outcomes and reduce deaths from heart disease. The benefits to patients from this commitment and attention to detail is the reason I continue to participate and support this work as a volunteer.

I had the misfortune to contract a very serious heart infection two years ago, which resulted in a complex operation, from which I am now fully recovered, thanks again to excellent cardiac care. One difference I noted in my local hospital was the emphasis on undertaking cardiac rehabilitation. Since my first experience, the take-up of cardiac rehabilitation has risen. However, it is still far too low nationally and especially among female patients; we must aim to improve this as we know it reduces the incidence of second heart attacks.

How else can individuals help to lower their risks from heart disease? Stopping smoking is always at the top of the list but tackling excess weight and taking regular exercise is also very important. There is a real risk that the clinical gains achieved by continual improvements in cardiac care, as are evident in this report, will be offset by the consequences of obesity and sedentary lifestyles. The public should make the right diet and exercise choices but when medical problems arise we want to know that health professionals are doing all they can to provide the best possible care. There are important messages for us all in this report and we each play our part in acting on those, where we can, and sharing them widely with others.

Alan Keys
MINAP Patient Representative

Foreword

The specialties of cardiology and cardiac surgery have a long history of self-reported clinical data, dating back to the 1980s. These audits were established and refined by clinicians and their specialist societies wishing to understand activity and outcomes. For many years data collection and analysis was unfunded, relying on the voluntary work of the societies and their members to provide annual reports. Those who led the establishment and development of these audits deserve much credit for their hard work and determination. Without their data we would have had much less idea of how innovative techniques and devices were impacting on specialist cardiac care.

Over the last 10 to 15 years the value of these clinical audits has been more widely appreciated. The data derived from them has become invaluable in helping understand variation in activity and outcomes, and in driving improvements in the quality of care for patients. Funding from the Department of Health and then NHS England, commissioned by the Healthcare Quality Improvement Partnership, has supported six of the cardiac audits; it is these that are the subject of this annual report. This report is different from those published previously, being the first time that the six have reported together and in focusing much more on quality improvement than in previous years. Future work will include an even greater attention to quality, and on data being reported quarterly, rather than annually, making the data even more valuable to clinicians and those who commission cardiac services.

I welcome this report and commend those who have worked so hard to bring it to fruition. Many will be unaware of the challenges faced in producing such a document; increasing data governance regulation, validation of data, technological challenges and responding to rapid changes in the techniques and equipment used to treat cardiac patients are just some examples. Overcoming these challenges requires great collaboration and I commend NICOR and its patient advisers, the national specialist societies and their members, HQIP and NHS England for making this happen.

Clinicians and commissioners want, indeed need to know that they are providing the safest care to patients, with outcomes that are as good as they can be, and need to be able to see where service improvements can be made. The data from clinical audits reported here, as with others published elsewhere, are invaluable sources of information not routinely collected in healthcare electronic systems. If all those involved work collaboratively we will achieve even greater value from data linkage and transparency in the future. I commend this report to all who are involved in the delivery or commissioning of cardiac services.

Professor Huon H Gray
National Clinical Director for Heart Disease, NHS England

NICOR Director's report

The last 50 years have seen the diagnosis and treatment of cardiovascular disease transformed as the result of major advances in drug therapies, surgical and interventional skills, new technologies and huge changes to the way services are organised and delivered. Figure 1 summarises just some of these developments.

Not only has this led to improved clinical outcomes for patients but services have also become more efficient, providing patients with improved experiences. For example, where treatment of a heart attack used to involve a hospital stay of several weeks, most patients are now treated with primary angioplasty and can be discharged safely from hospital in just a few days.

A number of important mechanisms have played a part in bringing about these improvements. Better scientific understanding of cardiovascular diseases has been applied to develop and test new drugs, technologies and treatment strategies. This application of basic science, through rigorous evaluation, has been fundamental to progressing rapidly from 'bench-to-bedside'.

The further evaluation of an intervention, once it is available for clinical use, includes wider scale testing, most commonly done through randomised controlled trials (RCTs). Carefully designed registries can indicate which patients might gain most benefit from the treatment. National and international bodies then incorporate the treatment within clinical guidelines, which form the templates, or descriptions, of best care, against which the performance of hospitals and individual clinicians can be compared through clinical audit. This process has resulted in cardiovascular specialties being some of the most evidenced-based disciplines in medicine.

At an organisational level, perhaps the greatest opportunity to make major changes followed the publication of the National Service Framework (NSF) for Cardiovascular Disease in 2000.[1] Notwithstanding the importance of the scientific advances mentioned above, the NSF, supported with an appropriate level of funding, demonstrated the remarkable and beneficial change that can be achieved through politicians, professionals and patient-advocate groups working together.

Since then there have been continuous developments in the available medicines, equipment and techniques. Hospitals and regions have to address how changes can be made to incorporate this evolution of knowledge to provide effective and efficient services.

A central part of this story has been the role of national audit, which has contributed greatly to the substantial reduction in cardiovascular morbidity and mortality in the UK. In 2011, the National Institute for Cardiovascular Outcomes Research (NICOR) brought together six major cardiovascular audits, which had been started by the professional societies, into one organisation. This was followed, in 2017, by the creation of a single National Cardiac Audit Programme (NCAP), covering important aspects of disease presentation and treatment.

The challenges of cardiovascular disease continue, however, with an aging population, changes in ethnic mix, deterioration in lifestyle and a rising level of obesity and diabetes. Furthermore, better treatment of other diseases, such as cancer, has resulted in more survivors with cardiovascular disease.

Against this backdrop, NCAP needs to evolve to support the changing needs of patients with cardiovascular disease, as well as those in the population who are at increased risk. We are committed to the creation of a single, comprehensive cardiovascular dataset that covers the risk factors, clinical presentations and treatments across the whole of a patient's life. This will address not only disease-specific issues, but also fundamental cross-cutting questions, including inequality of care delivery, adherence to guideline-directed treatments, and the reduction in avoidable complications and death.

Under the new contract managed by the Healthcare Quality Improvement Partnership, funded by NHS England and GIG Cymru/NHS Wales, we are planning a continuous process of improvement in data collection, analysis and reporting to provide valuable information to a broad range of stakeholders. A novel information technology platform will also support 'real-world evidence' research and surveillance, which is so important for 'future proofing' quality improvement initiatives.

As the initial step of that process, in this report we are, for the first time, combining the outputs of all our cardiovascular audits in a single document. We plan to enhance future reports with flexible, rapid data analysis, more sophisticated risk adjustment, and innovative reporting and communication to provide value for clinicians, hospitals, commissioners, patients and the public.

We are extremely grateful for the enormous efforts made by all those who are involved in the collection and collation of the 'Big Data' that underpins the audit work. NCAP is part of a growing body of data organisations that are committed to joint working, collaborating together to put in place the best possible care for patients. We believe that the tangible benefits of this collaborative approach will become clear and enable NICOR to contribute increasingly to the delivery of a world-class NHS.

Professor John Deanfield
Director of NICOR

Figure 1 – Timeline of key landmarks in cardiovascular healthcare

ACE-I = ACE-inhibitor
ASD = atrial septal defect
CCAD = central cardiac audit database
CCU = coronary care unit
CHD = coronary heart disease
CRT = cardiac resynchronisation therapy
CT = computed tomography
ECG = electrocardiogram
ICD = implantable cardioverter defibrillator
MINAP = Myocardial Ischaemia National Audit Project
MRI = magnetic resonance imaging
NIAP = National Infarct Angioplasty Project
NICE = National Institute for Health and Care Excellence
NICOR = National Institute for Cardiovascular Outcomes Research
NSF = National Service Framework
PCI = percutaneous coronary intervention
PDA = patent ductus arteriosus
PTCA = percutaneous transluminal coronary angioplasty
PPCI – primary percutaneous coronary intervention
RCT = randomised controlled trial
TAVI = transcatheter aortic valve implantation
UK = United Kingdom

How to use this report and the audit outputs

This report is designed to be useful to a wide audience of stakeholders, including patients, clinicians, management teams and commissioners of healthcare, who are interested in cardiovascular conditions and their treatments.

This aggregate report highlights aspects of safety, clinical effectiveness and patient outcomes. The audit findings recognise areas of clinical excellence that can be adopted across the NHS, but also identify areas where care falls below expected standards. These standards should be used to determine local and national quality improvement aims for clinicians, service managers and commissioners.

Learn about progress in diagnosis and treatment

The treatment of heart conditions continues to evolve and this report describes a number of key developments to enable an understanding of what constitutes high quality care.

See how improvements in services are changing outcomes for patients

The key aim of service improvement is to deliver better outcomes for patients, both in terms of their chances of survival and the experience they have while being cared for, and the report presents findings on how these are changing. With improved survival rates, emphasis is shifting to other measures that are important to patients and which can be used to audit change over time.

Find the key recommendations

A summary of the six sub-specialty audits that have come together as a single National Cardiac Audit Programme (NCAP) is provided in the Executive Summary, together with the key recommendations from this year's analyses. Click here to go directly to the Executive Summary, which also provides links to each sub-specialty report and a summary of all recommendations.

Find out the results for particular hospitals and clinicians

The findings in this aggregate report are presented at a national level. This should allow stakeholders to understand both where advances have been made to deliver quality improvement and remaining challenges. In reading this document it will be clear that many of the issues are common to the different types of heart disease and management. However, there is important information specific to individual cardiac conditions that are also of great interest. This report will enable an interested person to work from the improvement questions to the specific area of interest in a seamless and efficient way. More detailed information of the performance of a particular hospital (or to compare hospitals) is provided using links to the full 'granular' data analyses for each audit throughout the report. For the vast majority of hospitals, the results are reassuring and patients, providers and commissioners can have confidence in the quality of their local services. For some hospitals, however, there are elements of service delivery that could be improved and the audit data can point to where improvements can be made.

Two of the audits (Angioplasty and Adult Surgery) provide data on the performance of individual 'operators' (i.e. the surgeons or cardiologists undertaking the procedure). This is part of the Clinical Outcomes Publication (COP) programme run by the Healthcare Quality Improvement Partnership (HQIP) and made available through the NHS Choices website. While individual performance is dependent on a number of external factors, including 'case mix' and institutional/team characteristics, these data are of great interest to patients and the public and the results can form part of the annual appraisal that all practising medical professionals undertake.

Some of the cardiovascular services covered are funded by regional commissioners but many are highly specialised and are commissioned nationally. This report and the supporting hospital-level data provide a means of establishing how providers are performing and will aid local, regional and national discussions on service delivery.

Become more familiar with the nature of the conditions

A summary of the cardiovascular diseases and related treatments are included in Appendix A.

Understand how audit data come together and how the analysis works

The organisation of the national audits and the methodology used in producing results are explained in Appendix B.

The results of the Arrhythmia audit will be published later in 2018

This report covers five of the six audits in NCAP. A further report will be issued soon to highlight the findings and quality improvement suggestions from the Arrhythmia audit (as the validation and analysis for this is ongoing).

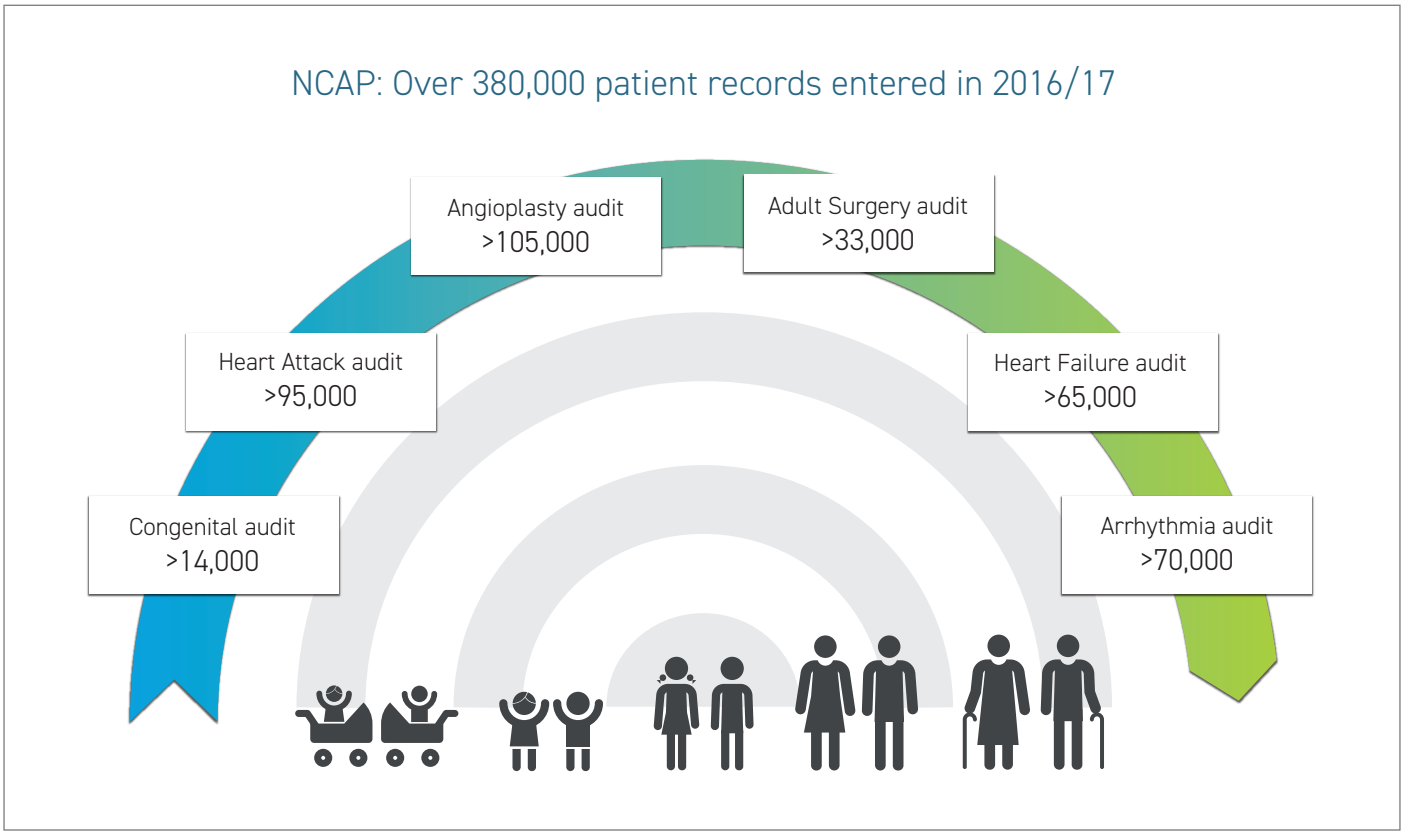
Executive summary and recommendations

The National Cardiac Audit Programme (NCAP) brings together, for the first time, six major national clinical audits of care of patients treated in the UK for heart disease. The six audits are:

- **Congenital audit** – about one percent of children are born with abnormalities of the structures of their heart and/or major blood vessels, known as congenital heart disease. Operations and interventions can be undertaken from birth through to adulthood, encompassing life-long management of these conditions.
- **Heart Attack audit** – a common condition in adults is coronary heart disease, which has a range of consequences, including heart attacks.
- **Angioplasty audit** – coronary patients with obstructions in their arteries may require techniques to improve blood flow (called coronary revascularisation). This could involve the insertion of stents, known as percutaneous coronary intervention (PCI) or 'angioplasty'.
- **Adult Surgery audit** – adult patients with acquired diseases of the blood vessels, valves or the muscle of the heart may require heart surgery. The commonest operation is a coronary artery bypass graft (CABG), where a narrowed coronary artery may be 'bypassed' using a vessel taken from inside the chest wall, the leg or the arm.
- **Heart Failure audit** – patients with diseases of the heart muscle, for example as a result of heart attacks or from congenital conditions, might develop heart failure, which is a worsening of the heart's ability to pump blood.
- **Arrhythmia audit** – patients of all ages are prone to heart rhythm disturbances but the more dangerous rhythm disturbances occur most commonly in patients with badly damaged heart muscle, whatever its cause. The results for the Arrhythmia audit will be presented later in 2018.

The reporting of six audits as a unified cardiovascular pathway reflects the intention to move towards a single national dataset and harmonisation of the audit processes, including data validation, analysis and reporting. This is a large-scale undertaking, with over 380,000 patient records entered into the NCAP dataset in 2016/17 financial year (Figure 2). The Angioplasty audit is based on data entered in the 2016 calendar year.

Figure 2 – Number of patient records across the NCAP pathway (2016/17)



Commissioned by the Healthcare Quality Improvement Partnership (HQIP) with funding from NHS England and GIG Cymru/NHS Wales (funding from Scotland has now been provided for some of the six audits and funding from Northern Ireland and the Republic of Ireland is under consideration), this is the first combined report that NCAP has published. It covers five of the six audits in NCAP (the findings and quality improvement suggestions from the Arrhythmia audit will be published in a version later this year, as the validation and analysis for this is ongoing).

As an 'aggregate report' for the six audits, it provides information of broad interest, sharing key messages and recommendations concerning quality improvements in the management of cardiovascular disease with a wide range of stakeholders including healthcare professionals, hospital managers, commissioners and, importantly, patients and the public.

The much more detailed information for each sub-specialty (including data on the performance of individual hospitals against the audit metrics) can be found here and via the links provided throughout this report. Two of the audits (Angioplasty and Adult Surgery) also provide specific data on the performance of individual 'operators' (i.e. the surgeon or other cardiologists undertaking the procedure).

The emphasis of this report has moved away from the simple reporting of data to the recommendation of key national improvement targets and the highlighting of best practice.

The report focuses on quality improvements grouped around three themes:

- **Patient outcomes** – what can we do to improve patient outcomes?
- **Safety** – how can services be made safer?
- **Clinical effectiveness** – are the best treatments being used and is care being delivered effectively?

Improvements to patient outcomes

1. Hospitals providing care for children with congenital heart disease have low levels of 30-day mortality. Survival rates are high and continue to be better than predicted (see section 4.1).

2. The use of angiography and angioplasty are both driving outcome improvements for patients with coronary artery disease. Improved heart attack outcomes are associated with the increased use of angiography and fewer complications are being observed in angioplasty (see section 4.2).

3. Adult cardiac surgery outcomes continue to improve. Surgical mortality rates have fallen over the last ten years to under 2.5% in 2016/17, in spite of the fact that older and sicker patients are undergoing surgery. Post-operative stroke rates have been analysed for the first time and are well below 1% for first time CABG operations and serious wound infections occurred in around one in 300 cases (although rates of reporting on complications are variable with poor data completeness from some hospitals) (see section 4.3).

4. Heart failure outcomes are improving as a result of access to specialist care, drugs and rehabilitation, with overall in-hospital mortality falling to under 10% in 2016/17. Patients receiving specialist care have a higher survival rate, as do those leaving hospital on all three recommended disease-modifying drugs (see section 4.4).

Improvements to safety

Published clinical recommendations outline the minimum annual volume of activity expected at hospitals performing surgical or interventional procedures.

5. **NHS England has published expected standards for the optimal volume of surgical procedures performed by individual surgeons at congenital heart disease centres.** Currently not all centres meet this standard.
Recommendation 1*: Hospitals undertaking congenital cardiac surgery should work with specialist commissioners and aim to meet the NHS England Standards for the number of surgeons and associated volume of surgical activity. All congenital heart centres should fully comply with the national data collection exercise to help demonstrate a high quality of care (see section 2.1.2).*

6. **The British Cardiovascular Intervention Society (BCIS) has published expected standards for the volume of activity at hospitals performing angioplasty.**
The majority of angioplasty centres perform levels of activity above the minimum recommended numbers but some centres do not reach these standards.
Recommendation 2*: Hospitals with an angioplasty centre should aim to meet the recommended annual activity volumes for angioplasty procedures. All angioplasty centres should report on outcomes to ensure a high quality of care (see section 2.1.2).*

Early recognition and treatment of patients with a heart attack will improve outcomes.

7. ***Recommendation 3****: Patients with a suspected heart attack should call an ambulance rather than take themselves to hospital (see section 2.3.1).*
Patients with higher-risk* heart attacks who self-present to a hospital without angioplasty facilities are disadvantaged because they then have to be transferred to an angioplasty-capable hospital; these delays impact on outcomes.

8. ***Recommendation 4****: Ambulance trusts should review ambulance performance times to ensure they do not impact on angioplasty call-to-balloon times (see section 2.3.1).*
Call-to-door and therefore overall call-to-balloon times for patients receiving primary angioplasty have increased,

** In this report, 'higher-risk' refers to ST-elevation myocardial infarction (STEMI) and 'lower-risk' to non-ST-elevation myocardial infarction (see Appendix A and Glossary for further details).*

which may adversely affect outcomes. This may relate to pressures currently experienced by the ambulance services. Ambulance services need to minimise delays in diagnosing and transferring higher-risk heart attacks. The NCAP is currently providing data to support an NHS England review of ambulance performance standards.

9. ***Recommendation 5**: Medical directors and their clinical leads should have clinical pathways that ensure the rapid detection of higher-risk heart attacks (see section 2.3.1).*
The hallmark of a higher-risk heart attack is 'ST-elevation on the ECG' and designing a pathway that ensures a timely transfer of patients with this to their local angioplasty services or to an angioplasty-capable hospital is a key improvement aim for all providers.

10. ***Recommendation 6**: Those centres with poorer performance for angioplasty times should seek advice from centres with the best performance on how they achieve such good results (see section 2.3.1).*
Primary angioplasty is now the default mode of reperfusion for patients with higher-risk heart attacks. The national data for door-to-balloon times for patients undergoing primary angioplasty are within the standards set but there is still unexplained variation between centres.

There is a growing use of specific techniques that are associated with safer outcomes.

11. ***Recommendation 7**: Clinical leads should ensure they are using radial artery access and drug-eluting stents during PCI whenever this is clinically appropriate to do so. When radial artery access is not being used, patients should be provided with information that informs them why this is the case (see section 3.3).*
There has been a year-on-year increase in the use of radial artery access for angioplasty and the use of modern generation drug-eluting stents, both of which are associated with improved outcomes for patients. There are still some centres, however, that fall well short of the performance of centres with the highest rates.

12. ***Recommendation 8**: Commissioners and clinical leads should ensure that patients who are at high risk for surgical aortic valve replacement are considered for transcatheter aortic valve implantation (TAVI) (see section 4.3.6).*
TAVI procedures are now mostly performed under local anaesthetic and are associated with a more rapid recovery and a shorter length of stay in hospital.

Delays to treatment are reducing but there is room for improvement.

13. ***Recommendation 9**: Hospitals with longer waiting times for adult cardiac surgery should reduce these by seeking advice from centres with good performance (see sections 2.3.3 and 2.3.4).*
Delays for elective and urgent CABG have reduced but there is still considerable variation between centres, with some hospitals showing much longer waiting times than others. These should consider the lessons around the improved use and allocation of resources from hospitals with shorter times.

Improvements to clinical effectiveness

Antenatal diagnosis of congenital heart disease requiring surgical or interventional treatment in infancy improves outcomes.

14. ***Recommendation 10**: Commissioners and providers of obstetric services with the support of tertiary centre fetal cardiologists should ensure that there is access to training and appropriate equipment for sonographers to support the prenatal detection of congenital heart conditions (see section 3.1).*
For children with congenital heart disease requiring a surgical or interventional treatment during infancy, there continues to be year-on-year improvements in the antenatal diagnosis of the congenital malformation although considerable regional variation persists. More than 4 in 10 of these children are now antenatally diagnosed.

Access to immediate and follow-up specialist care for patients is associated with better outcomes.

15. ***Recommendation 11**: Hospital providers and directors of nursing should review their clinical pathways for patients with lower-risk heart attacks as their primary diagnosis (see section 2.2.1).*
Patients with lower-risk heart attacks as their primary diagnosis benefit from being cared for on cardiology wards where possible.

16. ***Recommendation 12**: Hospital providers and directors of nursing should review their pathways for patients with heart failure and where this is a primary diagnosis these patients should ideally be cared for on a cardiology ward with access to heart failure specialist teams (see section 3.5.2 and 4.4.2).*
Patients admitted to hospital with heart failure who are cared for in a cardiology ward are more likely to be seen by a heart failure specialist team and significantly more likely to receive the recommended disease-modifying drugs. There has been an increase in the proportion of patients admitted to medical wards who are seen by the specialist teams but there is considerable variation between hospitals.

17. ***Recommendation 13**: Commissioners should ensure that access to specialist follow-up and to cardiac rehabilitation services is available to all patients following a heart attack as well as to patients admitted with heart failure (see section 3.6.2).*
Access to specialist follow-up and to cardiac rehabilitation services is associated with improved outcomes for patients.

18. ***Recommendation 14**: Commissioners should expect and clinicians should provide an evidence-based 'bundle-of-care' for patients with heart attacks (see section 5.1.2). The NCAP*

will work to facilitate this.
Heart attack patients ideally benefit from the appropriate combined use of angiography, revascularisation, stopping smoking and appropriate advice on life-style choices, optimal secondary preventive medication and cardiac rehabilitation.

Timely care for patients with heart attacks improves outcomes and provides more efficient services.

19. ***Recommendation 15**: Medical directors and clinical leads should review their local patient flow data to ensure that the time taken from presentation and diagnosis to angiography and revascularisation for patients with lower-risk heart attacks is as efficient as possible (see section 2.3.2).*
Almost half of all patients with lower-risk heart attacks are not receiving treatment within current guidelines on the time to angiography and there is significant variation in performance between centres. Patients presenting to a hospital without angioplasty facilities experience longer delays. Improvement in the timeliness of access to treatment could result in significant reductions in lengths of stay in hospital for patients.

Driving future quality improvement through audit

The NCAP programme is committed to supporting improvements in the quality of care delivered to patients. The programme will continue to collect data to capture areas of good practice that can be shared across the system and will also identify unwarranted variations in care where performance will need to be improved. From these data the audit will define national improvement aims that when achieved will have maximum impact on patient care. To support clinical teams, commissioners and patients in achieving these aims, the audit programme will provide a range of new outputs designed to optimise local quality improvement initiatives.

20. **Focus the audits on defining ambitious standards for quality of care.**
NCAP has commissioned a new IT platform with enhanced capability to support both data collection and reporting:

- a more comprehensive assessment of the clinical pathway, measuring all relevant aspects of the care pathway that have most potential to improve patient care
- incorporating new treatments into audits in a timely fashion, to ensure the audit reflects best clinical practice
- more timely and more frequent reporting of data
- better visualisation of data to support identification and communication of the key improvement messages
- increasing the value of audit outputs through the development of analytical approaches, risk models, and support of robust, real-world evaluations of treatment (this extended use of audit data will 'future proof' quality improvement).

21. **Use organisational audits to help identify the steps needed to deliver improved quality of care.**
'Organisational audits' are used by other national audits to understand the various inter-related changes that are made by hospitals in delivering improvements to services (including staffing, clinical and pathway protocols, levels of infrastructure, governance, partnership working and training).

22. **Focus more on outcomes that matter most to patients.**
The aim is for NCAP to expand the range of patient outcome measures further, beyond mortality into additional aspects of morbidity, improved patient experiences and quality of life.

23. **Understand the impact of changing demographics.**
The absolute number of elderly people in the UK is increasing, more people are living with long-term conditions, the younger population is seeing a rise in heart-disease-related risk and there is an increased incidence of congenital heart disease in certain ethnic groups. All of these are significant changes for commissioners and policy makers to deal with and the audits have a vital role to play in providing information that can make the most effective use of available resources to deliver high quality care to these groups across the entire system of health and social services.

24. **Make use of increased data linkages to explore system-wide factors and track the entire 'patient journey'.**
A fundamental aim of bringing the NCAP audits together is to make greater use of linked data (both across the audit datasets and with others) to look at a much wider set of factors related to heart disease and to track the whole clinical 'journey' for each patient, between community and hospital care, thereby creating new insights into the drivers of quality improvement and how that can be achieved. Steps will be taken to provide the best audit information while minimising the burden of data collection.

25. **Understand how the audit data are used by various levers for improvements of healthcare in the NHS and therefore the need for timely and accurate data.**
The NCAP audits are being aligned to other levers for improvements in healthcare, including Best Practice Tariff (BPT), Get It Right First Time (GIRFT) and the metrics used for the Care Quality Commission (CQC) reports.
***Recommendation 16**: To allow timely assessment of performance and to ensure that every hospital is assessed correctly, hospital management teams must ensure that accurate data are provided to the national audit programme on time (see section 1.4).*

A summary of all key messages and recommendations can be found here.

1 Using audit to improve services for heart conditions

The newly-integrated National Cardiac Audit Programme (NCAP) covers cardiovascular medical and surgical specialties, bringing together six major national clinical audits of patients treated in the UK for heart disease. The NCAP outputs are delivered by the National Institute for Cardiovascular Outcomes Research (NICOR).

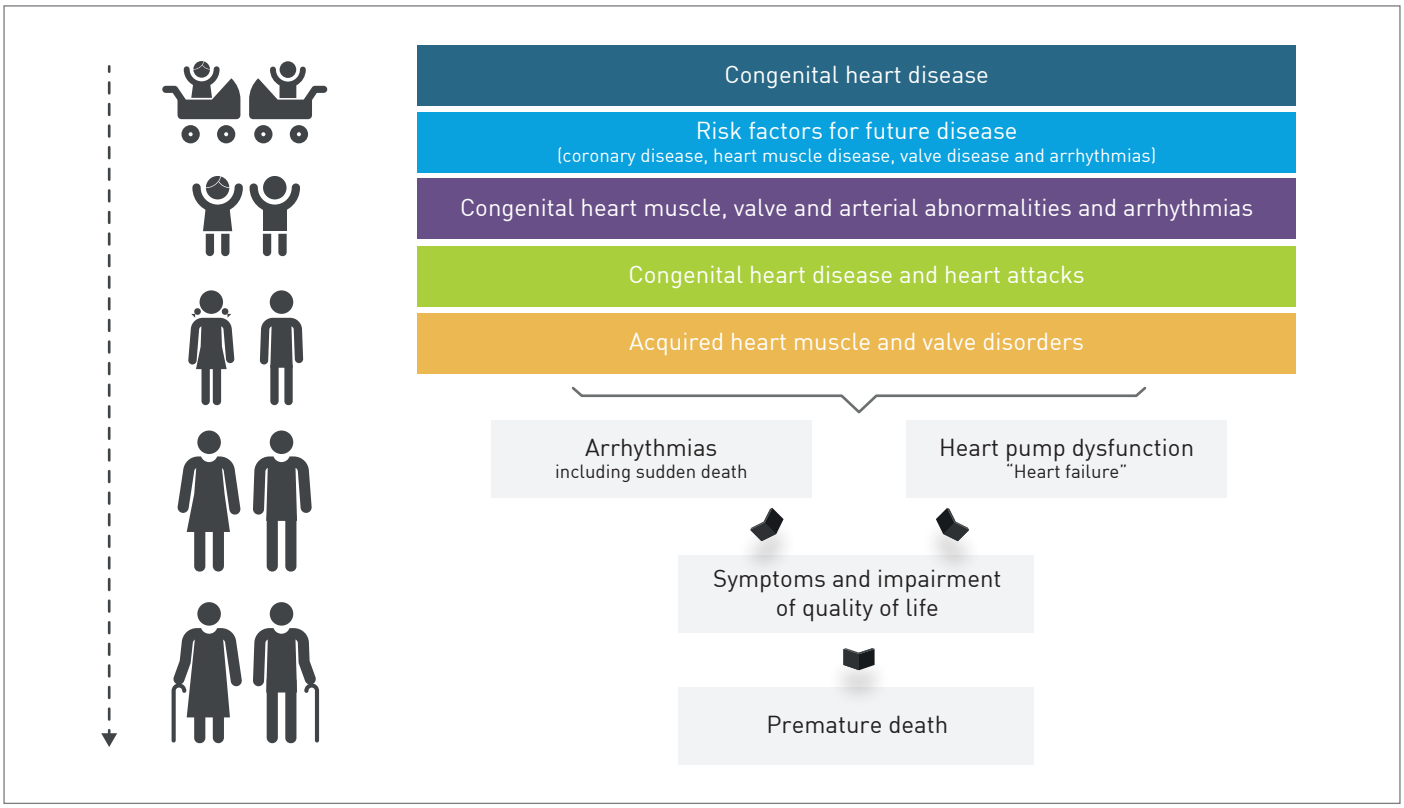
Commissioned by the Healthcare Quality Improvement Partnership (HQIP) with funding from NHS England and GIG Cymru/NHS Wales, this is the first combined report that NCAP has published. Funding from Scotland has now been provided for some of the six audits and funding from Northern Ireland and the Republic of Ireland is under consideration. The report's primary aim is to share key messages and recommendations concerning quality improvements in the management of cardiovascular disease.

This aggregate report summarises quality improvements based around three themes: safety, clinical effectiveness and patient outcomes. It does not include all the analyses from the audits; the full set of analyses separated by each sub-specialty is available here.

1.1 NCAP tracks the major treatments that patients with heart conditions might need throughout their lifetime

Heart disease can affect people at any point in their life (Figure 3).

Figure 3 – Continuum of heart conditions covered by NCAP



Across this continuum, the six audits within NCAP are:

- **Congenital audit** – about one percent of children are born with abnormalities of the structures of their heart and/or major blood vessels, known as congenital heart disease. Operations and interventions can be undertaken from birth through to adulthood, encompassing life-long management of these conditions.
- **Heart Attack audit** – a common condition in adults is coronary heart disease, which has a range of consequences, including heart attacks.
- **Angioplasty audit** – coronary patients with obstructions in their arteries may require techniques to improve blood flow (called coronary revascularisation). This could involve the insertion of stents, known as percutaneous coronary intervention (PCI) or 'angioplasty'.
- **Adult Surgery audit** – adult patients with acquired diseases of the blood vessels, valves or the muscle of the heart may require heart surgery. The commonest operation is a

coronary artery bypass graft (CABG), where a narrowed coronary artery may be 'bypassed' using a vessel taken from inside the chest wall, the leg or the arm.

- **Heart Failure audit** – patients with diseases of the heart muscle, for example as a result of heart attacks or from congenital conditions, might develop heart failure, which is worsening of the heart's ability to pump blood.

- **Arrhythmia audit** – patients of all ages are prone to heart rhythm disturbances but the more dangerous rhythm disturbances occur most commonly in patients with badly damaged heart muscle, whatever its cause.

Appendix A contains more detailed descriptions of the nature of each cardiovascular condition and treatments.

1.2 The NCAP data collections are run in collaboration with a number of professional societies

Clinical data on the treatment of cardiovascular disease have been collected in one form or another since the 1970s. Six major sub-specialties have their own data collection and reporting systems, with the datasets designed by clinicians working in collaboration with key professional societies (Table 1).

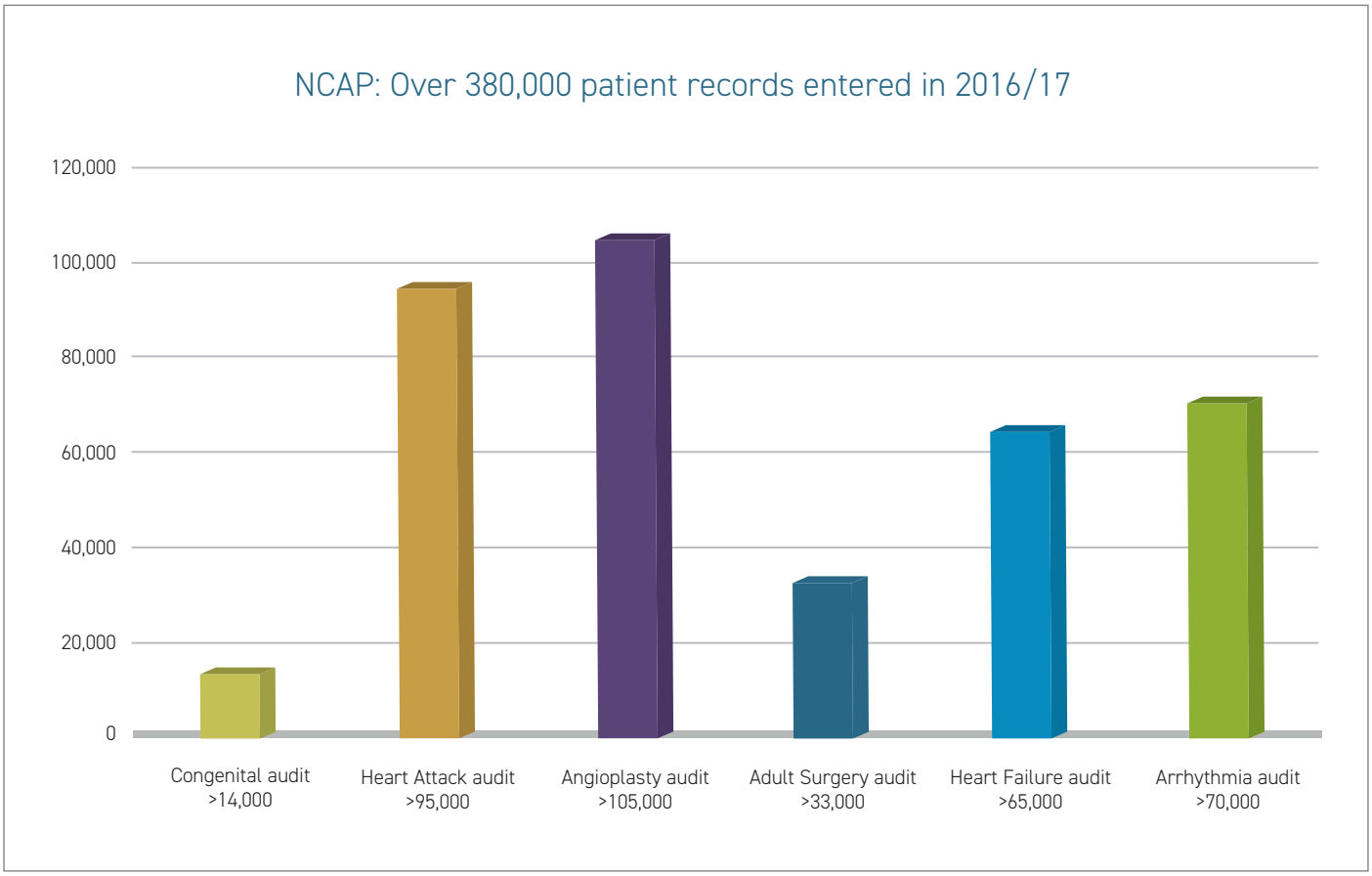
Table 1 – The aim of each of the national cardiovascular data collections in NCAP in partnership with the professional societies

Sub-specialties	Aim	Coordinating professional society
National Congenital Heart Disease Audit (NCHDA) 'Congenital audit'	To examine and improve service delivery for and outcomes of infants, children, adolescents and adults undergoing interventions for paediatric and congenital heart disease	British Congenital Cardiac Association (BCCA) Society for Cardiothoracic Surgery in Great Britain and Ireland (SCTS)
Myocardial Ischaemia National Audit Programme (MINAP) 'Heart Attack audit'	To examine and improve service delivery for and outcomes of patients admitted to hospital with an acute coronary syndrome (unstable angina or heart attack)	British Cardiovascular Society (BCS)
National Audit of Percutaneous Coronary Intervention (NAPCI) 'Angioplasty audit'	To examine and improve service delivery for and outcomes of patients undergoing coronary angioplasty	British Cardiovascular Intervention Society (BCIS)
National Adult Cardiac Surgery Audit (NACSA) 'Adult Surgery audit'	To examine and improve service delivery for and outcomes of adult patients undergoing cardiac surgery	Society for Cardiothoracic Surgery in Great Britain and Ireland (SCTS)
National Audit of Heart Failure (NAHF) 'Heart Failure audit'	To examine and improve service delivery for and outcomes of patients admitted to hospital with heart failure	British Society for Heart Failure (BSH)
National Audit of Cardiac Rhythm Management (NACRM) 'Arrhythmia audit'	To examine and improve service delivery for and outcomes of patients undergoing therapeutic electrophysiology procedures (ablations) or electronic device implantation to manage cardiac rhythm disturbances	British Heart Rhythm Society (BHRS)

1.3 More than 380,000 patient records were entered into the NCAP dataset in 2016/17

The numbers of patient records entered into each audit in 2016/17 are shown in Figure 4.

Figure 4 – Patient records entered into the NCAP in 2016/17



1.4 Audit data are used to assure and enhance quality of care in a number of ways

Responsibility for the NCAP was brought together in NICOR, which now collects and manages the data from hospitals. The dataset for each audit broadly follows the 'clinical pathway' from admission of a patient to hospital until their discharge. The required data items are designed to answer some key questions:

- How is treatment delivered across the country, including the number of hospitals delivering services and the volume of procedures undertaken?
- How are specific treatments provided and is that treatment appropriate?
- What clinical outcomes are associated with that treatment?

In terms of supporting quality, the resulting data provide a means of:

- driving up the quality of care in all hospitals, and for all operators, to the standards or benchmarks that are already known to be achievable (quality improvement)
- ensuring that high quality services are maintained (quality assurance)

thus raising the standards of care over time by identifying changes in the way care is provided and measuring whether these changes are associated with better outcomes for patients. The NCAP audits are being aligned to other levers for improvements in healthcare, including Best Practice Tariff (BPT), Getting It Right First Time (GIRFT) and the metrics used for the Care Quality Commission (CQC) reports.

***Recommendation**: To allow timely assessment of performance and to ensure that every hospital is assessed correctly, hospital management teams must ensure that accurate data are provided to the national audit programme on time.*

Appendix B has more information on NICOR's role in maintaining the NCAP data system and the audit methodology.

Box 1
The NCAP audits have contributed to the adoption of new technologies and processes and more consistent practice

Continuous publication of audit metrics has allowed hospitals and clinicians to see how they perform versus others and to discuss and implement selected improvements. Examples include:

- *the publication of antenatal diagnosis rates for infants requiring a procedure at a regional level, leading to targeted training and provision of equipment and a year-on-year improvement in antenatal detection rates over the past decade*
- *the creation of a best-practice tariff that rewards hospitals for providing coronary angiography in a timely fashion for lower-risk heart attack cases*
- *the early administration of thrombolysis in high-risk heart attacks and, following publication of the National Infarct Angioplasty Project (NIAP), the 'roll-out' of timely primary angioplasty*
- *the use of Heart Attack audit data to improve secondary preventive therapy following acute coronary syndromes and, through high quality observational research, to inform national (National Institute for Health and Care Excellence (NICE)) and international (European Society of Cardiology (ESC)) guidelines on management of acute coronary syndromes*
- *the increased use of the generally safer radial artery access for angioplasty, rather than via the femoral artery*
- *the creation of a best-practice tariff for including sufficient cases in the Heart Failure audit to demonstrate that most relevant patients with heart failure are seen by a specialist team*
- *the use of Heart Failure audit data to improve optimal medical therapy and access to specialist heart failure services*
- *the use of Arrhythmia audit data to improve rates of physiological pacing.*

1.5 This report heralds an even stronger focus on identifying and communicating the quality improvement learning from the NCAP audits

The current report emphasises three broad themes:

- **Safety** – how can services be made safer? (Section 2: Improvements to safety)
- **Clinical effectiveness** – are the best treatments being used and is care being delivered effectively? (Section 3: Improvements to clinical effectiveness)
- **Patient outcomes** – what can we do to improve patient outcomes? (Section 4: Improvements to patient outcomes).

The specific metrics captured by each audit that relate to these quality themes are shown in Table 2. The important messages that are reported for each of these metrics highlight the value and continued opportunities for quality improvement from comprehensive, longitudinal national audit.

As noted earlier, this aggregate NCAP report focuses on these quality improvement themes and does not describe all the data available. Additional analyses for the individual audits are available here.

1.6 The data in this report primarily cover the 2016/17 financial year

In most cases, the latest data in this report relate to the 2016/17 financial year.

For two audits, three-year rolling data are provided:

- Adult Surgery audit (some data are also broken down into the three individual years to give temporal trends)
- Congenital audit (because the number of specific procedures performed each year is relatively low).

For the Angioplasty audit, 2016 calendar year data are provided, with three-year rolling calendar year data used in the consultant outcomes reports (published separately here).

1.7 The results of the Arrhythmia audit will be published later in 2018

This report covers five of the six audits in NCAP. A further report will be issued soon to highlight the findings and quality improvement suggestions from the Arrhythmia audit (as the validation and analysis for this is ongoing).

Table 2 – Quality improvement themes: relevant metrics reported in each audit (see Glossary for explanation of abbreviations)

Type of metric	**Congenital audit (NCHDA)**	**Heart Attack audit (MINAP)**	**Angioplasty audit (NAPCI)**	**Adult Surgery audit (NACSA)**	**Heart Failure audit (NAHF)**	Arrhythmia audit (NACRM)
Safety	Number of procedures (paediatric/adult): ■ overall ■ surgical ■ interventional ■ electrophysiology	For NSTEMI: ■ admission under cardiologist ■ admission to cardiac ward ■ timeliness to angio For STEMI: ■ call-to-door times for PPCI ■ door-to-balloon times for PPCI ■ call-to-balloon times for PPCI ■ temporal trends	Centre case volume For NSTEMI: ■ time to PCI ■ split for admission route	Waits for CABG: ■ urgent cases ■ elective cases ■ temporal trends		Not included in this version of the report. Results will be published later in 2018.
Effectiveness	Antenatal detection and diagnosis: ■ overall in those requiring an intervention ■ for two specific diagnoses: hypoplastic left heart syndrome; and transposition of the great arteries with intact ventricular septum	Discharged on appropriate medications (both STEMI and NSTEMI) % of STEMI not receiving reperfusion therapy % of STEMI patients having an echocardiogram	Hospital radial access Operator radial access in COP (all cases)		% of HFrEF patients discharged on ACEi/ARB % of HFrEF patients discharged on beta blocker % of HFrEF patients discharged on MRA % seen by a specialist	
Outcomes	30-day risk-adjusted mortality: ■ aggregate 30-day mortality for all paediatric cardiac surgery procedures, risk adjusted using PRAiS2 methodology ■ 30-day mortality for 83 individual procedures, surgical and interventional, in children and adults	30-day unadjusted mortality (STEMI only)	30-day risk-adjusted mortality All cases (with the exception of those needing pre-PCI ventilation)	In-hospital mortality Reoperation: ■ any cause ■ bleeding ■ infection New dialysis New post-op CVA	Unadjusted aggregate in-hospital mortality 30-day 1-year	

2 Improvements to safety

2.1 The volume of procedures carried out can be a significant factor in developing the necessary skills and infrastructure

2.1.1 Minimum volumes have been recommended for a number of services

It is generally accepted that the more one practises a specific skill, the greater the performance improvement – 'practice makes perfect' – and professional societies and commissioners have recommended minimum volumes of activity at hospitals for particular services, including:

- Congenital heart disease – an expert group of commissioners, clinicians and regulators have suggested minimum volumes of activity for both individual operators and hospitals undertaking congenital heart procedures.[2]
- Rhythm management – the British Heart Rhythm Society (BHRS) has recommended minimum volumes of activity for individual operators and hospitals performing ablation procedures and implanting electrical devices.[3]

Furthermore, data from the USA confirm an association of better outcomes in relation to heart failure for high volume centres.[4]

2.1.2 Analysis of outcomes relating to volume of procedures is complex

In several countries, a volume–outcomes relationship has been shown to exist for angioplasty, especially for urgent and emergency use of angioplasty and this led to national recommendations on the minimum volume of activity that centres should aspire to. However, a recent analysis of risk-adjusted outcomes looking at UK services failed to show a volume–outcomes relationship.

There are a number of possible explanations for these different results. The UK analysis was performed evaluating the organisation of services as recommended by the national guidelines, and it suggests that this organisation (in effect, recommending against very low volume centres) may be the key to delivering consistent outcomes.[5] These results are reassuring. That said, there is a group of hospitals that do not meet the activity as set out by the national standards.

***Recommendation**: Hospitals with an angioplasty centre should aim to meet the recommended annual activity volumes for angioplasty procedures. All angioplasty centres should report on outcomes to ensure a high quality of care.*

The organisation of congenital cardiac services is also based on national standards.[6] There are currently no data to show the effect of implementing these recommendations across the country but the expectation is that higher volumes will deliver a more consistent and sustainable service with the appropriate infrastructure to treat these complex patients. As with angioplasty services, previous analysis of the Congenital audit data was not able to identify a statistically-significant volume-outcomes relationship for UK centres undertaking paediatric cardiac procedures although there was a definite trend to support better outcomes in larger centres. This supports the way that congenital heart centres have been commissioned in the UK over the last decade, not allowing centre volumes to fall to the low numbers that can occur in other countries (including the USA).

NHS England has recommended national standards for staffing, related patient volumes and infrastructure that are based on the expectation that this will ensure a consistent and sustainable service to help continue to improve the outcomes for these complex patients. The NHS England review concluded that not all English centres treating children and adults fully met the current requirements. Hospitals undertaking congenital cardiac surgery should continue to work with specialist commissioners and aim to meet the NHS England Standards, which will be reviewed again in three years' time.[7]

***Recommendation**: Hospitals undertaking congenital cardiac surgery in England should continue to work with specialist commissioners and aim to meet the NHS England Standards for the number of surgeons and associated volume of surgical activity.*

2.1.3 Volume of activity is not the only consideration for good outcomes

Volume of activity is not the only consideration for good outcomes and there are other issues to consider. These include the sustainability of services, the number of support staff, the required infrastructure and the frequency of on-call commitments. However, the reported performance of hospitals or clinicians is less likely to be influenced by a small number of atypical cases when the overall number of cases is large.

To see the volume of activity for individual local services, click here.

2.2 Access to specialist care is important for safety, and work is needed to address variations in provision

2.2.1 More patients with lower-risk heart attacks should be admitted under specialist teams

In the case of heart attacks, the routine provision of primary angioplasty necessarily leads to patients with ST-elevation myocardial infarction (STEMI) (higher-risk heart attacks) being managed by cardiologists, physiologists and nurses in specialised cardiac facilities during the early part of their admission to hospital. For those with non-ST-elevation myocardial infarction (NSTEMI), which we refer to as 'lower-risk heart attacks' in this report (see Appendix A), the situation is more varied.

The Acute Cardiac Care Association of the European Society of Cardiology (ESC) recommends that patients with lower-risk heart attacks should be admitted to a cardiac ward/cardiac unit for non-invasive monitoring.[8] The proportion of patients with lower-risk heart attacks admitted to cardiac wards has improved a little, from 56.9% (2014/15) to 59.6% (2016/17), but could still be considered disappointingly low.

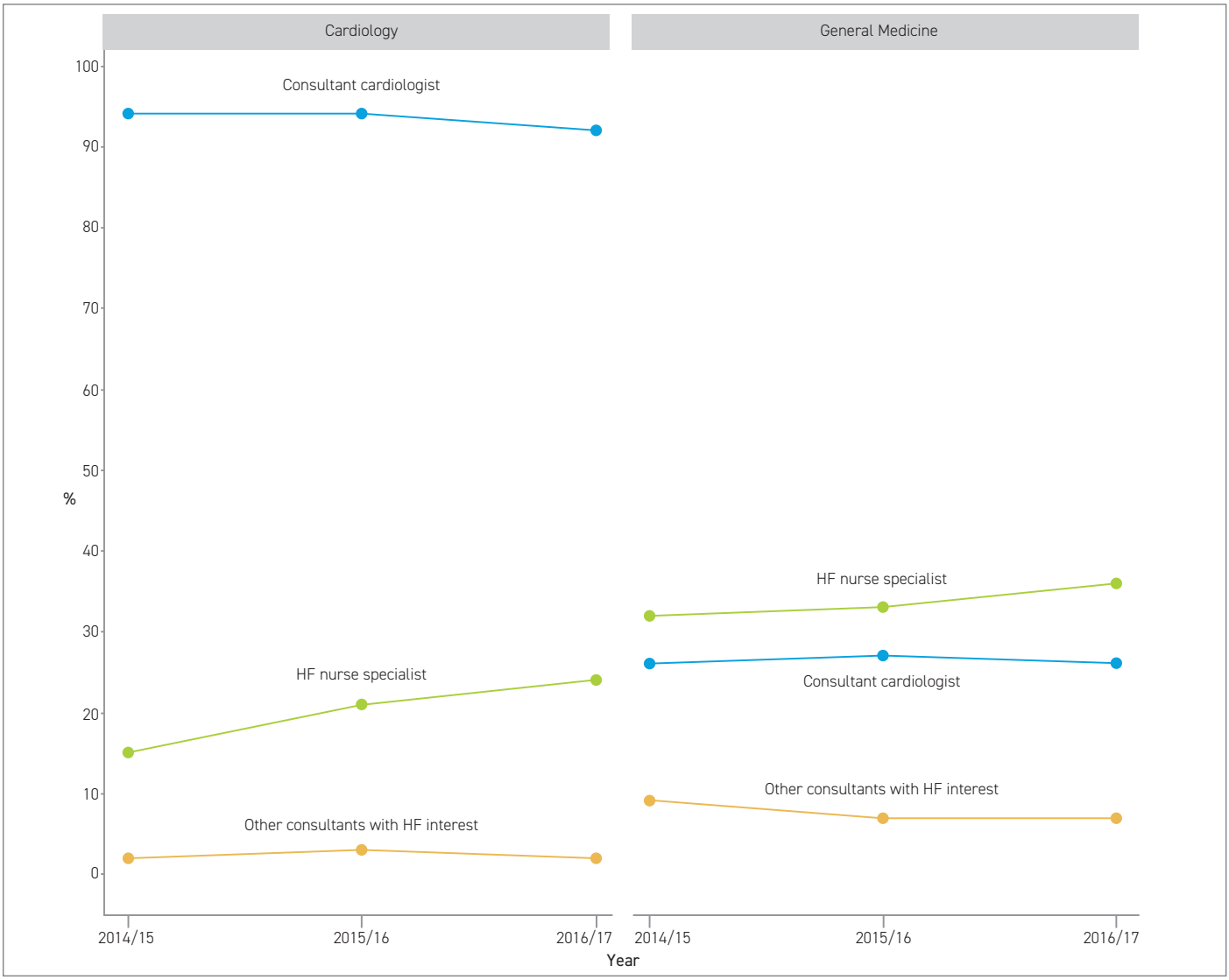
Furthermore, previous observational research using the Heart Attack audit data showed that outcomes were better for such patients if they were admitted under the care of cardiologists and their teams, rather than under generalists.[9] Providing immediate cardiology input is difficult and requires adequate staffing and organisation. Nevertheless, the proportion of patients being seen by a cardiologist while in hospital remains high: 94.8% in 2014/15 and 96% in 2016/17. However, many smaller hospitals do not have sufficient cardiology consultants, registrars or nurse specialists to provide immediate cardiology care to all patients with lower-risk heart attacks.

***Recommendation**: Hospital providers and directors of nursing should review their clinical pathways for patients with lower-risk heart attacks as their primary diagnosis.*

2.2.2 Patients with heart failure should have the opportunity to see a heart failure specialist team during the admission

The proportion of patients admitted with heart failure seen by some form of heart failure specialist remained at the same level (80%) between 2014/15 and 2016/17. The main shift within this overall figure was an increase in the proportion of those seen by a heart failure nurse specialist (rising from 24% to 31%) and the slight fall in those seen by a consultant cardiologist (from 58% to 56%). For heart failure patients on a cardiology ward, over 90% of patients were seen by a consultant cardiologist (Figure 5).

Figure 5 – Proportion of heart failure patients seen by specialists according to their place of admission (England and Wales, 2014/15 to 2016/17)



To see the data for access to specialist care in local services, click here for the Heart Attack audit and the Heart Failure audit.

Box 1
The NCAP audits have contributed to the adoption of new technologies and processes and more consistent practice

Portsmouth Hospitals NHS Trust is a District General Hospital that provides care to a large population of around 600,000. During 2014/15, the heart failure team consisted of two cardiology consultants, two full-time nurses and a healthcare support worker. The nursing team only covered cardiology and medical wards and therefore saw many, but not all, inpatients with heart failure. Data for these patients were entered onto the NICOR national Heart Failure audit by the nurses and healthcare support worker. The nursing team also ran daily outpatient clinics for the most complex patients with heart failure and for those who did not meet the criteria to attend the community services (e.g. patients with heart failure with preserved left ventricular function).

This period saw a significant increase in the number of patients discharged with a hospital episode statistic (HES) code of heart failure. The national audit report from that year showed the number of patients entered on to the database by the Trust was below the 70% target. Internal audits confirmed that we were missing substantial numbers of patients. These patients did not therefore benefit from multidisciplinary care and the associated proven improvements in outcomes.

To address this, a business case based on the uplift in funding provided by the heart failure Best Practice Tariff allowed an expansion of the team to include more consultant time, 1.5 more full-time nurse specialists and a full-time administrative assistant. It also allowed us access to natriuretic peptide assays for inpatients.

As a result, inpatients with heart failure are now seen regardless of where they are in the Trust, allowing equitable access to the multidisciplinary team for all. Accessibility of the team has been further enhanced by implementation of electronic referrals and via advertising.

The expansion of the team allowed us to meet the national audit targets of specialist review for at least 60% of heart failure inpatients and 70% data entry onto the audit.

Expanding the team has also allowed us to establish a dedicated clinic for outpatients with suspected heart failure that is fully compliant with the 2- and 6-week NICE targets. Patients with suspected heart failure seen in the clinic have much lower admission rates than those who are not. The associated income generation was also influential in obtaining funding for a third heart failure consultant.

We established a weekly multidisciplinary team meeting chaired by a heart failure consultant. The meeting is well attended and allows discussion of patients with complex needs which facilitates good clinical care. It is also an opportunity to review case notes of patient episodes coded as heart failure to ensure accurate data entry into the NICOR Heart Failure audit.

There has been a significant improvement in how we deliver care to our heart failure patients. This was achieved as a result of a lot of enthusiasm from the entire heart failure team and facilitated by the heart failure tariff.

In the 3-month periods after these service changes, 164 more inpatients were referred compared to a comparable preceding 3-month period. There has been a 30% increase in the number of patients seen by a heart failure specialist team.

We still have a lot to do and high on the agenda is access to cardiac rehabilitation for all heart failure patients.

One patient who has benefited from cardiac rehab said, "I had 11 days in hospital and the staff were first class and I felt supported all the way through. My heart failure nurse Trish and the cardiac rehab team have been brilliant. With the classes sometimes I had to sit down doing the exercises. At first I felt 'Why me?' but then in classes I found I wasn't alone. Talking to others is very important. I have volunteered to be the treasurer at our new heart support group we are setting up."

Dawn Lambert, Lead Heart Failure Nurse Specialist, and
Geraint Morton, Consultant Cardiologist

2.3 Time to treatment impacts on clinical effectiveness, service efficiency and patient experience

For many aspects of cardiovascular care, the timeliness of a particular intervention – the delay from the recognition of the need for a treatment to the time that treatment is provided – gives an indicator of quality of care. Such a delay may best be expressed in seconds (for example the start of resuscitation following cardiac arrest), minutes (for example the performance of primary angioplasty for higher-risk heart attacks), hours (for example initial time spent in the Emergency Department, or the performance of a coronary angiogram in patients with lower-risk heart attacks) or days and weeks (for example the waiting time to undergo a coronary artery bypass graft operation).

As new therapies become standard treatment, the desire is always to provide services locally for the convenience of patients and their relatives and carers. This requires a build-up of local expertise and thus a transformation of the services that have existed previously.

While the provision of local treatment can help in enabling timely access to some aspects of care, there can also be competing issues to consider. For example, insufficient local infrastructure might mean that care is not available at all times, or procedures may only be performed infrequently; both these

factors might adversely affect the quality of services. However, where common treatments cannot be provided locally, regional centres can be used to provide specialised services that require specific skills, infrastructure and complex sets of treatments for smaller groups of patients with less common conditions.

This balance between what should be delivered regionally or even supra-regionally and what can be delivered locally will change over time but the level of skill specialisation and the growing requirements for efficiencies in healthcare give an impetus towards fewer but larger centres. This is likely also to improve quality of care as well as provide training and research opportunities.

Although there are concerns about access to treatment, it should be remembered that (by international standards) the UK is a comparatively small country. The majority of the population lives relatively close to a specialised cardiac centre that can provide a comprehensive range of cardiovascular services.

2.3.1 For higher-risk heart attacks, ambulance performance has declined slightly and some hospitals have much higher treatment time than others

The presence of ST-segment elevation on the electrocardiogram (ECG) of a patient with typical cardiac chest discomfort is highly suggestive of an abrupt and complete occlusion of a coronary artery (STEMI). The preferred management is immediate transfer to the cardiac catheter laboratory of an interventional cardiac centre for primary angioplasty, so that the blocked artery can be reopened. The sooner this happens, the less likely is the heart to suffer severe permanent damage, heart failure, disability or death. Particularly for those patients who present soon after the onset of symptoms, prolongation of the delay to treatment can lead to significant reduction in the potential for heart muscle salvage. Analysis of the Angioplasty audit confirms that, even in the era of organised national primary angioplasty services, longer delays to treatment are independently associated with greater 30-day mortality.[10]

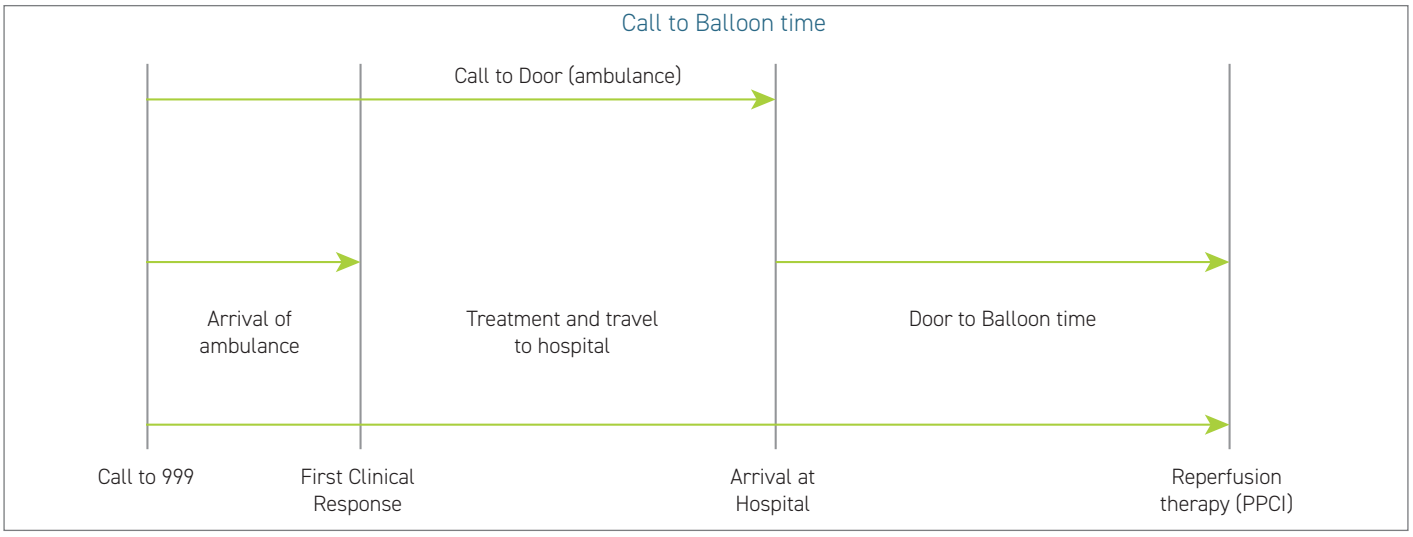
The majority of such patients with these higher-risk heart attacks call the emergency ambulance service for assistance (though approximately 15% arrive at hospital unexpectedly). This allows a number of measures of the timeliness of care (Figure 6):

- **Call-to-balloon time** – the interval between the call for help to the emergency service and the beginning of the angioplasty procedure; an expression of the overall response of the healthcare system. The NICE quality measure suggests that a call-to-balloon time of up to 150 minutes is acceptable.[11] A position paper of the British Cardiovascular Intervention Society (BCIS) endorsed an audit standard of a call-to-balloon time of less than 150 minutes in at least 75% of patients (excluding those presenting with very low blood pressure or needing ventilation before the angioplasty).[12]

- **Door-to-balloon time** – the interval between the time the ambulance stops outside the hospital (or the patient 'self-presents' at the hospital) and the beginning of the angioplasty procedure. This is an expression of the 'hospital response', though the performance of an ECG before arrival at hospital and early warning by the ambulance service can alert the receiving hospital and so reduce this interval. A door-to-balloon time of less than 90 minutes has been the standard for hospital response to higher-risk heart attacks. However, a position paper of the BCIS suggested that optimal performance should be defined as a door-to-balloon time of less than 60 minutes in at least 75% of patients (excluding those presenting with very low blood pressure or needing ventilation before the angioplasty).[13]

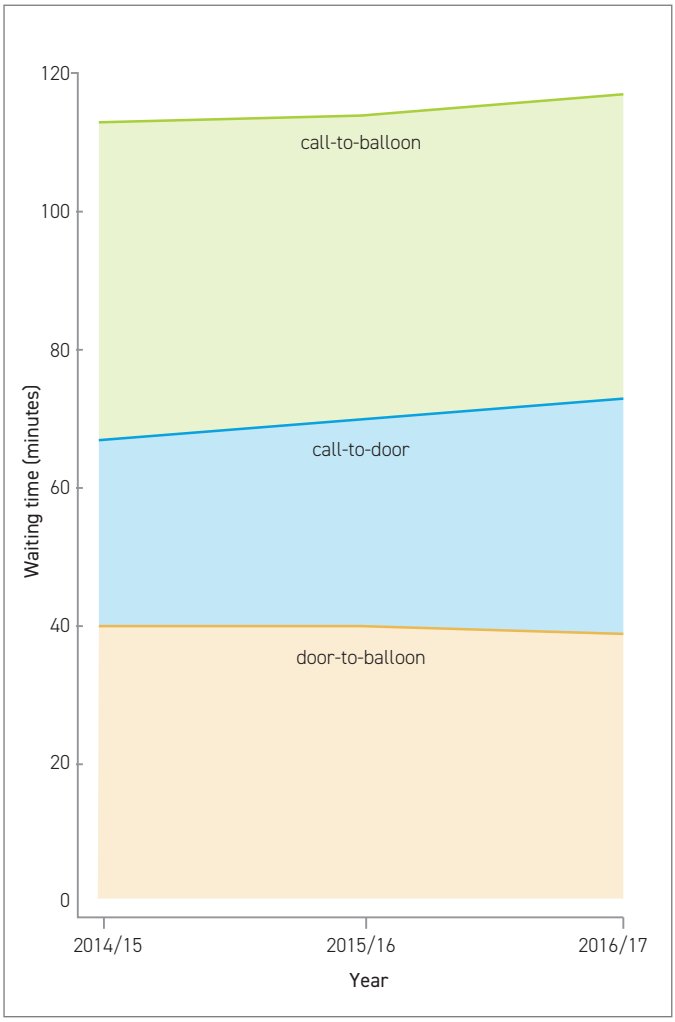
- **Call-to-door time** – the interval between the call for help to the emergency service and the time the ambulance stops outside the hospital: an expression of the ambulance service response including the prioritisation of the call, the ambulance response time, the diagnosis and treatment at scene and the transport time. The call-to-door time is likely to be longer in more remote areas.[14]

Figure 6 – Categorisation of times to angioplasty treatment for patients with heart attacks (call-to-balloon, door-to-balloon and call-to-balloon) (PPCI = primary percutaneous coronary intervention – see Glossary)



For higher-risk heart attacks, the most obvious change over the last three years has been a lengthening of the call-to-door interval, combined with static door-to-balloon time, resulting overall in slightly increased call-to-balloon times (Figure 7).

Figure 7 – Call-to-door, door-to-balloon and call-to-balloon times for patients with higher-risk heart attacks undergoing primary angioplasty (England, Wales and Northern Ireland, 2014/15 to 2016/17)



The median call-to-door time has increased progressively over the past three years, from 67 minutes in 2014/15 to 73 minutes in 2016/17. Three-quarters of patients arrived at hospital within 83 minutes of calling for help in 2014/15 and within 91 minutes in 2016/17.

The cause for this lengthening delay is unclear. One explanation could be a gradual increase in provision of primary angioplasty services to patients in more remote areas (with consequent prolonged transport times) in more recent years. Yet this seems unlikely given the widespread implementation of such services by 2014. It is possible that increased pressures on ambulance services and/or changes in the priority of response provided to patients with chest pain or breathlessness play a part.

In any case, while door-to-balloon times have remained much the same over the last three years (with a median time of 39 minutes in 2016/17 compared with 40 minutes in 2014/15) this has not compensated for the lengthening call-to-door time, and so overall call-to-balloon time has increased from a median of 113 minutes in 2014/15 to 117 minutes in 2016/17.

Further evidence of increasing pre-hospital delay is provided by analysis of the Angioplasty dataset. Here, the proportion of patients with higher-risk heart attacks (excluding those with shock or those ventilated following cardiac arrest) achieving a door-to-balloon time of less than 90 minutes improved from 88.7% in 2012 to 91% in 2016, yet the proportion of these patients in whom an overall call-to-balloon time of less than 150 minutes was achieved fell from 79.5% to 75.2% over the same period.

The timings for patients admitted directly to a hospital with around-the-clock angioplasty services (50% treated within 117 minutes of call for help; 77.7% achieving a call-to-balloon time of less than 150 minutes*) are very much better than for patients who present to a hospital without angioplasty services, who then have to be transferred to the angioplasty hospital (50% treated within 152 minutes of call for help; 48.9% achieving a call-to-balloon time of less than 150 minutes). In 2016, the median call-to-balloon time was 114 minutes for those admitted directly to the angioplasty centre, compared with 163 minutes for those requiring a transfer from one hospital to another.

These data on timeliness of primary angioplasty are an aggregate of performance from all participating hospitals. Further analysis of the Angioplasty audit data reveals obvious variation between hospitals, and points to opportunities to further improve practice.[15] How local services compare with the national average for timing of delivery of primary angioplasty can be seen here. The NCAP is currently providing data to support an NHS England review of ambulance performance standards.

***Recommendation**: Patients with a suspected heart attack should call an ambulance rather than take themselves to hospital.*

***Recommendation**: Ambulance trusts should review ambulance performance times to ensure they do not impact on angioplasty call-to-balloon times.*

***Recommendation**: Medical directors and their clinical leads should have clinical pathways that ensure the rapid detection of higher-risk heart attacks.*

***Recommendation**: Those centres with poorer performance for angioplasty times should seek advice from centres with the best performance on how they achieve such good results.*

2.3.2 For patients with lower-risk heart attacks, there are still long delays to angiography

For those patients diagnosed with acute coronary syndrome without ST-segment elevation on the ECG (lower-risk heart attacks), immediate angioplasty is not essential. Medical therapy is usually effective in stabilising the situation in the short term. However, for most patients with these lower-risk heart attacks the risk of further coronary events can be reduced by a policy of early coronary angiography with a view

** The Angioplasty audit data are slightly different from the Heart Attack audit data as they are collected over a calendar year rather than a financial year and also cover the whole of the UK.*

to proceeding directly to angioplasty or urgent CABG where appropriate.

Based on evidence from clinical trials, NICE guidelines suggest that a coronary angiogram should be performed within 96 hours of admission to hospital; however, a marker of a good standard of care would be the provision of angiography within 72 hours of admission. This 'acceptable delay' from admission to angiogram applies even if the patient is first admitted to a hospital that does not have the facilities to perform angiography and so needs to be transferred to another hospital for the procedure.

On average, patients across England, Northern Ireland and Wales have to wait 61 hours after admission to undergo angiography. While just under 50% do undergo angiography within 72 hours of admission, there is substantial variation in care and, in England, a quarter of patients with lower-risk heart attacks wait at least 105 hours for angiography.

The overall national situation is of greater concern because these data are presently restricted to those patients – the majority – who are admitted directly to hospitals with angiography facilities. The Angioplasty audit reveals that those patients who require transfer between hospitals before undergoing the procedure – for which angiography is a necessary and immediate precursor – wait approximately 20 hours longer than those who are admitted directly to an interventional centre.

Failure to achieve the quality standard for timely angiography, even when not associated with lasting clinical detriment, leads to potentially avoidable prolonged length of stay in hospital, which is inconvenient for patients, frustrating for clinicians and an inefficient use of resources. From a patient perspective, the ideal is to be investigated and treated at a hospital capable of performing angioplasty.

To see how local services compare with the national average for timeliness of treatment for heart attacks, click here.

***Recommendation**: Medical directors and clinical leads should review their local patient flow data to ensure that the time taken from presentation and diagnosis to angiography and revascularisation for patients with lower-risk heart attacks is as efficient as possible.*

Box 3
Timeliness to angiography for lower-risk heart attacks at the University Hospital of Wales

The University Hospital of Wales delivers tertiary cardiac care to 1.3 million people in South East Wales. Historically, we have struggled to deliver NSTEMI angiography in a timely fashion, with delays for transfer from referral hospitals often reaching 7–14 days. These problems were compounded by launch of the 24/7 network primary angioplasty service in 2012, placing further pressures on bed availability. In recent years, we attempted to address these delays, defining referral criteria, developing e-referral, using dedicated acute coronary syndrome (ACS) nurses to run the service, and identifying a ward area to improve efficiency. In hindsigh,t these developments were relatively modest iterations that did not address the fundamental issues delaying patient transfer, i.e. availability of beds and transfer ambulances. At times of severe front door pressure, a lack of available beds for ACS transfers resulted in major fluctuations in transfer times and only modest improvements in overall median delay to angiography. A more fundamental change of approach was required.

Having identified the weaknesses in the system, we put in place robust solutions to deliver timely transfer and angiography. We converted the four-bedded ACS cardiology ward space into a regional Treat & Repatriate Unit. Beds were replaced with trolleys (thus in essence protecting them from being filled by other patients), with the area open on a day-case basis only. We changed our whole ethos of regional NSTEMI care from one of planned transfer, inpatient admission for treatment and discharge home for our hospital, to one of a day-case visit from the referral hospital, immediate angiography+/–angioplasty followed by same-day repatriation back to the referral hospital afterwards. Central to the success of a treat and repatriate system is ambulance support. Our traditional ambulance service could understandably not guarantee timely transfers due to unpredictable emergency pressures, and the knock-on effect of late transfers would be late angiography (or no angiography at all), cancelled repatriation and further delays. The solution to this was to contract St John's Ambulance to bring patients to the Treat & Repatriate Unit from referral hospitals early in the day and return them back following angiography+/–angioplasty. We also created dedicated catheter laboratory slots, changing the ethos of the catheter laboratories in moving away from the traditional fixed elective and ACS laboratories, to a more fluid approach, mixing patients between laboratories and consultants in response to clinical priority and transfer timelines.

The early results have been very encouraging, with compliance with angiography within 72 hours improving from less than 30% of patients to greater than 85% of patients in the first 3-month pilot, along with significant reductions in length of stay. Feedback from patients, relatives, staff and referral hospitals has been universally positive. There remain challenges to solve, however, in particular maintaining performance in the longer term and also funding of the dedicated ambulance service. Although huge costs savings can be found in reduced bed stays in referral hospitals, from reduced staff costs (from the closure of the ward area in the evenings and weekends) and from less standard ambulance journeys, we face the perennial NHS problem of moving money from one pot to another. Additionally, like many other hospitals, while 7-day working will reduce delays to angiography even further, delivering this within the current staff and financial framework remains a huge challenge for the future. Notwithstanding these issues, we look forward to continuing our novel service and reporting significant improvement in treatment times for NSTEMI patients in future MINAP reports.

Tim Kinnaird, Lead Interventional Cardiologist and
Sean Gallagher, Consultant Cardiologist

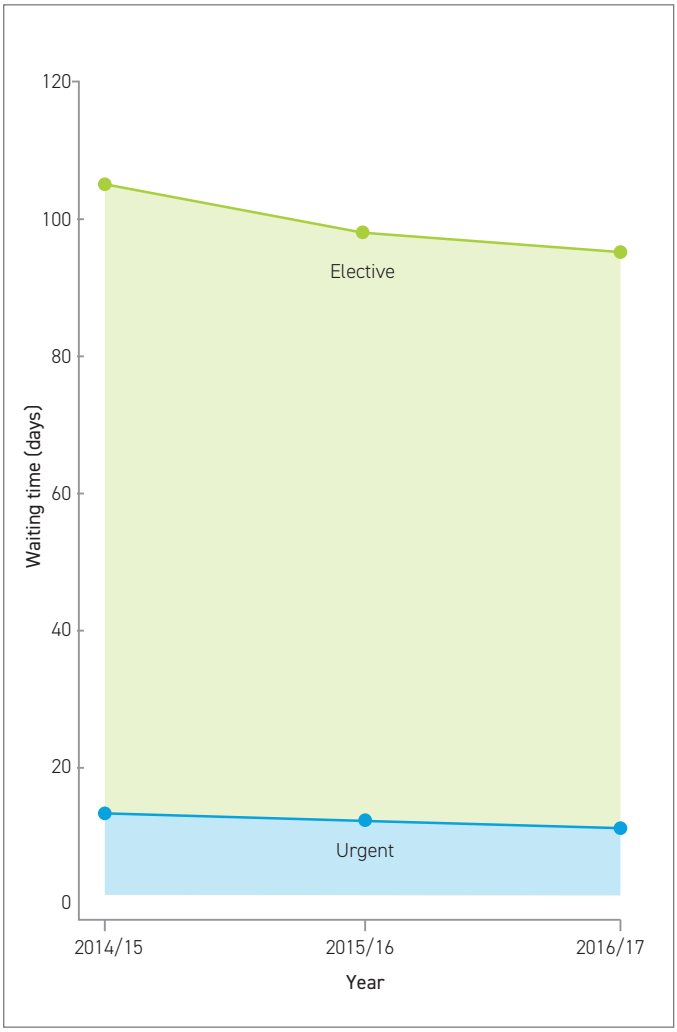
2.3.3 Overall waiting times for elective adult bypass surgery have fallen, but significant variations persist between countries and between individual hospitals

For patients with stable angina, once a cardiologist has performed an angiogram and suggested that CABG might be the best treatment, the patient is referred to a cardiac surgeon for assessment. Once the decision for surgery is confirmed, the patient joins a surgical waiting list for the procedure.

For the purposes of calculating waiting times, the data are based on the time taken from the angiogram to the day the surgery was performed, as this is the portion of the patient pathway over which the surgical centres have control. Also, to remove the effects of different case mix between surgical units, only waiting times for those patients undergoing CABG for the first time have been used as this is performed in every unit and by nearly all cardiac surgeons.

Waiting times across the UK for elective cardiac surgery fell considerably in the 2000s and, based on this audit, continued to fall over the three years between 2014/15 and 2016/17, from a mean of 105 to 96 days (Figure 8).

Figure 8 – Waiting times to elective and urgent first time CABG (UK, 2014/15 to 2016/17)



However, there is still significant variation across the country and at a local level. Data on mean waiting time for elective CABG in 2016/17 show considerable differences between units, from a longest of 154 days to a shortest of 21 days (although the latter was in a hospital predominantly providing private care). The shortest mean waiting time for an NHS hospital was 67 days. It should be noted that data on this metric have not been fully submitted by all hospitals and this might affect overall trends. Unfortunately only 20 of the 41 units provided the date of the angiogram for more than 80% of operations, so there is definitely a need for improved data quality by most centres.

2.3.4 Urgent cardiac surgery waiting times are improving, but should ideally be much shorter, to align with the period when bleeding risks are lowest following discontinuation of anti-platelet drugs

Patients admitted with a heart attack requiring urgent heart surgery are often kept in hospital (or 'in house') from the point of diagnosis until the time of their operation. It is essential that this time is minimised, for the benefit of patients and to make best use of scarce resources such as ward beds.

Patients in the UK usually undergo angiography after lower-risk heart attacks having already received dual anti-platelet treatment – a combination of drugs that interfere with blood clotting. These drugs optimise outcomes in cases where immediate angioplasty with stenting at the same session as the angiogram is the preferred treatment option. However, if CABG is deemed best, the use of this combination of drugs unfortunately, though unsurprisingly, increases the risk of bleeding during and after surgery. Given that these drugs take several days to wear off, immediate surgery should be avoided if possible. One of the drugs is normally stopped and most patients are ready for surgery 5 to 7 days later.

In-house waits for CABG in the UK have fallen over the last three years from a mean of 12 to 10 days, but as the ideal time for surgery is 5 to 7 days following the angiogram there are opportunities to improve on this. There are considerable differences between the units from a longest of 22 days to a shortest of 5 days.

As with non-urgent cases, only 24 units of the 41 provided data on more than 80% of their operations, so data completeness is an issue. In addition, some hospitals do not keep all heart attack patients in house for surgery, but prefer to send less high-risk patients home to wait as elective patients, and this may skew the figures.

The data completeness levels and times for elective and urgent CABG at each surgical centre in the UK can be found here.

***Recommendation**: Hospitals with longer waiting times for adult cardiac surgery should reduce these by seeking advice from centres with good performance.*

Box 4
Providing timely urgent CABG surgery following heart attacks at James Cook University Hospital, Middlesbrough

The Cardiothoracic Unit in Middlesbrough was set up in 1994 to meet the huge demand for elective bypass surgery. Long waiting times for surgery were commonplace, with less than a quarter of patients kept 'in house' for immediate operation, most having to return home to await their surgery date.

Since then, cardiology practice has changed, with most patients requiring coronary surgery being referred as an inpatient following a NSTEMI. By 2013 nearly half of our work was such patients. Traditionally, we had scheduled them second on the theatre list, but this would mean they would be the ones that would be cancelled if there weren't enough intensive therapy unit (ITU) beds. We would often have over 20 such patients blocking beds – frustrating themselves, their families and the nurses looking after them, as well as their cardiology teams.

In 2013 we had a full process review of our service using rapid process improvement workshop (RPIW) methodology. This included all key members of the team (medical, nursing, surgical care practitioners (SCPs), secretarial, support services, referring district hospitals, IT etc.).

As a result we flipped the service on its head. In-house patients were to be our priority – they would be first on the operating list. A bespoke web-based referral system was set up (and designed to be as user friendly as possible). Referrals were assessed by the on-call team on the day of referral and accepted for transfer. All referrals were placed under the care of the surgical team (not cardiology as previously).

The SCPs are key to the administration of the system and allocate the patients to the next available theatre list. The surgeons work as a team with a joint waiting list. If the patient is cancelled, another surgeon will take them on to their list. Patients requiring more complex procedures are discussed so as to get the right patient on the right surgeon's list. Our aim is that no patient waits longer than 7 days.

The impact of these changes has been to transform the service at James Cook University Hospital:
- *no more upset and frustrated patients/relatives/staff*
- *reduced wait for surgery (from 14 days to 8 days) and total length of hospital stay by a similar amount*
- *reduced inpatient bed base (reduced by 12 beds)*
- *associated reduction in mortality (3.2% to 2.6%) and reopening rate for bleeding (7.9% to 3.9%)*
- *improved further the sense of 'Team' in the department.*

We were anxious that we would attract even more in-house patients as waiting times fell, but this didn't materialise. The proportion of urgent and elective referrals has remained roughly constant. We were also concerned that the change would have a negative impact on our elective programme, with longer waiting times – but this didn't occur either (and actually reduced during the same time period).

Our only regret: why didn't we change sooner?

Simon Kendall, Honorary Secretary SCTS, formerly Clinical Director Cardiothoracic Surgery James Cook University Hospital

3 Improvements to clinical effectiveness

3.1 The proportion of patients undergoing procedures in infancy successfully diagnosed antenatally is approaching 50%

At least eight in every 1,000 babies are born with a heart or circulatory condition. Failure to recognise and promptly treat major congenital heart disease is associated with increased morbidity and mortality rates, and is recognised as an important quality-of-care issue.[16]

A goal of congenital heart disease services is to diagnose heart disease as early as possible and the ideal is before birth, referred to as antenatal diagnosis. Poor antenatal diagnosis rates are associated with limited opportunity to counsel expectant patients and worse outcomes for babies.[17] We do not yet know what proportion of children with CHD are diagnosed antenatally (NICOR is working with Public Health England to develop better measures) but we do know this for those children who have a procedure in the first year of life. Amongst this group, detection continues to improve—more than 4 in 10 of these children are now antenatally diagnosed.

Antenatal diagnoses require sophisticated ultrasonography equipment and highly skilled obstetric sonographers to acquire and interpret the images, as well as a robust and swift referral system to fetal cardiologists to make a definitive diagnosis, decide upon a management pathway for the pregnancy, provide counselling and support for the parents and coordinate postnatal care.[18]

The latest audit data for 2016/17 show a continued improvement in antenatal detection rates for those requiring a procedure in infancy (Figure 9). It is important to understand that these figures are probably an underestimate of the national antenatal detection rates as they do not take into account four scenarios: 1. fetal deaths that may occur during pregnancy (spontaneous or termination of pregnancy); 2. perinatal deaths before a procedure was possible; 3. less severe malformations that did not require a procedure in infancy; and 4. where a decision is made not to intervene due to the complexity of the heart abnormality or associated comorbidities (compassionate care).

Antenatal detection rates are much higher for babies with more severe functionally single ventricle lesions (such as hypoplastic left heart syndrome), as such defects are more easily seen by the obstetric sonographer [19]. However, many important congenital heart malformations, especially where the great arteries are not normal, are technically more difficult to detect. Mandatory antenatal detailed screening for abnormalities of the great arteries has only relatively recently been introduced by the NHS Fetal Anomaly Screening Programme.[20]

The Congenital audit has looked at the overall detection rates of congenital heart disease in infants requiring an intervention and also examined the success of antenatal screening to detect two contrasting specific heart malformations:

- hypoplastic left heart syndrome (with a functionally single ventricle circulation)
- transposition of the great arteries with an intact ventricular septum.

In both conditions, infants often need an emergency procedure within hours of delivery followed by major surgery within a few days of birth. Research has shown that an antenatal diagnosis improves survival with fewer complications and better neurocognitive outcomes.[21] An antenatal diagnosis will impact on the place and timing of delivery, with care often transferred to the tertiary congenital heart centre so that the paediatric cardiologist can be rapidly at the bedside if required.

Figure 9 – Average proportion of patients undergoing a procedure in infancy successfully diagnosed antenatally (UK and Republic of Ireland, (2007/8 to 2016/17)*

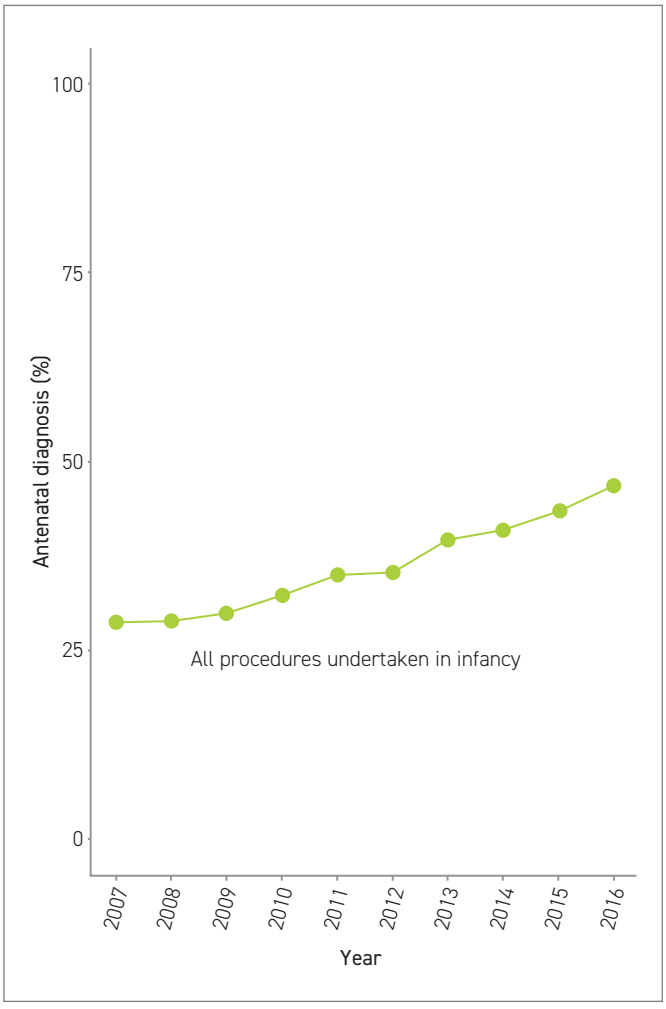
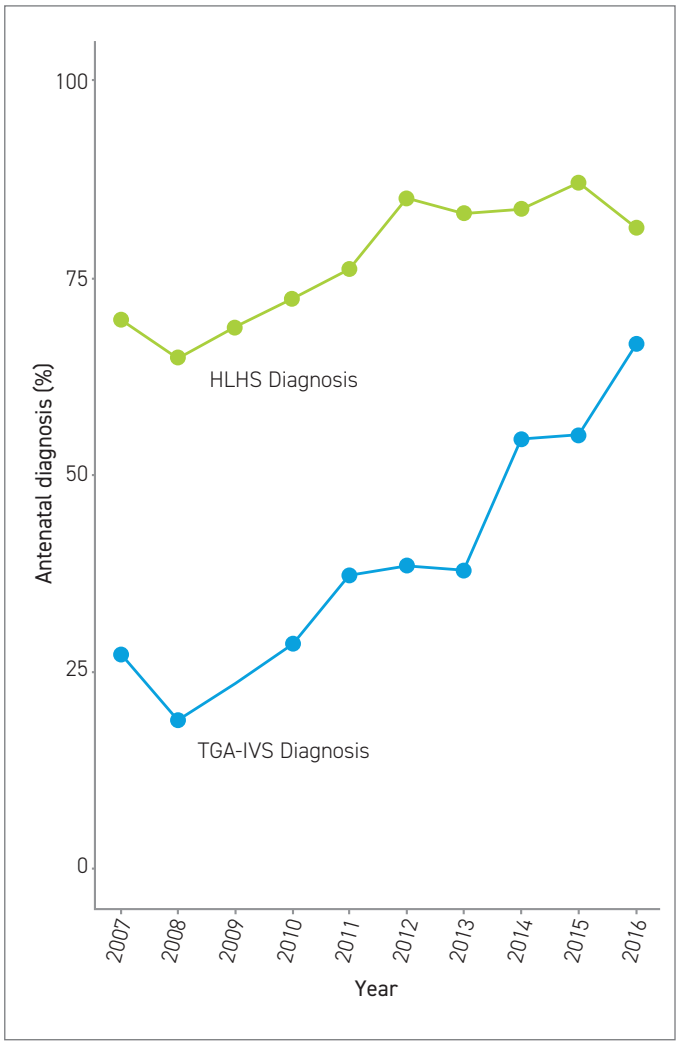


Figure 10 shows an expected high diagnosis rate for hypoplastic left heart syndrome, rising from about 70% ten years ago to over 80% in recent years. These figures are an underestimation as many families decide not to continue the pregnancy when

** Note that the methodology has changed this year. Calculations are based on the number of individual patients with an antenatal diagnosis and a first procedure in infancy (previously based on any procedure in infancy).*

this severe congenital heart malformation is diagnosed. There has also been a significant increase in the rate of diagnostic success for transposition of the great arteries with an intact ventricular septum, rising from just 26% in 2007/08 to over 65% in 2016/17, consistent with international figures.[22] This is likely to have had a major influence on the outcomes after the arterial switch procedure, not only with respect to mortality, but also to pre- and post-procedural morbidity and support for families, as described in the patient story below.

Figure 10 – Proportion of patients with two specific congenital heart malformations requiring a procedure within six months of birth with a successful antenatal diagnosis (UK and Republic of Ireland, 2007/8 to 2016/17)*



However, there remains considerable regional variation, especially for transposition of the great arteries, with only 20% detection rate in some regions compared with 80% or more in others. The regional results can be found here. The considerable rise in detection rates in the last three years for this condition corresponds to the introduction of the mandatory three-vessel and tracheal view in 2016 to the fetal cardiac sonographer protocols and the preceding two-year national training programme.

It is important to ensure that feedback mechanisms and links are in place between the Congenital audit, the fetal cardiology community and antenatal ultrasound scanning departments to enable learning related to congenital heart cases that have not been detected. The audit will facilitate this by passing on these results to the UK National Fetal Cardiology Group and Tiny Tickers Charity, enabling its members to target individual centres most in need of improvement for staff training and optimisation of ultrasonography equipment. Results will also be shared with the relevant Clinical Commissioning Groups (CCGs).

***Recommendation**: Commissioners and providers of obstetric services with the support of tertiary centre fetal cardiologists should ensure that there is access to training and appropriate equipment for sonographers to support the pre-natal detection of congenital heart conditions.*

Box 5
Transposition of the great arteries, Arthur's story

"I will never forget the brilliant medical teams who looked after Arthur and me, but especially the sonographer who saved his life." Mel's son, Arthur, was born with transposition of the great arteries, a heart condition that needs to be detected as early as possible. This is their story.

My husband and I got pregnant with our first child in October 2014 and experienced all the usual excitement and anticipation of what was to come. To put it simply, we were over the moon.

I was feeling anxious before going to the 12-week scan, as a lot of expectant parents are. But everything looked normal so I stopped worrying and started to enjoy the early stages of pregnancy, despite battling with morning sickness.

** HLHS = hypoplastic left heart syndrome*
TGA-IVS = transposition of the great arteries with an intact ventricular septum

By the time the 20-week scan came around, we were both relaxed and excited, confident that if anything was seriously wrong, the 12-week scan would have picked it up. We knew that we didn't want to know the gender so our focus was on that; there was no nerves or anxiety.

Forty minutes into the scan, that began to change. Our sonographer tried desperately to see what she needed to offer some reassurance but after a few jumps, emptying my bladder and turning on my side, still no luck.

She said, "I'm sorry – I think there is something wrong with the four chambers of the heart."

Instant tears. And guilt. Why had I not been more prepared?

The specialist confirmed there was a problem. All scenarios seemed terrifying. We were referred to Great Ormond Street Hospital for another scan in two days' time, with the strict instructions to try not to worry. But of course, we did.

Two days later, our consultant gave us the diagnosis – our baby had transposition of the great arteries (TGA) . It all became very real, very fast. He was wonderfully patient, drawing me a picture to explain what transposition of the great arteries was all about (a picture I still have) and reassuring us that the prognosis was very good. Surgery was necessary but 99% of children survive it, and early detection of our baby's condition meant that everything could be controlled and planned.

We met our cardiac nurse for the first time – she has been a vital and supportive part of our journey ever since.

Travelling home that day my husband and I talked through the information given, trying to digest it all. It was a very long journey on the train, surrounded by people focused on their 'normal' routines, while we felt like a massive bomb had been dropped on us. Not to mention the heartache we were feeling.

As the weeks passed, we tried to enjoy the rest of the pregnancy. There were two further appointments at Great Ormond Street, and more regular appointments with our local hospital. The support was first class but, nevertheless, the stress and anxiety that we both felt was extremely high.

It was hard to comprehend that our new baby could be thriving inside my body and yet, when born, he or she would be immediately at risk.

On 11 June 2015, our little boy arrived. Arthur. I wasn't able to hold him immediately after birth as he had to be whisked away for his checks. Thankfully, he didn't need a balloon septostomy, something we had prepared ourselves for, and before I was taken to the ward for recovery, I was able to have my much-needed cuddle with my beautiful baby boy!

Arthur was transferred to Great Ormond Street the next day. He was put on prostin to keep the duct open, had a cannula in his hand, a tube in his nose, chest pads on and a pulse pad wrapped around his other hand, but otherwise, there lay my baby boy whom I had waited nine months to meet.

For the next six days, I tried to be with him as much as possible but recognised that the advice given by the cardiac nurse was sensible. To be there for Arthur, we needed to keep our strength up and rest was important. Thankfully, we had been extremely fortunate to get temporary accommodation at the hospital so we were never far away.

Arthur had open heart surgery to correct the transposition of the great arteries when he was just six days old. I carried him down to theatre and stayed with him until the anaesthetic took hold. Five hours later we got the call; we could come and see him.

To be honest, seeing his little body post-surgery was probably the scariest part of the whole experience. He was swollen everywhere and his puffy features meant that he was virtually unrecognisable as Arthur.

But day by day, he got stronger. The swelling reduced and he was feeding and gaining weight. I was able to take on the 'normal' mother duties – nappy changing, holding his hand, singing to him. On the sixth day, we were transferred up to the ward, and by the time he was 16 days old, we were home.

That was almost 18 months ago and we have barely looked back since. Arthur has had one cold and a viral infection in that time. Not bad going for any toddler! He is strong and resilient, full of energy, with a wonderful scar on his chest that he can tell his children and grandchildren about one day.

I will never forget the brilliant medical teams who looked after Arthur and me, but especially the sonographer who saved his life. It was only through her diligence and skill that Arthur's condition was detected – and I want all babies born with transposition of the great arteries to have the same chance. That is why Tiny Tickers' work is so important. They train sonographers to be better able to detect these heart conditions and it is vital and lifesaving work.

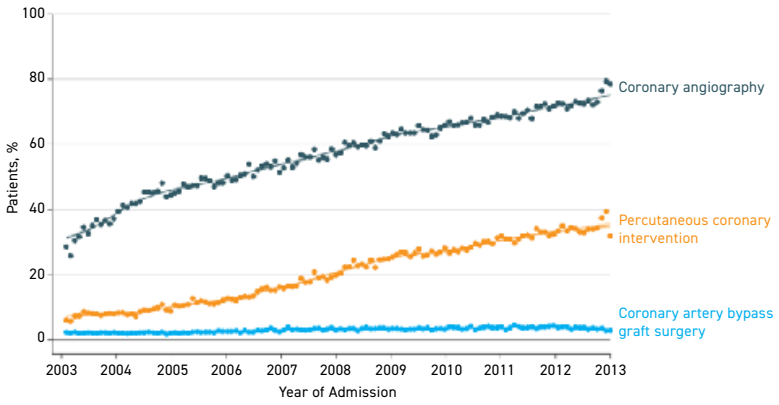
Mel Lawson and her son Arthur (with thanks to *Tiny Tickers***)**
Photos: Tiny Tickers/Mel Lawson

3.2 Increased use of angiography leads to more effective care for those suffering from heart attacks

Coronary angiography provides information about the state of the coronary arteries, abnormalities of which are the usual cause of heart attacks. It allows identification of those patients who would benefit from techniques to improve blood flow – angioplasty or CABG – and those for whom staying on medical therapy on its own is deemed best.

Despite continuing concerns about the timeliness of angiography, as noted earlier, in cases of lower-risk heart attacks, there has been a progressive increase in the proportion of eligible patients who undergo the test. Between 2003 and 2013, the use of angiography after lower-risk heart attacks increased from 42.7% to 78.6% and more recently reaching 87.6% in 2016/17 (up from 81.6% in 2014/15).

Figure 11 – Proportion of eligible patients admitted with NSTEMI who received coronary angiography, PCI and CABG (UK, 2003 to 2013) [Source: JAMA 2016][23]*



3.3 The use of radial access for angioplasty is a major success story but more lives could be saved if all hospitals used it to the same extent

To perform an angioplasty, tubes (called catheters) have to be inserted into one or more of a patient's arteries. When angioplasty was first introduced, the large femoral artery (at the top of the leg) was used. However, some of the commonest complications after angioplasty are due to difficulty preventing the puncture site from bleeding after removing the catheter at the end of the procedure. Angioplasty equipment has become smaller and so it is now possible to perform almost all angioplasty from the smaller radial artery in the wrist. This artery is easier to compress, and any bleeding is also much easier to see. As a result, the use of this access route is associated with reduced complications, including reduced mortality in both observational datasets and certain randomised trials.

The adoption of radial access required a number of experienced interventional cardiologists to learn new techniques, and the switch from femoral to radial access varied across the country. By 2016, radial access was used in 84.3% of all angioplasty, which represents an almost complete switch (Figure 12). It must be remembered that some angioplasty still requires femoral access (for example, if large equipment is required, for some patients in cardiogenic shock and for some having treatment of chronic total occlusions – where multiple access sites may be needed).

As with the introduction of any new method, there is variation in the rate of uptake, partly driven by variation between clinicians' enthusiasm at adopting new methods, and interpretation of the evolving evidence base to support benefit. A study of this heterogeneous uptake demonstrated that the overall switch to radial access has saved about 450 lives, and that a more uniform uptake, assuming that every operator changed practice as quickly as the quickest, would have potentially saved an additional 264 lives between 2005 and 2012 (Figure 13).[24]

** Those receiving angioplasty or CABG had also undergone angiography.*

Figure 12 – Change in use of radial access for coronary angioplasty (UK, 2004 to 2016)

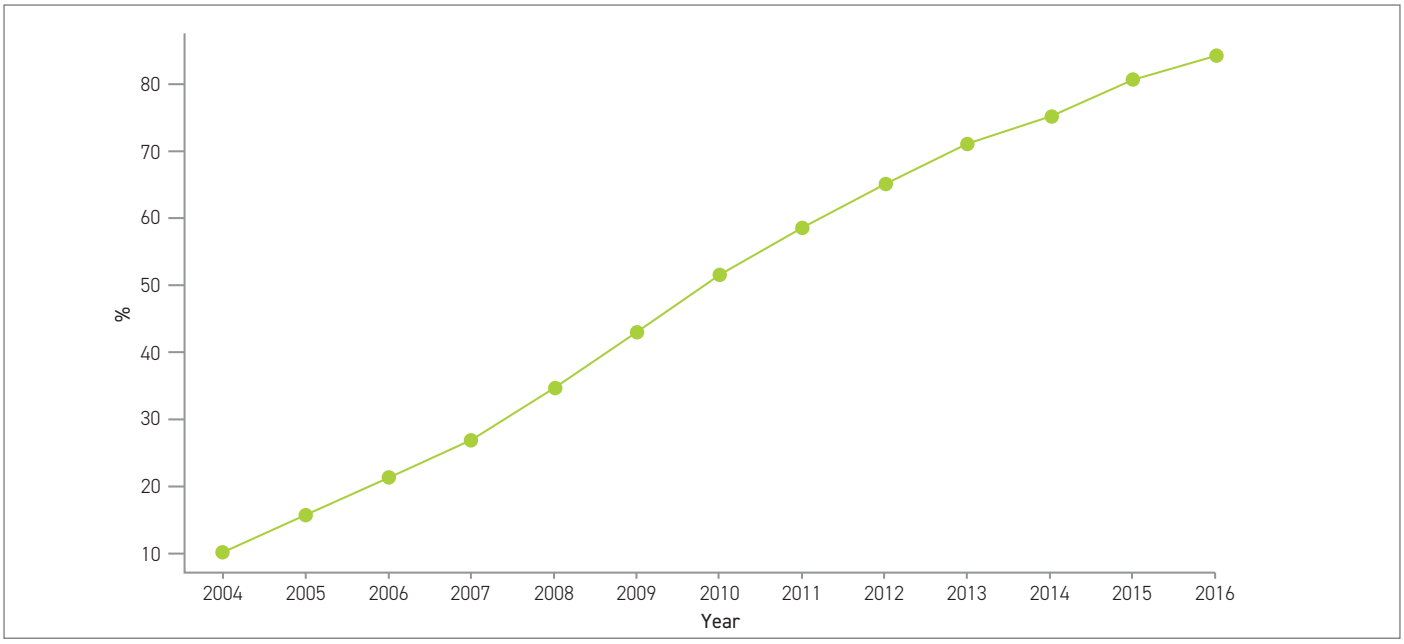
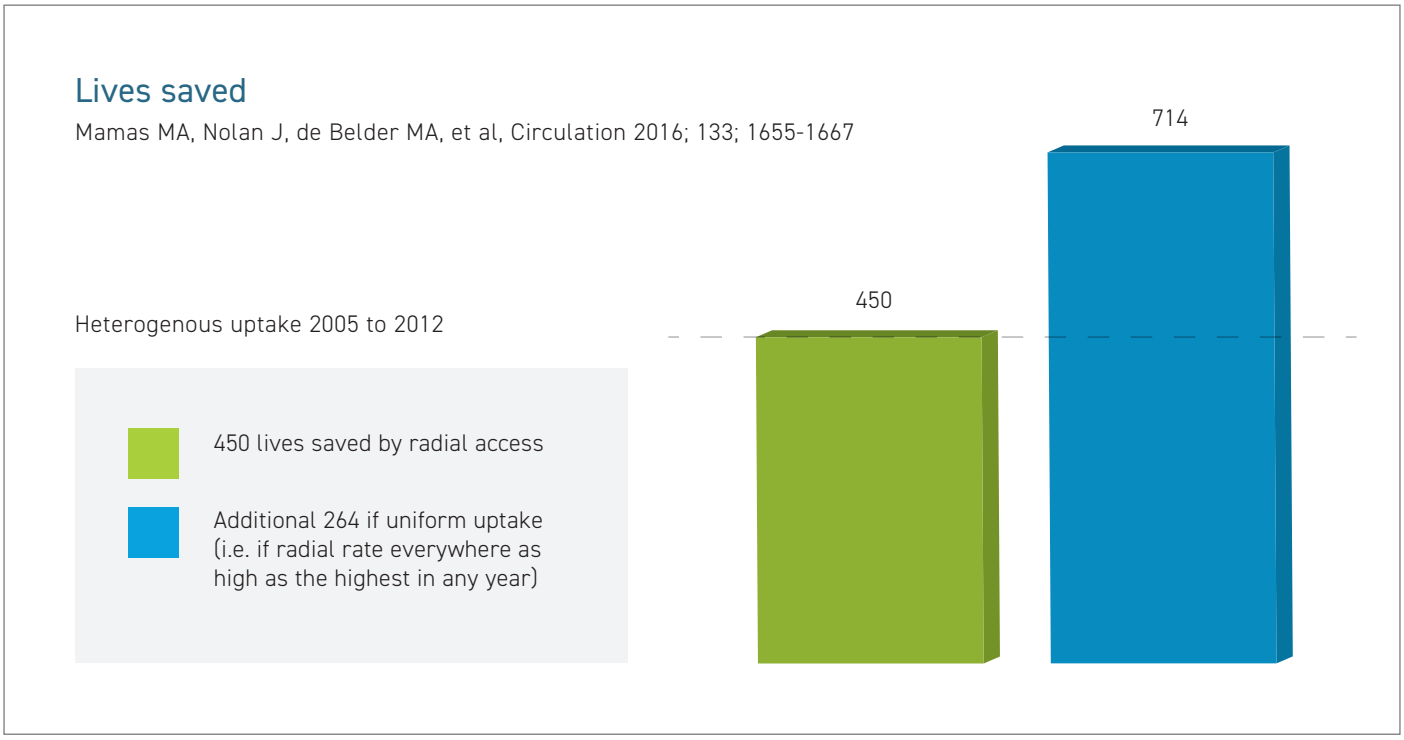


Figure 13 – Potential lives saved through uniform uptake of radial access (UK, 2005 to 2012)



The switch to radial artery access for angioplasty has also reduced complications and has been associated with a shorter length of stay in hospital and improved outcomes.[25]

Box 6
Drug-eluting stents have been very effective in reducing re-narrowing of arteries after angioplasty

Coronary angioplasty started by stretching narrowed blood vessels with sausage-shaped balloons, but then stents made of stainless steel were introduced. While this improved results, there was still a risk of the vessel re-narrowing due to scar tissue within the stent (re-stenosis). Drug-eluting stents were developed to counter this problem, and have been extremely successful.
These stents release antimitotic drugs into the vessel wall for a few weeks after implantation. Usually the stent is coated with a polymer from which the drug is eluted. The inhibition of cellular proliferation reduces neo-intimal formation (the scarring) and profoundly reduces the re-stenotic process to about 5%. Patients treated with first-generation drug-eluting stents had an annual rate of 'late stent thrombosis' of 0.4–0.6% for at least three years after angioplasty. Hospitals across the UK all now use this as the standard treatment.

Box 7
Jacqueline's story – undergoing angioplasty using radial artery access

I had been getting chest pains on and off for a few months and I could feel my heart pounding when I went for a walk. I was sent by my GP to see the nurses in the rapid access chest pain clinic who arranged for me to have a CT scan of the heart blood vessels. Although my brother had heart disease I was surprised when I was told I had a severe narrowing of one of the main arteries and that I might need a stent.

I was admitted to the hospital first thing in the morning and was lucky to be the first person operated on that day. To be honest, I was pretty scared but the staff were really kind. They introduced themselves one at a time and did a great job reassuring me. The doctor then put a small tube into my wrist that I hardly noticed. I actually fell asleep during the operation and was woken up by the consultant talking to me.

I was expecting there to be more pain but it was really straightforward. I had a look at the pictures of my heart on the TV screens towards the end of the operation, which was amazing. It is incredible how the doctors can use the pictures on the screen to guide putting the stent in. This was all done through a small tube in my wrist. I was up walking straight after the operation and I have been left with a small scar on the wrist.

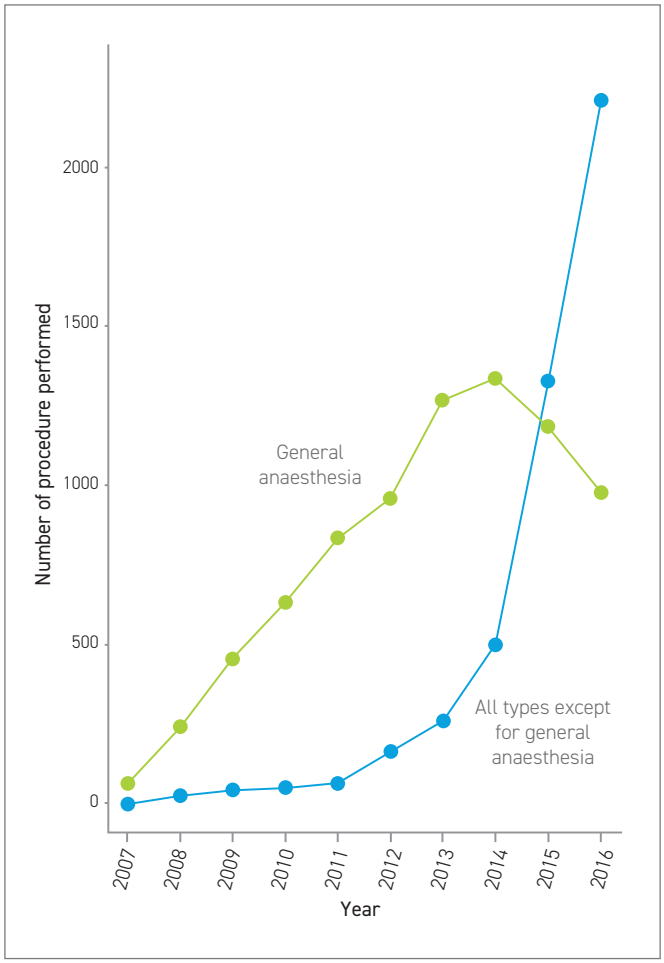
I was only in hospital for about five hours and was sent home early afternoon on the same day. I remember when my brother had a stent inserted a few years ago and he had to have the tube put into the top of his leg and he was not able get up and about for a good while after. The whole experience was incredible.

***Recommendation**: Clinical leads should ensure they are using radial artery access and drug-eluting stents during PCI whenever this is clinically appropriate. When radial artery access is not being used, patients should be provided with information that informs them why this is the case.*

3.4 Advances in the treatment of adults with heart valve disease offer treatments that are more effective and better for patient experience

Many patients with aortic stenosis are too frail to be considered for open heart surgery or, where surgery could be offered, it is deemed to be at higher-risk with the potential for complications and extended recovery periods. The development of transcatheter aortic valve implantation (TAVI) offers such patients the opportunity for treatment with a percutaneous or minimally invasive surgical approach. There has been a progressive uptake of the use of TAVI, many of which are now performed without the need for general anaesthesia (Figure 14). This is associated with faster recovery and significantly reduced lengths of hospital stay.[26,27]

Figure 14 – Number of TAVI cases performed without general anaesthesia (UK, 2007 to 2016) [Source: BCIS and SCTS]



3.5 There is very good evidence for the medications to be used and clinical teams should be adhering to the standards

Cardiovascular disease management is established upon a firm foundation of 'evidence-based' interventions. In other words, in treating any particular patient, the clinician is guided by the results of many large placebo-controlled clinical trials, accumulated over years through the voluntary participation of hundreds of thousands of patients, and translated into clinical guidelines by expert groups. This allows the clinician and patient to have confidence in the procedures and medicines that are being offered and to understand both risks and benefits of

treatment.

This is not to say that every patient should receive precisely the same treatment. The wise clinician takes into account the characteristics of the patient in front of them, including the patient's preferences and concerns, in determining the suitability of each possible intervention.

So, for example, a patient with angina may decline CABG, despite its proven benefit, because they simply do not want heart surgery. Again, a patient may refuse to enroll on a cardiac rehabilitation programme because they feel that they cannot commit the time required to participate in the activity, even though clinical trial results show that it reduces future risk.

On some occasions, the patient may be judged unsuitable for particular treatments either because of lack of efficacy in their case (for example, the patient with a higher-risk heart attack who presents to hospital the day after their symptoms occurred has little to gain from immediate primary angioplasty if those symptoms have resolved) or of ineligibility (for example, beta-blocker medication, recommended in most cases after acute coronary syndrome and in heart failure, may sometimes provoke wheezing and may reasonably be withheld in the patient who has severe asthma).

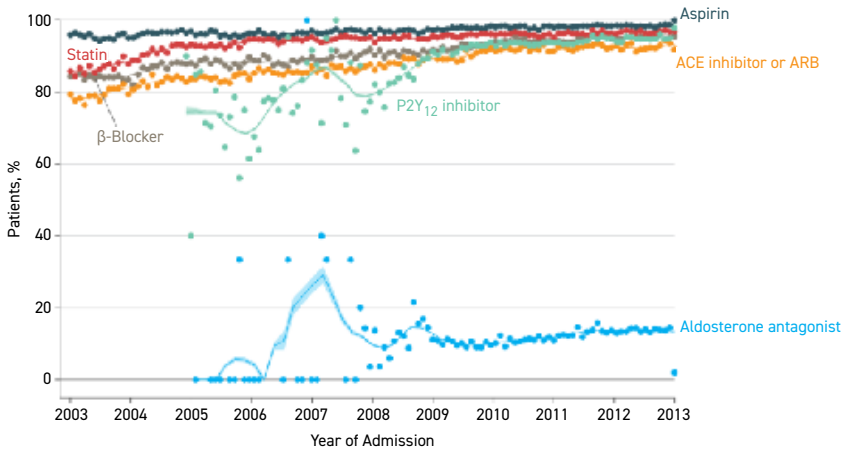
Nevertheless, evidence-based, guideline-supported treatments should be provided wherever possible. There is clear evidence from observational research of the Heart Attack dataset that missed opportunities to provide such care leads to poorer outcomes for patients.[28]

A number of domains within the NCAP collect information about drug treatments. The Heart Failure audit has reported on drugs used in the hospital management of patients with heart failure with reduced ejection fraction that modify the natural history of the condition, reducing the severity of symptoms and prolonging life. The Heart Attack audit has reported on drugs prescribed at the time of discharge from hospital to reduce the risk of subsequent heart attacks.

3.5.1 For heart attacks, some hospitals appear more capable of providing optimal care in terms of discharging patients with all appropriate medications

The performance of individual participating hospitals was reported with respect to use of each of the various 'secondary prevention' medications (Figure 15). More recently, as the proportion for use of each separate drug class reached about 90% of all eligible patients, this metric has been expressed as a composite: the proportion of patients discharged on all the secondary prevention drugs for which they were eligible, based upon their particular situation. Despite this more taxing performance measure, some hospitals appear capable of providing optimal care while others do not reach these levels.

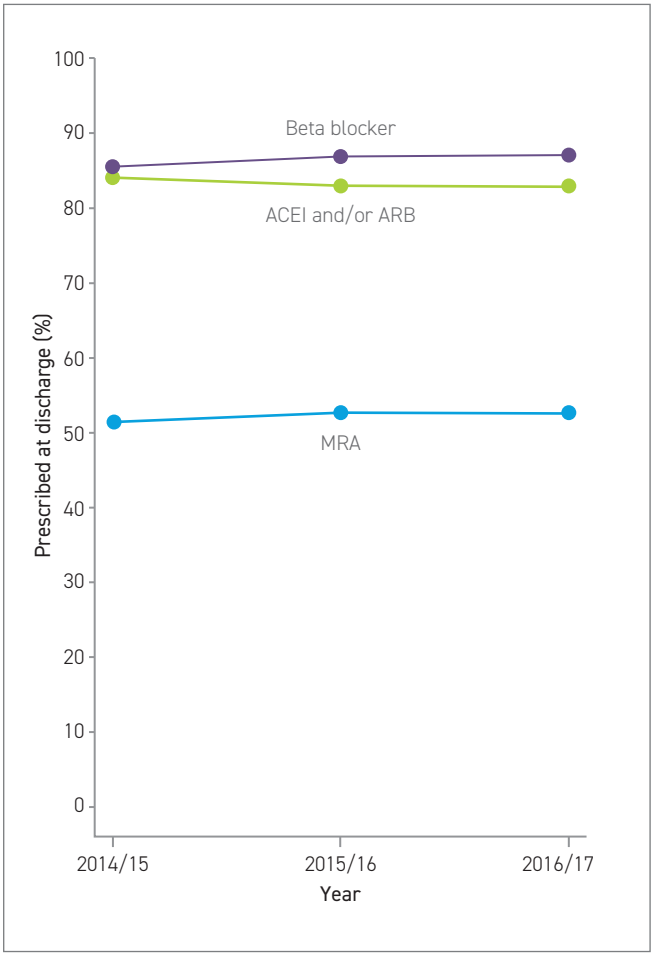
Figure 15 – Percentage of patients discharged on secondary preventive medication following NSTEMI (UK, 2003 to 2013) [Source: JAMA 2016][29]



The national audit programme records drugs prescribed at the time of discharge. Yet there is no reliable way of determining whether patients persist in taking such treatments, some of which are to be taken for limited periods while others are 'lifelong'. Future linkage with national prescribing databases could be established to detect and understand early discontinuation of treatment, which is known to be associated with worse outcomes.

Another challenge for established national audits arises when guidelines are updated to include new drugs. So, for example, mineralocorticoid receptor antagonists (MRAs) have a protective effect after myocardial infarction, and are now recommended for the subset of patients with poor left ventricular function and/or evidence of heart failure. The Heart Attack audit shows an increased use of these drugs in higher-risk heart attacks – from 18% in the first quarter of 2014 to 25% in the first quarter of 2017 – but does not reliably identify those patients who are most appropriately treated. The solution lies in active dataset changes so that the audit collects data which can inform contemporary practice.

Figure 16 – Use of secondary prevention medications in patients with heart failure with reduced ejection fraction (England and Wales, 2014/15 to 2016/17)



3.5.2 Use of disease-modifying drugs in heart failure is increasing and is at levels that compare favourably in international studies

In the last audit cycle for patients with heart failure, of those discharged from hospital with left ventricular systolic dysfunction (whatever the aetiology), 83% were on an ACE inhibitor (ACE-I) or angiotensin receptor blocker (ARB), 87% were on a beta blocker and 53% were on an MRA (Figure 16).

Over the last few years, the previous increase in those discharged on a beta blocker and an MRA has been maintained.

The Heart Failure audit clearly shows that access to cardiology wards improves prescription rates of ACE-I/ARBs, beta blockers and MRAs (Figure 17). Trends in prescription rates of key disease-modifying drugs have been maintained or are increasing in patients accessing cardiology and specialist care whereas there is a reduction in beta blocker prescribing in those discharged from medical and 'other' wards. This may be due to the shorter length of stay for those admitted to medical wards or those not seen by specialists.

Overall, it is evident that prescription of disease-modifying drugs is consistently much higher in those accessing cardiology and specialist services compared to those being treated in medical wards and by those with no expertise in heart failure.

***Recommendation**: Hospital providers and directors of nursing should review their pathways for patients with heart failure and where this is a primary diagnosis these patients should ideally be cared for on a cardiology ward with access to heart failure specialist teams.*

3.6 There are significant benefits to cardiac rehabilitation and specialist follow-up

3.6.1 All heart attack patients should have their left ventricular function measured

All patients suffering a heart attack – whether higher- or lower-risk – should undergo evaluation of left ventricular function (the power of the heart pump). This is most often achieved by echocardiography, a non-invasive ultrasound technique that should be available in all hospitals that admit such patients. This requirement, for an inpatient echocardiogram, is implicit within the NICE guideline for management of heart attacks, which recommends that those with reduced function should receive an MRA.

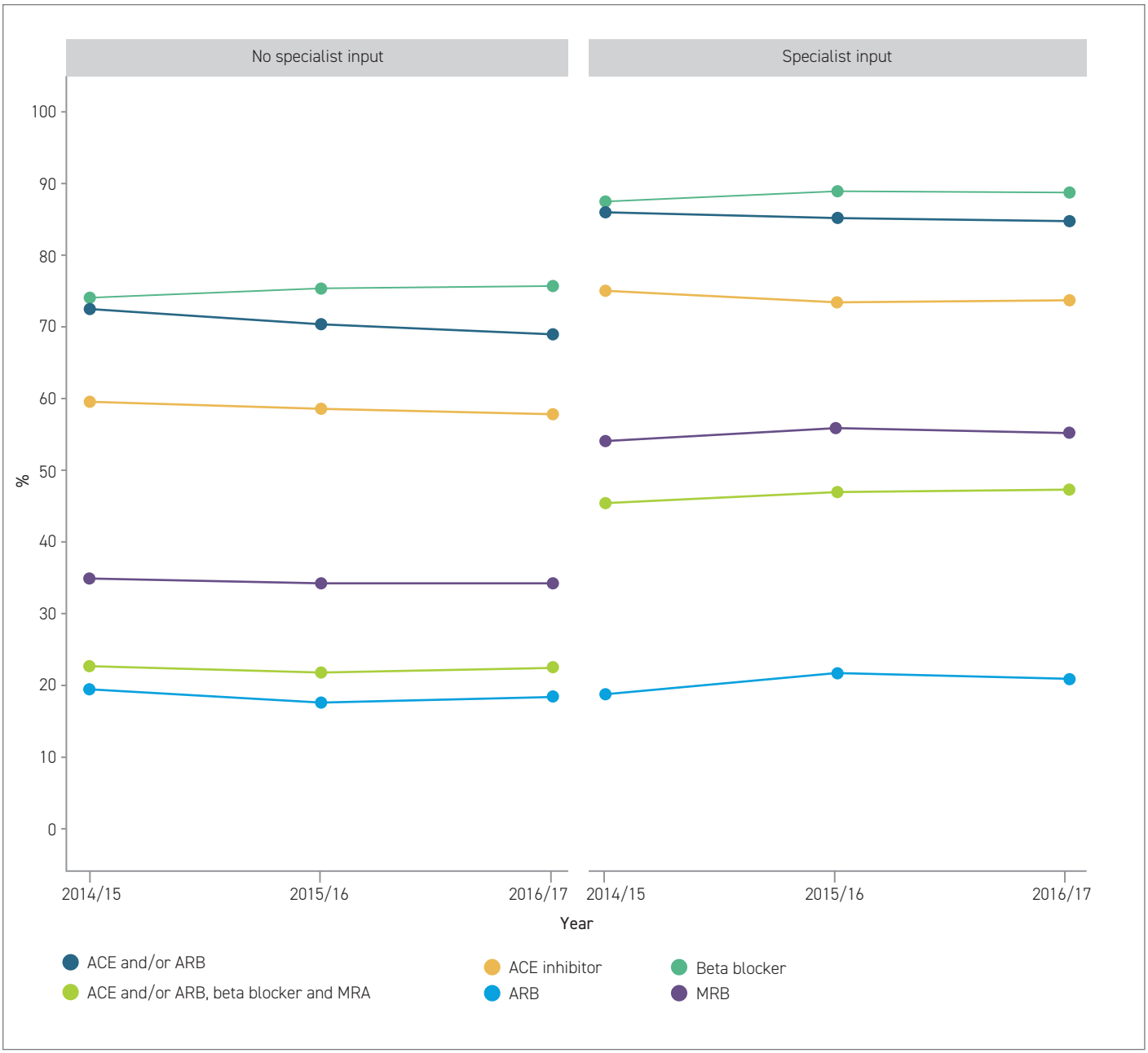
There is, however, significant variation in practice, with 52 hospitals reporting performance during admission in at least 90%, while others are below 50%. With lengths of stay of only a few days after higher-risk heart attacks, many hospitals appear to arrange echocardiograms following discharge from hospital rather than during hospitalisation; 11 participating hospitals report arranging echocardiograms in the outpatient setting in more than 30% of patients. Information about hospital performance with respect to performance of echocardiograms can be found here.

3.6.2 For patients with heart failure, levels of referral to rehabilitation are low

Cardiac rehabilitation is useful for patients with heart failure, as well as those who have suffered a heart attack. Although a few hospitals offer this to many patients, overall levels of referral for rehabilitation remain poor at 14.5% of patients.

***Recommendation**: Commissioners should ensure that access to specialist follow-up and to cardiac rehabilitation services is available to all patients following a heart attack as well as to patients admitted with heart failure.*

Figure 17 – Trends in prescription of disease-modifying drugs in heart failure patients depending on level of specialist input (England and Wales, 2014/15 to 2016/17)



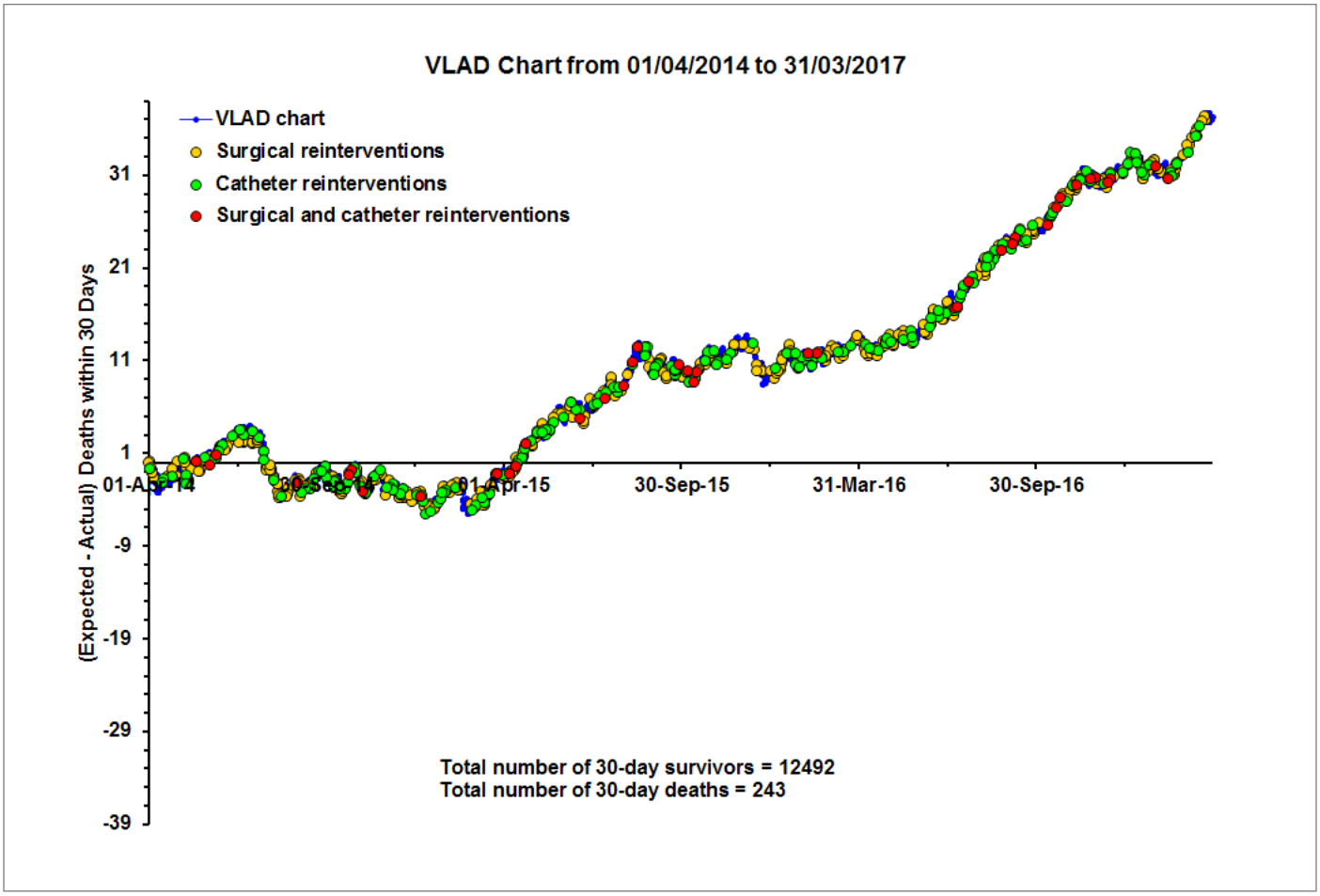
4 Improvements to patient outcomes

4.1 For children undergoing heart surgery, risk adjusted survival appears to be better than predicted

Centres specialising in congenital heart disease use risk adjusted variable life adjusted display (VLAD) charts to help them monitor outcomes after treatment. These are calculated using bespoke Partial Risk Adjustment in Surgery (PRAiS2) software to identify potential areas of concern or strengths to improve patient safety and quality of care for whole centre 30 day survival outcomes following children's surgery. For a fuller description of the VLAD chart, see section 3.1.1 in the NCHDA summary report. A positive value (line going up) indicates survival at a better rate than is predicted by the risk model.

As Figure 18 shows, for children undergoing heart surgery, survival appears to be better than predicted. It is not fully clear whether this represents a true improvement in outcome or differences in outcomes brought about by an inability of the risk model to account for variations in case mix or improved data collection of associated risk factors such as non-cardiac diseases, but the trend is encouraging.

Figure 18 – Variable life adjusted display (VLAD) chart for all 13 paediatric centres in the UK and Republic of Ireland undertaking procedures in patients under 16 years of age (2014/15 to 2016/17)



Analysis of 30-day risk adjusted programme survival rates at hospital level indicates that:

- two hospitals performed 'better' than the level expected and one centre 'much better than expected'. This represents an opportunity for sharing optimal practice across specialist centres.
- One hospital has a lower-than-predicted survival rate and the hospital has been advised to review the cases involved (including relevant comorbidity factors, issues with respect to local clinical practice and, if relevant, lessons learned).
- Thirty day survival at all other specialist children's heart units was within the predicted range.

More detailed information, including the outcome results for individual hospitals and specific surgical additional background to PRAiS2 risk stratification methodology, is available here. It is also available on the Understanding Children's Heart Surgery Outcomes website.

Detailed information on survival at 30 days for 83 major surgical, transcatheter cardiovascular and electrophysiological

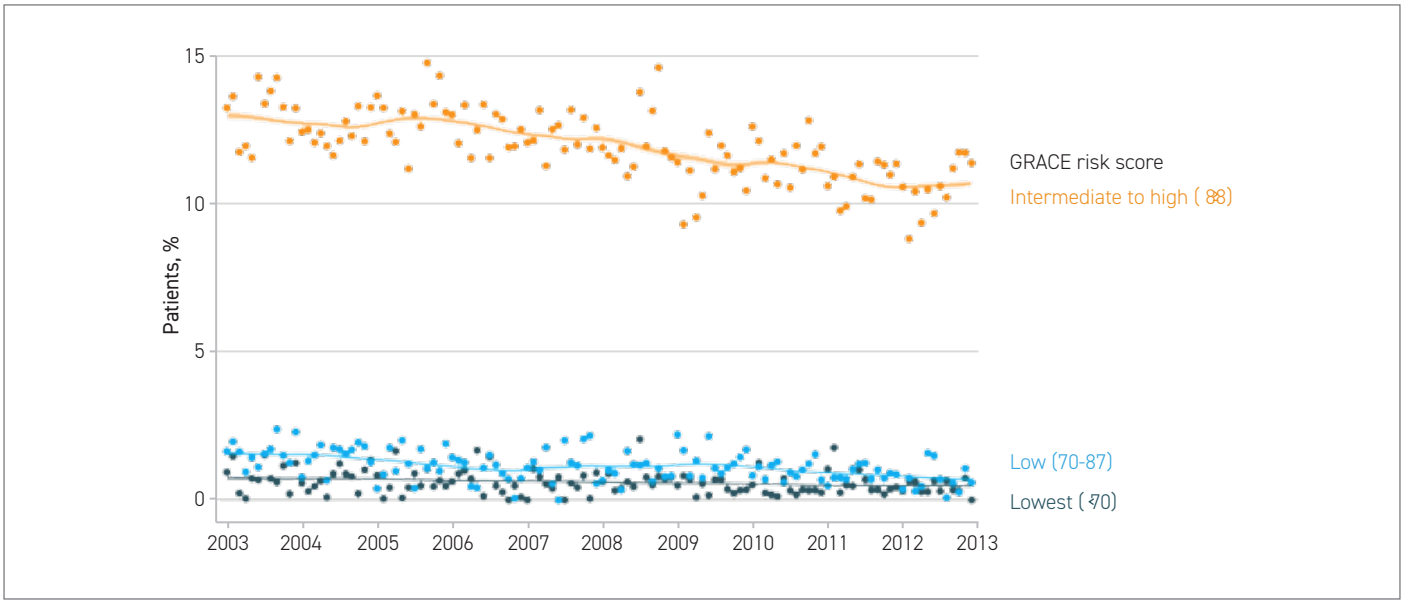
interventions undertaken to treat congenital heart disease at any age (children and adults analysed separately) is available here.

4.2 The use of angiography and angioplasty are both driving outcome improvements for patients with coronary artery disease

4.2.1 Improved heart attack outcomes are associated with the increased use of angiography

Observational research using Heart Attack audit data suggests that the increasing use of angiography has been clinically important. Between 2003 and 2013, the use of angiography after lower-risk heart attacks increased from 42.7% to 78.6% and, consistently, half of those undergoing angiography went on to angioplasty or CABG.[30] At the same time, the unadjusted death rate six months after the acute admission fell from 10.8% to 7.6% (a relative reduction of 30%) (Figure 19). This improvement could neither be entirely explained by changes in the baseline risk of the patients, nor by improvements in the use of drug treatments at the time of discharge (although such improvements did take place). An increase in angiography provision was significantly associated with the reduction in mortality.

Figure 19 – Changes in 180-day death rates for lower-risk heart attacks based upon estimated risk of death at time of admission (UK, 2003 to 2013) [Source: JAMA 2016][31]



4.2.2 Fewer complications are being observed in angioplasty

For patients undergoing coronary angioplasty, early mortality and complication rates are low and stable, with fewer patients suffering a heart attack or requiring emergency CABG (Figure 20). For all patients undergoing primary angioplasty, the early mortality is also stable.

There has been a slight increase in the proportion of patients treated in the context of cardiogenic shock (2.4% in 2012 to 3% in 2016).

4.3 Adult cardiac surgery outcomes continue to improve

4.3.1 Mortality rates have fallen over the last ten years to under 2.5% in 2016/17

Adult cardiac surgery was the first specialty in the UK to introduce reporting of patient outcomes at both hospital and individual surgeon level. The in-hospital mortality following surgery has continued to fall over the past ten years to 2.45% in 2016/7 (Figure 21). This is despite the average age of the patients, the comorbidity and the complexity of operations all continuing to rise. The outcomes of patients undergoing heart surgery in the UK are amongst the best in the world.

The latest outcomes of individual hospitals and surgeons for the three years between 2014 and 2017 will be published later in the year as part of the annual COP programme and will be available online here.

4.3.2 Stroke rates have been analysed for the first time and are well below 1% for all adult surgery operations

While mortality rates (or survival rates) following major surgery are an important measure, they do not give a complete picture of the quality of care that patients receive. For the first time in the UK, this report has included data on other important outcomes, including post-operative stroke, the need for return to theatre (for bleeding or other causes), rates of kidney failure (requiring renal support therapy), and serious sternal (breastbone) wound infection.

Figure 20 – Early outcomes after all elective coronary angioplasty (UK, 2012 to 2016)

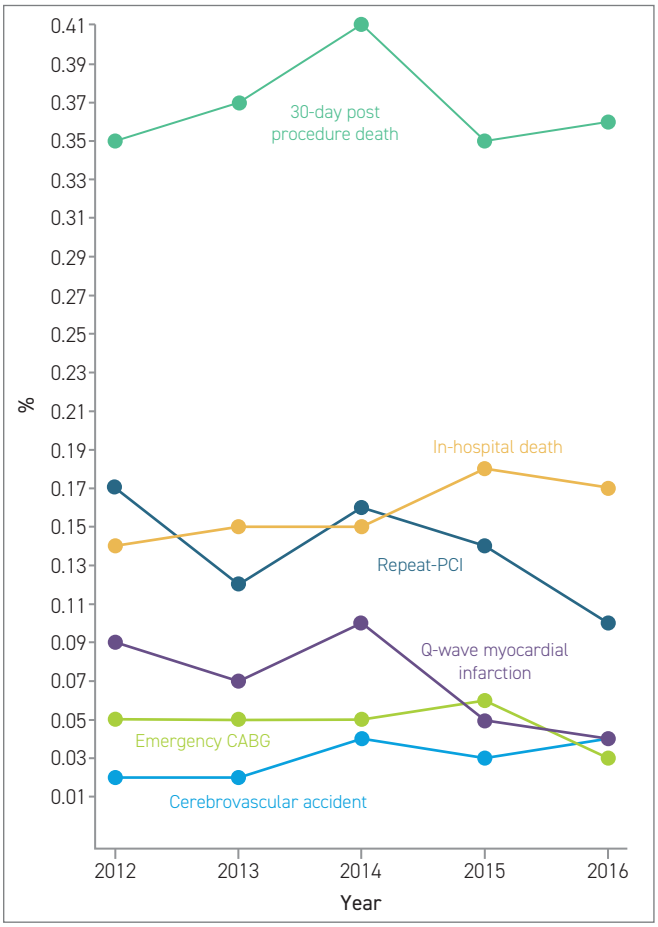
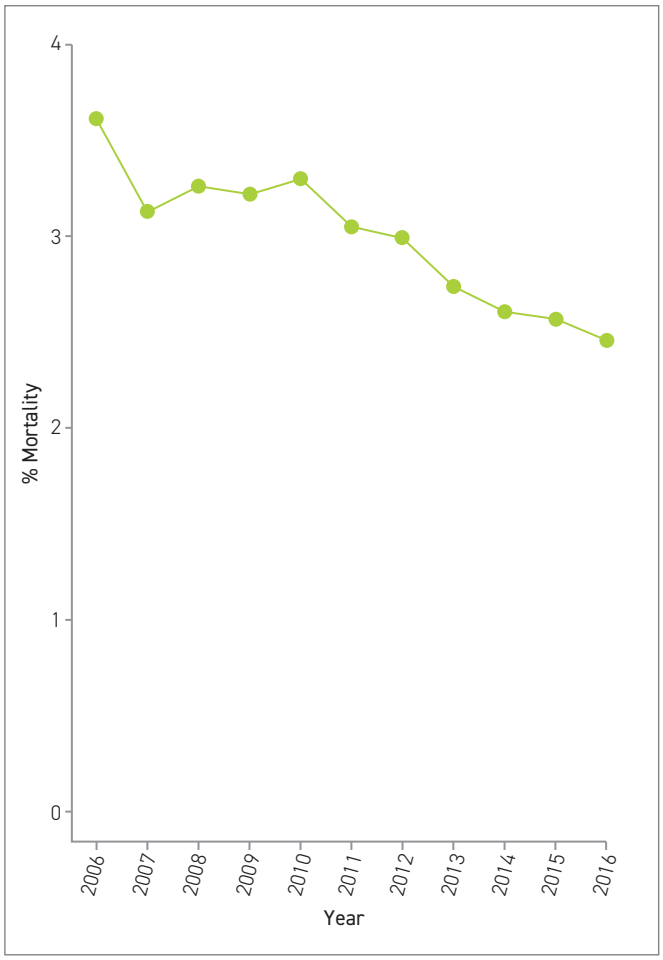


Figure 21 – Overall mortality rates for adult cardiac surgery (UK and Republic of Ireland, 2006 to 2016)



In the UK as a whole, between 2014 and 2017, the risk of a stroke (including both permanent and transient strokes) post-operatively following first time CABG was 0.78%. The risk of a permanent stroke was 0.43%. Strokes can present in many ways and with a very wide variation of symptoms and severity, which can make deciding whether a stroke has occurred post-operatively not as straightforward as it may seem.

There are some concerns about data accuracy, as several units are reporting very low rates, and in some cases zero percent for a year. Units with high reported rates may not necessarily be performing less well, but may be collecting more accurately all cases of neurological injury and may be including patients with more minor symptoms.

As this is the first year the data have been analysed, it is important that units look to identify cases of stroke as accurately as possible and to enter and crosscheck data carefully for future years.

4.3.3 Re-operations occurred in just over 3% for first-time CABG operations

The proportion of patients needing to return to theatre (for bleeding or other causes) following a first time CABG was 3.12% in the UK between 2014 and 2017, of which the rate of return to theatre for bleeding was 2.6%. Data completeness was good at 92%, but two units provided less than 80%. Data relating to the identification of patients returning to theatre for any reason are easy to define, identify and collect, so reported rates should be fairly accurate for most hospitals. However, some hospitals reporting zero percent or very low rates may be under-reporting complications, or only performing relatively small case numbers.

Hospitals with low data completeness may look worse than is actually the case as data are presented as a proportion of patients in whom the data field was completed (so failure to record that a patient did not undergo re-operation will not be counted). For future audits, we aim to achieve data completeness rates of more than 95% for re-operations.

4.3.4 Kidney failure was a complication in 1.5% of cases

Kidney failure is a major complication after heart surgery and may result from pre-existing reduced kidney function, or reduced cardiac output in the perioperative period. The overall rate of kidney failure (patients requiring renal support therapy on intensive care following first time CABG) in UK for 2014 to 2017 was 1.5%. The data overall are reasonably complete at 89%, but six units had less than 80% data completeness. Data relating to renal support therapy – the need for dialysis or haemofiltration – following operation is easy to define and collect, so the rates should be accurate, although this cannot be

verified from the current data returns.

Overall for the UK, the rate of renal support required is at the level that would be expected from previous studies.

4.3.5 Serious wound infections occurred in fewer than one in 300 cases

Wound infection following cardiac surgery has been identified in surveys as a complication about which patients are particularly concerned. Failure of the sternum (breastbone) to heal due to a serious infection within the mediastinum (tissues around the heart) may require surgery to remove the infected tissue and to repair the wound. This is usually a major procedure and often involves input from plastic surgeons.

The rate of deep sternal wound infection (serious enough to require surgical treatment or debridement) during the initial hospital stay following CABG surgery (when most such infections arise) was 0.32% between 2014/5 and 2017/18. It is acknowledged that this definition will miss cases of less serious wound infection (for example, those with superficial infections treated just with antibiotics) or those patients needing subsequent readmission to hospital.

For results of post-operative complications reported at each centre, click here.

Box 8
Terry's story – undergoing adult cardiac surgery for a triple bypass

It was a good couple of years before I realised I had a problem. I've always been a very fit and active man but noticed I was becoming out of breath and all the things I used to do easily became harder, even playing with my grandchildren who were tiny then. The problem was brought to a head when I was late for a football match and I ran to the ground and nearly passed out.

I saw my GP who organised an angiogram. The consultant told me I had three blocked arteries. They were very badly blocked and he told me that I would not survive a heart attack if I had one. I had to wait three months and after every ache and pain I thought, "This is it." After three months, I was admitted a couple of times but the surgery was delayed each time as more urgent cases came in. Thankfully, the third time I had the surgery and was in hospital for six days.

The aftercare was very good and I used to go to the local gym classes with my wife. That was really helpful as they monitored my health and made sure I was doing all the right things. I did everything by the book and they said I couldn't play golf for three to four months. My surgery was life changing. I don't get out of breath and have no pain.

Thirteen years later, I play golf three to four times a week, walking five miles each time, and have more grandchildren to keep us both busy.

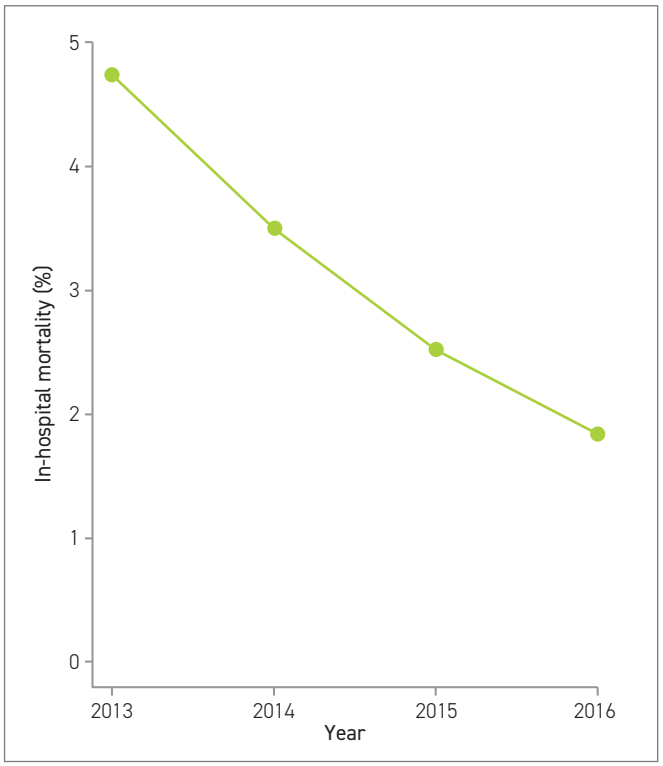
Terry underwent a triple bypass at Derriford Hospital Plymouth in 2005.

4.3.6 TAVI outcomes are improving

The early mortality from TAVI procedures has fallen to less than 2% (Figure 22). It is not clear whether this reflects the advantages of newer generation devices and methods of delivery, a greater use of the trans-femoral approach or better case selection.

***Recommendation**: Commissioners and clinical leads should ensure that patients who are at high risk for surgical aortic valve replacement are considered for transcatheter aortic valve implantation (TAVI).*

Figure 22 – Outcomes following TAVI procedures (UK, 2013 to 2016) [Source: BCIS and the SCTS]



4.4 Heart failure outcomes are improving as a result of access to specialist care, drugs and rehabilitation

4.4.1 Overall in-hospital mortality fell to under 10% in 2016/17

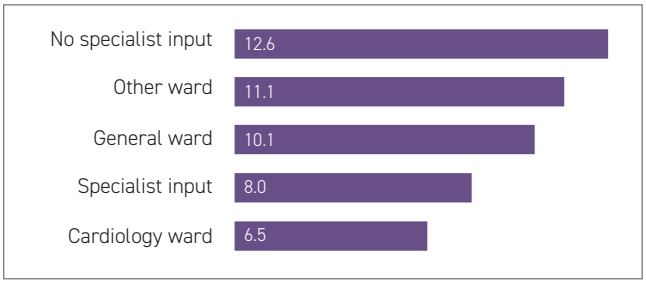
Despite many more patients being entered into the audit and a slight increase in the mean age of patients over the last five years, the reduction of in-hospital mortality from 11.1% in 2010/11 to under 10% from 2011/12 onwards has been maintained at 9.4% in 2016/17.

4.4.2 Patients receiving specialist care have a higher survival rate

Patients seen by a member of a specialist heart failure team had a mortality of 8.4% compared to a mortality of 12.9% for those not seen by specialists, irrespective of their place of care.

In-patient mortality was lower for heart failure patients admitted to a cardiology ward than for those for those admitted to a general medical ward (7.0% compared with 10.4%).

Figure 23 – Hospital mortality for heart failure patients dependent on whether cared for on a cardiology ward and whether seen by a specialist heart failure team (England and Wales, 2016/17)



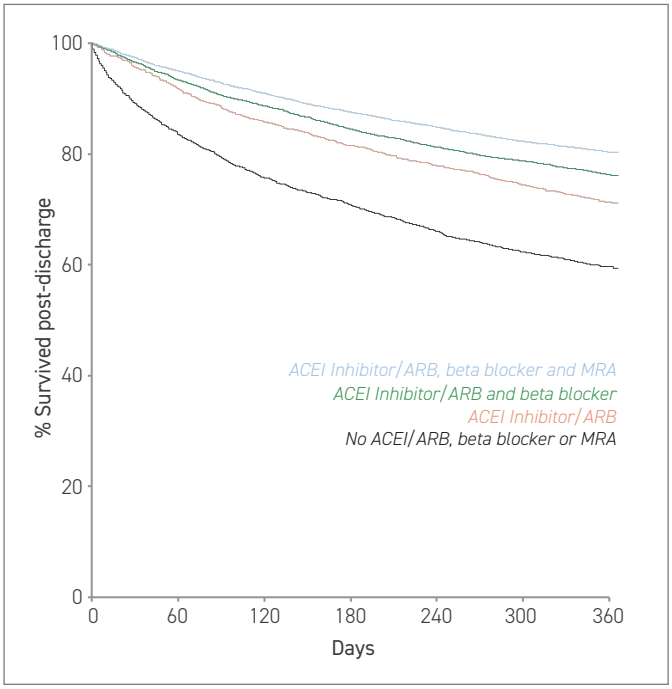
4.4.3 Leaving hospital on all three recommended disease-modifying drugs is associated with a significantly higher chance of 12-month survival

Overall, it is evident that prescription of disease-modifying drugs is consistently much higher for those accessing cardiology and specialist services compared to those being treated in medical wards and by those with no expertise in heart failure.

Those patients leaving hospital with left ventricular systolic dysfunction on no disease-modifying drugs had a survival rate of 70% after 12 months compared with 85% for those leaving hospital on all three drugs (Figure 24).

4.4.4 Higher 12-month survival rates are associated with being given specialist follow-up and referrals to rehabilitation

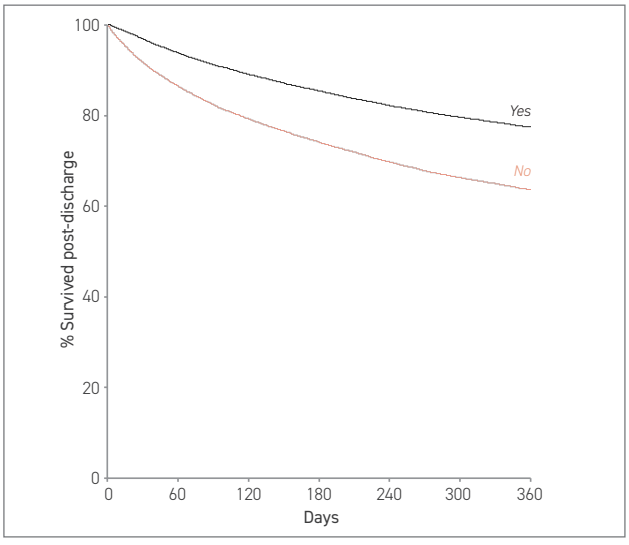
Figure 24 – Association between cumulative drug classes prescribed and longer-term survival rates in heart failure patient with reduced ejection fraction (England and Wales, 2016/17)



Patients who are discharged after a heart failure admission should have specialist cardiology follow up (both medical and heart failure nurse input) and should be offered rehabilitation, as these are associated with a better survival at one year:

- Seeing a heart failure nurse was associated with an average mortality rate of 22% compared to 26% without.
- Cardiology follow-up was associated with an average mortality rate of 19% compared to 27% without (Figure 25).
- Referral to rehabilitation was associated with an average mortality rate of 18% compared to 24% without.

Figure 25 – Association of referral to cardiology follow-up after discharge with 12-month survival rates (England and Wales, 2016/17)



5 Driving future quality improvement through audit

It is anticipated that the design and conduct of the NCAP audits will continue to evolve to inform and drive future quality improvement.

5.1 Focus the audits on defining ambitious standards for quality of care

Effective audit requires clear standards that should be achieved or else a means of benchmarking against one's peers. For any marker of quality of care, information gathering has to be easy and relevant and feedback has to be provided. The feedback has to be done in a clinically useful way, so that hospitals can identify whether they are doing well, are just 'average' or whether their performance is not as good as their peers or they have failed to reach the standards expected. As mentioned in Appendix B, there are several explanations for variation in clinical care, which have to be understood when making these comparisons. Ideally, the comparison has to be of like versus like (one shouldn't compare 'apples with pears').

Once a hospital receives the feedback it should take time to reflect. It may be that the reported performance is 'average'. However, for some performance measures the required standard may be better than the existing national average. Improving care should be the focus of all, particularly when a clinical team is not achieving the performance reached by others. The team should then look at the various steps in the relevant clinical pathway and consider service redesign. This may simply require 'fine-tuning' or it may need a fundamental rethink. Either way, lessons can be learned from those who perform well. If a team finds it is amongst the best performers in a certain aspect of care it should consolidate that standard while increasing attention to areas of poorer performance.

Historically, the six audits within the NCAP programme have provided important data on care provision, 'state-of-the-art' reports and feedback to participating hospitals and clinicians. However, there is a need to make reporting more clinically useful. This will include:

- a more comprehensive assessment of the clinical pathway, measuring all relevant aspects of the pathway of care (access to hospitals, waiting times, etc.)
- incorporating new treatments into audits in a timely fashion, with more rapid reporting of outcomes from these
- better visualisation of data to support identification and communication of the key improvement messages
- more timely and more frequent reporting
- increasing the value of audit outputs through the development of analytical approaches, risk models, and support of robust, real-world evaluations of treatment (this extended use of audit data will 'future proof' quality improvement).

The new NCAP structure and investment in supporting systems, such as a new IT platform that can deliver quarterly or even continuous reports, are all designed to ensure that the process of learning from audit and driving improvement in practice and outcomes happens as quickly and effectively as possible.

5.1.1 Post-procedural care and spreading learning between hospitals will be a focus for young patients with congenital heart disease

The Congenital audit reviews the care for a smaller number of patients than the other cardiac audits and this provides its own challenges in statistical analysis. This is one of the reasons why data are analysed over a three-year rolling programme, allowing the collection of data on sufficiently large groups of patients undergoing a variety of specific procedures to allow for reliable comparisons. Given the large number of different cardiac malformations with associated specific surgical and/or transcatheter procedures, relatively small variations in data quality can result in different conclusions about the quality of care.

This audit has developed a unique data quality index that provides confidence in the findings and has also developed a unique risk model that allows hospitals to see how they are doing with respect to their own patient case mix and compare monthly outcomes to what is expected nationally and in their own practice.

These results are fed into the Congenital Heart Services Specialised Services Quality Dashboard for monitoring outcomes in England and Wales by the Congenital Heart Services Clinical Reference Group, as are the overall number of complications within 30 days of procedures. However, the risk model is focused only on 30-day post-procedural and re-interventions mortality.

Challenges for the future are to:

- investigate other aspects of post-procedural care, including complication rates and the need for unplanned additional procedures using recently accumulated data following procedures undertaken in the 2015–18 three-year cycle. These results will allow drilling down to individual complications and linkage to specific procedures
- understand why some centres might get statistically better results than other centres and then to help spread the necessary learning to allow all patients to be provided with uniformly good treatment.

5.1.2 Identifying 'bundles-of-care' that consistently deliver high quality care will be important for heart attack patients

It is evident that outcomes after a heart attack rely on a rapid diagnosis, fast and effective provision of emergency treatments to restore coronary blood flow and the use of evidence-based secondary preventive treatments, including a cardiac rehabilitation programme. To allow a clearer understanding of the variations in 30-day mortality, the Heart Attack audit is developing a new risk model. In the meantime, recently published research using MINAP data confirms that part of the explanation for differences in outcomes are differences in the quality of care provided.[32] This justifies the continued audit of care of this major cause of morbidity and mortality in the population and the potential for further saving of life with quality improvement.

With respect to the management of patients suffering a heart attack it will be important to:

- continue to monitor (and feed back to participating hospitals and ambulance trusts information about) delays from calling for help to arrival at hospital as well as the time from arrival at hospital to the time to angiography and subsequent treatment
- identify those hospitals (or networks) that provide most timely angiography following lower-risk heart attacks and use them (and their systems of practice) as exemplars for hospitals with poorer performance; these data will also inform the Best Practice Tariff initiative in England
- pilot linkage with other datasets such as the National Audit of Cardiac Rehabilitation
- revise the existing datasets to accommodate new developments in diagnosis and treatment, and to enable the expression of performance as the provision of a bundle of interventions or treatment opportunities
- participate in or facilitate international comparisons of outcomes and organisation
- work with participating centres to maximise the quality of data (case ascertainment and completeness) to allow reliable case adjustment and valid comparisons.

The Angioplasty and Heart Attack audits have been working together for some years to look at different aspects of care. They are complementary in as much as the Heart Attack collects information on all patients with heart attack, from the onset of symptoms in the community until their discharge from hospital, whether they are offered treatment with angioplasty or not, and the Angioplasty Audit augments this with detailed information on the interventional treatment provided in hospitals by specific clinicians.

Given this, it will be important to focus on those interventions that, together, mark good quality – for example, timely primary angioplasty, use of radial artery access and drug-eluting stents, timely ECG evaluation of heart pump function, provision of secondary prevention medications and cardiac rehabilitation, future risk evaluation and treatment such as devices for those at highest risk of malignant rhythm disturbances. These various interventions can be expressed as a single or limited number of 'bundles-of-care' – set menus – provision of which should lead to the best outcome for patients. This will need changes to the current datasets and in systems of data collection.

***Recommendation**: Commissioners should expect and clinicians should provide an evidence-based 'bundle-of-care' for patients with heart attacks. The NCAP will work to facilitate this.*

5.1.3 For adult patients undergoing cardiac surgery, understanding the impact of new surgical techniques and waiting times will be important

Cardiac surgical techniques are well established and effective, but new minimally invasive techniques, new types of valve repair and new valve prostheses are being introduced. Research will need to determine the effectiveness of these treatments and then the Adult Surgical audit will need to promote the implementation of best care across the country. The COP programme has focused on deaths after surgery, but there are many more markers of quality of care. This year's report focuses on some of them but others should be examined.

The Adult Surgical audit can progress to:

- include more information on waiting times best practice, including international comparisons
- drive up data quality on aspects of care that have not been reported in the past
- look at the interface between surgical and new interventional techniques
- include reports on other aspects of care relating to the morbidities after surgery.

5.1.4 Extend the Heart Failure audit to look at new therapies, integration of care and a better comparison of hospital outcomes

There are several important developments in the care of patients with heart failure. One challenge is to ensure the datasets allow an analysis of appropriate care between hospitals. The heart failure teams are multidisciplinary but there is no current evaluation of the specialist teams and infrastructure provided. Patients may be admitted to many parts of the hospital and coordinating their care and collecting the necessary data is challenging. To address this, the audit could extend to look at the care provided to those where heart failure is a secondary diagnosis (depending on the resources available to do this).

The follow-up of patients appears important, and there is a need to ensure an optimal interface between primary and secondary care such that patients receive the best care and are maintained on optimal secondary preventive treatments. Many hospitals now have established community heart failure teams that work together with the hospital services.

The Heart Failure audit can develop to:

- report on appropriateness of specific treatments, such as device therapy
- develop a new UK-specific heart failure risk model to allow for better comparisons between hospitals
- look at integrated care between primary and hospital care
- link with the National Cardiac Rehabilitation Audit to help reduce variance in services offered.

5.2 Use organisational audits to help identify the steps needed to deliver improved quality of care

'Organisational audits' are used by other national audits to understand the various inter-related changes that are made by hospitals in delivering improvements to services. These primarily use a survey-based approach to look at factors such as staffing, clinical and pathway protocols, levels of infrastructure, governance, partnership working and training.

Each NCAP audit has the opportunity to make use of these organisational audits to further understand why particular hospitals are achieving strong results in comparison with their peers and share these lessons across all providers and clinical staff.

5.3 Focus more on outcomes that matter most to patients

Defining the quality of care that patients receive is complex. It should encompass more than just whether a patient survives; more than whether and when recommended treatment is provided. It also includes such things as: the courtesy and professionalism of the clinical and administrative staff; the efficiency of administration systems; waiting times for appointments and treatments; possibilities for flexibility, to allow care to fit into other aspects of patients' lives; the empathy demonstrated by, and the confidence felt by patients in, their clinical teams; the ease of arranging future appointments; and the style and timeliness of communication between clinical teams, with general practitioners and with patients.

Because of this multi-faceted nature of quality of care, there may be a 'disconnect' between those aspects of quality expressed by national clinical audits in aggregate reports of thousands of cases, and the personal experience of individual patients and their families. So, for example, a patient may accept that they have been provided with the best evidence-based medical and surgical treatments, yet remain dissatisfied because they received no information or were treated dismissively. Conversely, a patient may be treated so humanely by well-meaning and kindly clinicians that they are content with their care even though they did not receive the best treatment.

Clinical datasets have tended to contain measurements concerning patient characteristics and treatments provided, but have largely lacked systems that capture elements reflecting both the patient experience and their quality of life. Treatments are not always effective or may provide only limited improvement in quality of life and patients may continue to suffer despite the best of treatment. Consequently, there are other things that are as important as the medical care provided, including:

- ensuring shared decision-making, so that patients are making more informed choices about the care they need and want
- managing expectations and providing access to other services that can provide additional help
- promoting patients' dignity, being honest and providing them with information about the decisions taken, the care provided and the prospects for recovery.

It will be important in future years for hospital providers to understand better those issues that patients find inadequate at the moment. The national clinical audit programmes cannot currently provide feedback on all these aspects of care, having been built around the evidence base for improving survival and symptoms. For the time being, other methods such as local collection of patient feedback about local services, 360 degree feedback to individuals or teams from a number of sources, and local audits aimed at specific areas of interest may make good this deficiency. One step in this direction, initiated by NHS England, is the recently introduced mandatory Patient Reported Experience Measure questionnaires for children and adults with congenital heart disease following hospital encounters, both inpatient and outpatient, whose results will feed into the Congenital Heart Services Specialised Services Quality Dashboard.

Over time though, the aim for NCAP will be to expand the range of patient outcome measures beyond into other aspects of morbidity, improved patient experiences and quality of life. Datasets will need to change over time to monitor these and to allow a uniformly good quality of care across the country. This report marks the start of a moving away from concentrating primarily on mortality metrics alone towards a broader range of indicators of good quality service.

5.4 Understand the impact of changing demographics

The absolute number of elderly people in the UK is increasing; age itself is a major risk factor for heart disease. The population presenting to hospital has gradually shifted so that the majority of patients are now over 65 years of age and the average age of those with heart failure is 79.

Many of these patients have characteristics that increase the chance of poor outcomes but that also increase the risks of treatments. Elderly patients often have multiple morbidities and significant degrees of frailty. For example, 60% of patients in the Heart Attack audit have at least one long-term health condition (such as chronic lung disease or diabetes) at the time of their heart attack and there is a specific cluster of conditions – hypertension, heart failure and peripheral vascular disease – associated with a particularly poor outcome. Amongst those with long-term conditions, this cluster is becoming more frequent, from 7.9% in 2003–06 to 9.0% in 2011–13.[33] This makes decision-making more difficult, especially as the evidence base for the management of many of these patients is incomplete.[34]

At the same time, for the younger population, although there has been a reduction in smoking, the rise in diabetes and obesity is associated with a continuing need to provide services as these risk factors translate into heart disease.

Although mortality rates for adult congenital heart disease patients remain very low, there is a need to develop a risk stratification model which accounts for factors or comorbidities which are specific to adult patients. From April 2015, the NCHDA dataset was updated with new fields to support the eventual development of such a model. Analysis of these fields will be included in the 2015-18 report. Adult congenital heart disease outcomes will also be analysed using the published Society of Thoracic Surgeons model, although adjustments will need to be made as details at procedural level are not identical between the two datasets.

All of these are significant changes for commissioners and policy makers to deal with and the audits have a vital role to play in providing information that can make the most effective use of available resources to deliver high quality care to these groups across the entire system of health and social services.

5.5 Make use of increased data linkages to explore system-wide factors and track the entire 'patient journey'

Increasingly important consideration in health policy is equity of access to care and the parity of esteem. The NCAP programme reports on two disease-specific programmes (the Heart Attack and Heart Failure audits) and four treatment-specific audits. Linkage of the treatment-specific audits to the disease-specific audits offers the potential to further study the characteristics of those who are not offered treatment. Linkage to routinely-collected administrative hospital coding systems might also help in this regard. There is no stand-alone angiography database and so there is no current prospect for routinely evaluating the outcomes of patients with obstructive coronary disease or other less common coronary abnormalities who are not offered revascularisation.

Future questions might also require linkage of the NCAP audits to other national data collection systems such as the cancer registries or the national registries for stroke, diabetes and renal replacement therapy. Research work linking the cancer and NCAP registries is already underway. The Heart Attack dataset has already been successfully linked to registries of drug treatments in rheumatoid arthritis to demonstrate that newer 'biologic' treatments are safer than existing alternatives.[35] Linkage to primary care data offers the potential to monitor progress across the whole clinical pathway, incorporating efforts to prevent disease or to manage 'pre-disease'. The potential for linkage to the national registry for cardiac rehabilitation has already been highlighted. Linkage to datasets with variables reflecting mental health characteristics would also yield useful audit tools. Some of this work is currently aspirational but forms the basis for future work programmes.

Researchers are also interested in linking the Congenital audit database with the Adult Surgical database as well as additional data collected by BCIS to investigate outcomes for adults with congenital heart disease. The Linking Audit and National datasets for improvement in Congenital Heart Services (LAuNCHeS) programme has received a grant to create a new research dataset connecting five national datasets that will allow a description of the trajectory through the NHS for patients with congenital heart disease, exploring variation in services across England to identify priority areas for quality improvement and measurement.

Much work has been done to increase the number of survivors for people who suffer out-of-hospital cardiac arrest. Researchers now plan to link the Out of Hospital Cardiac Arrest Outcomes (OHCAO) registry with NCAP and other relevant datasets.

Finally, a fundamental aim of bringing the audits together and integrating the data collected is to facilitate tracking of the whole clinical 'journey' for each patient, which may involve several different presentations and treatments. The intention is to expand this approach over the next five years to include 'pre-clinical information' about individual cardiovascular risk factors as well as relevant measures from other datasets (for example, genetic information).

Appendix A: Cardiovascular conditions and their treatments

Congenital heart disease

Congenital heart disease refers to any malformation or disease of the heart present from birth. It includes structural defects, congenital arrhythmias and some cardiomyopathies. Over 90% of cardiac pathology in the paediatric population in the developed world is congenital in origin, in that it is present at birth, even if undetected until older; in contrast, adult heart disease is largely classified as being acquired. Acquired heart disease develops after birth and examples of heart disease developed in childhood include most cardiomyopathies and inflammatory heart disease such as rheumatic heart disease and Kawasaki Disease.

The diagnosis and treatment of heart malformations has dramatically improved over the past few decades, with major advances in both surgical and percutaneous transvascular techniques (transcatheter 'keyhole techniques'). Examples of the latter include balloon dilation for valve stenosis and device closure of the arterial duct, secundum atrial septal defect and certain ventricular septal defects.

Surgical risks are highest for neonates who present in poor condition so a goal of congenital heart disease services is to spot heart disease as early as possible, ideally before birth (referred to as antenatal diagnosis).

Services for congenital heart disease are concentrated in a small number of centres to ensure that there is a sufficient number of procedures undertaken to develop and retain skills, experience, and organisational processes. There is also a need for them to be in close proximity to other specialist tertiary services, including the care of children with acquired heart disease.

Acute coronary syndromes (including heart attacks)

The most common form of heart disease in adults relates to coronary artery disease (atherosclerosis or 'hardening of the arteries'). This may result in angina or acute coronary syndromes such as unstable angina or heart attacks when the build-up of fatty deposits within the wall of the artery leads to blockages that affect the flow of blood to the heart muscle. Sometimes, inflammation around a cholesterol-rich fatty deposit causes an ulcer or fissure of the inner surface of the artery; the body's automatic healing response is associated with the development of blood clots – clots that serve to heal the fissure but which may also cause an abrupt cessation of blood flow, leading to heart attacks. Less commonly, heart attacks can occur through other mechanisms including spontaneous coronary artery dissection or due to adrenaline surges ('Takotsubo syndrome'). Whatever the mechanism, a heart attack can be associated with sudden changes in heart rhythm, some of which can be lethal – some, but not all, heart attacks can lead to cardiac arrest. For survivors, the heart muscle may be considerably weaker than before and patients may be prone to heart failure (see below).

Significant improvements in treatment have occurred over the last few decades, with drugs aimed at stabilising atherosclerosis, reducing the risk of heart attacks. The risk of heart attacks can also fall dramatically with better lifestyles (avoiding smoking, taking exercise and having a healthier diet).

When a major heart attack occurs, it is essential to restore blood flow down the coronary artery and the best way to do this is with emergency angioplasty (so-called 'primary PCI', or PPCI, or just 'primary angioplasty'). Once a patient calls for help, speed is of the essence as the longer it takes to restore blood flow the more damage is done to the heart and the more likely the patient is to have a lethal rhythm disturbance and later heart failure.

Following a heart attack, drug treatments to thin the blood (anti-platelet drugs) and so reduce the likelihood that further clots will obstruct the coronary artery, as well as ones which reduce cholesterol levels (statins and others), control blood pressure, stabilise heart rhythm, maintain heart pump function and reduce inflammation (beta blockers, angiotensin-converting enzyme inhibitors (ACE-Is) and others) have all led to improved outcomes. Patients' well-being and longer term outcomes are also improved by cardiac rehabilitation programmes.

In this report, the terms 'higher-risk' and 'lower-risk' have been used to differentiate those patients whose heart attacks are characterised by a specific electrical change seen on an electrocardiogram (ECG) early after the onset of symptoms from those in whom it is not. Those with ST-segment elevation are most likely to have complete coronary occlusion and require primary angioplasty. Higher-risk heart attacks in this report therefore refer to what clinicians call ST-elevation myocardial infarction (STEMI) – patients who are at high risk of substantial heart muscle damage or early death. Patients who do not have this ECG change, who are likely to have only partially obstructing clots in the coronary artery and so do not need immediate angioplasty, are at lower risk of early death. Lower-risk heart attacks in this report therefore refer to what clinicians call non-ST-elevation myocardial infarction (NSTEMI) – though, because patients with NSTEMI tend to be significantly older and have more comorbid conditions than those with STEMI, over a one-year period the risk of death is about the same.

Percutaneous coronary intervention (PCI) or 'angioplasty'

When obstructions in the heart arteries lead to exertion-

induced chest pain (angina) that cannot be controlled by medical treatment, then patients may be helped by methods to improve blood flow. The two techniques are percutaneous coronary intervention (PCI) (often referred to as 'angioplasty') and coronary artery bypass grafting (CABG). With angioplasty, a fatty deposit is pushed aside by the use of a balloon or wire mesh ('stent') that can be inserted under X-ray vision. The stent is taken up to the heart through a guide catheter that is passed into the body under local anaesthetic from either the groin (using the femoral artery) or the wrist (using the radial artery). Recent research has shown that complications are fewer when the wrist is used.

When angioplasty was first introduced, the arterial narrowing was stretched with just a balloon, but sometimes problems led to the need for emergency open heart surgery. Even successful treatments did not hold up over time because the vessel could re-narrow for a number of reasons. These early complications and the subsequent potential for re-narrowing were significantly reduced by the use of stents. The first stents were tubular wire meshes ('bare metal stents') but even some of these re-narrowed because of scar tissue developing inside the stent. Research led to the development of stents with a plastic coating which contained special drugs to minimise the development of scar tissue ('drug-eluting stents'). The drug is slowly released into the wall of the vessel to have its effect. Although there was a slight concern that drug-eluting stents might be a little more prone to the developments of clots after implantation ('stent thrombosis'), improvements in technology and the routine use of dual anti-platelet therapy (DAPT – using two drugs that inhibit platelet function by different mechanisms, thus enhancing the effect that can be achieved with just one drug) have led to improved outcomes. New research has led to the development of plastic coats on these stents that slowly dissolve over time (bioabsorbable polymers) which may further improve outcomes. Additional research is also being done to develop stents made entirely of special plastics that will slowly dissolve away (bioabsorbable stents).

In the early years of using angioplasty, it was used mainly for patients with stable angina. However, over the last 20 years it has been used more and more to treat patients with acute coronary syndromes, and especially for patients with heart attacks.

Heart surgery

The most common form of heart surgery is coronary artery bypass grafting (CABG), which is used for patients with severe angina or after a heart attack. There is good evidence for the benefits of CABG, which may also improve heart pump function in some patients with heart failure secondary to blocked blood vessels. As the specialty of cardiology developed, more and more people were put forward for heart surgery and waiting times for treatments grew to unacceptable levels. However, from 2000 onwards, much work has been done to improve access to heart surgery and these waits have fallen dramatically, although there is continuing awareness of variation around the country. Although open heart surgery is classified as major surgery, new 'minimally invasive' techniques have been introduced, recovery in general is quicker than it used to be, patients can be discharged earlier and complications have fallen. There are some major complications associated with all of these cardiac treatments but fortunately they are infrequent. Outcomes in terms of improved symptoms and quality of life are well established.

Open heart surgery is also required for patients with severe heart valve lesions causing the valve to be narrowed or very leaky. These problems can lead to patients becoming tired and breathless and may result in irreversible heart muscle weakness or changes in the lungs. These valve abnormalities may be due to congenital abnormalities, rheumatic heart disease (less frequent in the UK nowadays) and other inflammatory conditions affecting the valves, or to degenerative problems causing valves to thicken or split over time. It is important to make accurate diagnoses and to follow patients up so that treatment can be provided before these changes occur. Valve replacements make up a large part of the workload of surgical programmes although new techniques mean that many of these valve problems can now be treated by surgical repairs. For patients with narrowing of the aortic valve but who are at high risk for surgery, a new technique called transcatheter aortic valve implantation (TAVI) has been introduced, whereby a new valve can be inserted without the need for open heart surgery. Other new techniques for valve problems and other structural abnormalities of the heart are being explored.

Open heart surgery may also be needed for rare congenital problems that might not present until adulthood as well as for problems with the aorta, the major artery through which blood passes from the main heart pump to the rest of the body. This can weaken because of congenital problems with the strength of the vessel wall or through wear and tear associated with high blood pressure, atherosclerosis and ageing.

Heart failure

Whether due to congenital heart muscle abnormalities (cardiomyopathies), inflammation of the heart (myocarditis) or damage associated with problems arising from coronary artery or valve disease, the pumping chambers of the heart may increase in size and their pump power reduce ('heart failure with reduced ejection fraction' or HFrEF). This may be associated with fatigue and breathlessness and may be associated with dangerous heart rhythm abnormalities and a reduced survival rate. The ejection fraction is a measure of the pumping capability of the heart. Symptoms might also occur in patients with thickened heart muscle that may become stiff. Although the pump power may be retained, the wall of the pump does not relax well, the cavity of the main heart chamber can reduce in size and this leads to back pressure on the blood vessels in the lungs. The syndrome of heart failure can be exactly the same but this combination is referred to as 'heart failure with preserved ejection fraction' or HFpEF.

In the past, symptoms of heart failure could only be improved by the use of diuretics ('water tablets') and in some people

by the use of digoxin, but over the last two decades new treatments have had an impact on reducing the rate of deterioration of heart muscle problems, have made patients less prone to dangerous heart rhythm abnormalities and have helped improve symptoms and quality of life. These 'disease-modifying treatments' include beta blockers, ACE-Is, angiotensin receptor blockers (ARBs) and mineralocorticoid receptor antagonists (MRAs).

In some patients with specific characteristics related to a combination of their symptoms, their pump power and the shapes seen on their ECGs, the power of the pump may be improved by special pacemaker devices (cardiac resynchronisation therapy or CRT). These devices may also be able to monitor the patient's heart rhythm and provide special pacing techniques or shock treatment should any life-threatening rhythms occur. Other devices provide these functions but without the resynchronisation function – so-called implantable cardioverter defibrillators (ICDs). Most of the research for improved outcomes has been on patients with HFrEF. Ongoing research is looking to see whether new treatments other than that aimed at the causative mechanism might improve outcomes for patients with HFpEF.

Cardiac rhythm management

Patients may suffer from a number of problems should they develop abnormalities of heart rhythm, whether a conduction problem leading to the heart beating too slowly or electric circuit problems that can cause the heart to pump too fast. Although a small number of patients present with slow heart rates due to congenital abnormalities of the conducting system of the heart, most of these problems occur in older adults as the electric conduction pathways become scarred with age. Patients with heart block are prone to fatigue, breathlessness, black-outs and even sudden death. Their symptoms and prognosis can be dramatically improved by the implantation of a pacemaker. Research suggests that better outcomes in terms of symptoms occur when the electrical coordination between the upper chambers of the heart (the atria) and the lower pumping chambers of the heart (the ventricles) is maintained (so-called 'physiological pacing'). This usually requires a pacemaker with one lead in the right upper chamber and one lead in the right lower chamber of the heart (dual-chamber pacing).

Some arrhythmias are not especially dangerous but can cause impairment to quality of life by producing symptoms such as palpitations, dizziness, breathlessness and fatigue. There are subsets of patients though where these problems can lead to a weaker heart muscle or where the rhythm disturbance can degenerate into even faster and more dangerous rhythms. Many of the problems seen in children and young adults may arise as a consequence of residual pathways ('short-circuits') that may be brought into play in certain circumstances. There are some rare congenital causes of dangerous heart rhythm problems which lead to the pumping chambers of the heart going dangerously fast (ventricular tachycardia or ventricular fibrillation), although the vast majority of patients with these two sorts of rhythm abnormality have scarred hearts associated with problems such as a previous heart attack or cardiomyopathy.

It is important for patients with these rhythm problems to be seen by a cardiologist with expertise in their management (electrophysiologists). The correct diagnosis is not always possible from looking at a standard ECG and special internal recordings of the heart rhythm might be needed (an electrophysiology or EP study). Once the correct diagnosis is made, the heart rhythm team can decide whether this is best treated with special anti-arrhythmic drugs, ablation techniques or pacemakers or the special implantable devices mentioned above under 'Heart failure', namely ICDs and CRT devices. The latter devices have been shown to be better at improving survival rates than using anti-arrhythmic drugs, although for some patients the use of drugs is all that is needed. Ablation techniques are designed to interrupt either the initiating areas or the circuits that can maintain these rhythms, and in many patients can result in a cure for the rhythm disturbance.

Appendix B: Background to the audits and methodology

The National Institute for Cardiovascular Outcomes Research (NICOR) oversees the collection and reporting of data

The National Cardiac Audit Programme (NCAP) brings together six separate cardiovascular audit programmes. The datasets were developed by the relevant professional societies. Over time, it was decided to combine efforts and to collect data at an individual patient level within the same informatics system. In 2000, data for the Heart Attack audit (MINAP) was collected on a national level through the Central Cardiac Audit Database (CCAD). The other sub-specialties followed.

The combined database provides a means of evaluating the services needed to provide these treatments and to see how each hospital's performance compares against a range of benchmarks or with the results of other centres where the treatment is provided.

In 2011, responsibility for the maintenance of the data system was brought together in the National Institute for Cardiovascular Outcomes Research (NICOR), which now collects and manages the data from hospitals. The NICOR Stakeholder Group oversees the audit programme and has representation from patients and the public, commissioners and regulators, as well as the professional societies.

There has been a major advance in audit methodology and statistical analysis, with robust approaches to data quality, risk adjustment methodology, pre-defined planning of statistical analyses and reporting. NICOR has consistently been transparent in publishing its approaches in the different audits but the new harmonised NCAP programme will enable application of consistent methodology across all outputs.

Each audit has its own expert group to guide its work, including deciding on the data that can be included

The expert groups are made up of clinicians linked to professional societies, allied health professionals, patient representatives and, where appropriate, commissioners and regulators. These groups identify the key questions that can provide reassurance about quality of care and reveal where that quality can be improved. Quality standards are either selected from national or international guidelines or from a consensus of the expert group. The datasets are currently designed around the most common forms of heart disease, so information is not gathered on all heart conditions or treatments. The expert groups will review the datasets each year and consider new questions as well as other audit methods to gather information on different aspects of care.

The data in all six audits covers England and Wales and in some cases also Scotland, Northern Ireland and the Republic of Ireland

All the national professional societies share the aim of collecting data for all patients treated in the UK. Where possible, this report includes data for the whole of the UK but in some cases the geographic coverage is limited to patients in England and Wales. The aspiration for future years, subject to discussions between the relevant funding bodies, is that all data covers the whole of the UK and also includes patients treated by private sector providers.

The anonymous data on each patient treated at UK hospitals are analysed and feedback is provided to these healthcare providers so that they can review their own performance. However, as the data are also useful to patients and the public, as well as to commissioners of healthcare, this report provides information for all relevant groups.

The audit teams seek to include as many relevant patients as possible so as to understand how variations in treatment might arise

To provide the best means of comparing the performance of hospitals, it is important to collect data on as many patients as possible, and to apply a consistent approach to data collection in all of the participating hospitals. Although snapshot audits and case sampling have their roles, the need to develop and apply risk models to allow a better understanding of the variation in healthcare delivery depends on a comprehensive collection of the entire spectrum of the way that patients present with different conditions.

Hospital administration statistics, because they were designed to gather administrative rather than clinical data, do not collect all the variables needed to appropriately detect the extent of variations and identify factors that explain these variations. Although others have compared hospitals using such data, the clinical community believes it is important to try and take account as much as possible of variation due to patient and hospital characteristics, which can only be collected through clinical datasets. Systems such as Hospital Episode Statistics (HES) and Patient Episode Database for Wales (PEDW) contain some coding inaccuracies and lack the richness of clinical information that is needed to create useful risk models.

'Quality' in healthcare can be difficult to define. Patients want the best outcomes possible, in terms of improved quality of life and reduction in complications related to their disease and/or

the treatments provided, as well as improved survival.

However, patients, their relatives and carers do not expect 'survival at all costs'. Judgments have to be made about the potential benefits (and possible unwanted effects) of every clinical intervention in each case. So for some patients, after due deliberation and discussion, it might be decided that it is inappropriate to undertake a specific therapy. Moreover, some cannot tolerate drugs or do not want to undergo certain treatments for their own reasons. Understanding variation in the delivery of healthcare therefore has to take account of these and other such factors.

The national datasets are designed to interrogate a number of factors:

- **Structure** – which organisations and what staff are available to deliver healthcare?
- **Process** – how well are the components of care provided?
- **Appropriateness** – did specific patients get the appropriate evidence-based treatment?
- **Outcomes** – what is the end result of the care provided?

This report provides information at an aggregate national and hospital level rather than an individual patient level. In other words, this is not a review of individual cases, but rather a consideration, for each hospital, of the sum of care provided to all the patients that were managed there. However, we do highlight individual stories where excellent care was delivered and include some patient experience reports. Although there are formal methods to evaluate patient-reported outcomes and experiences, these are not included in this year's report.

The inclusion of all relevant patients can be challenging due to multiple morbidities and the subtleties of disease diagnosis

While NCAP has been designed to capture as many of the relevant patients as possible, this can be a challenge. This is especially so where inclusion in the audit is based upon a clinical diagnosis rather than the performance of a particular intervention. Some patients may not feature in the audit at all as their primary diagnosis will be for another, non-cardiovascular condition, while in the case of others the correct diagnosis may require careful interpretation of the clinical history and of relevant investigations.

For example, diagnosing NSTEMI (lower-risk heart attacks) is difficult and requires judgement. In this type of heart attack the ECG may be entirely normal and the diagnosis may require the identification of elevated levels of certain bio-markers of heart muscle damage (for example, troponin) in the blood stream. However, while an elevated troponin blood level is necessary for the diagnosis, it is not sufficient; many other common clinical conditions (for example, anaemia, severe infection, heart rhythm disturbances) may also cause release of troponin from the heart. Therefore, an over-reliance on the blood troponin concentration may lead to incorrect diagnosis. Cardiologists and nurse specialists have a key role in interpretation of such tests.

The same is true for heart failure. While the audit collects information on patients with a primary diagnosis of heart failure, there will be other patients with heart failure in the hospital (whose primary admission reason was not for heart failure) or in the community who are not included. Moreover, there are different causes and forms of heart failure, for which clinical pathways will differ, as will the level of evidence available around the optimal therapeutic options.

The audits use various statistical methods to increase the robustness of comparisons between hospitals and operators

When making comparisons between hospitals or between clinicians, it is important to take into account those hospital and patient factors that influence outcome, and the characteristics of the patients receiving care (such as age and pre-existing comorbidity). Clinical pathways are complex. Many patients can be treated in their local hospitals by their local specialists and clinical teams, but some patients need to be transferred to specialist centres where different equipment and skills are available. In addition, although the main characteristics of patients can be defined and categorised, such grading systems cannot take account of every feature. To overcome these issues, researchers use statistical methods to take account of the most common variations. This is the process of 'risk adjustment'. Even these statistical models have limits, and although they can help explain some of the variation in the delivery of care or outcomes, not all the variation can be explained and this may be due to a host of other complex issues that are not measurable. This is particularly important to appreciate when interpreting tables, graphs or plots.

At the very highest level, when one is trying to determine whether care is delivered at an unacceptable level, or whether care is unusually good, statistical methods are used to identify 'outlying' institutions or operators – those whose performance seems to be measurably and significantly different from that expected. However, it is very important to understand the limitations of statistical analysis. An outlier might not actually be performing any worse than others, but may just be dealing with sicker patients or very rare conditions. Even so, such analysis is important as it can contribute to discussions about where performance may be sub-optimal and where improvements could be made. It is also important to recognise that the quality of care covers a whole range of processes and although audit programmes highlight areas where care might be improved, it is not appropriate to concentrate on a single metric. The quality of care as a whole should be evaluated.

Statistical robustness relies on hospitals providing all applicable data on all the patients with the relevant conditions

Each audit aims to capture a carefully defined set of data that is applicable to each patient admitted with the condition of interest. To comment on performance, it is necessary to examine how care is delivered to all patients and not just to selected subsets. This raises the challenge of 'case ascertainment', whereby some method is needed to identify whether a hospital is providing information on all the patients they treat with these conditions. There are different methods of doing this. There is considerable variation between hospitals, and the NCAP programme is working to harmonise this across the separate domains to ensure data capture is as complete as possible.

Another problem relates to the completeness of the dataset for each patient. In the past this has only become recognised as an issue when the relevant final analyses are being performed. The accuracy of data is also important and there are a number of methods that can be used to establish the validity of the information provided. The NCAP is actively working to ensure a more consistent approach across the country.

Some national and international audit programmes only allow participating hospitals to use a single web-based data collection system, but a decision was previously made that NICOR should be able to accept data from whatever IT system each hospital had acquired or designed. For those who collect data through the central web-based systems, data collection is contemporary, but other hospitals only download data in batches once they have applied their own validation processes. Although the latter are important, it is essential for all participants to understand the timetable for data collection, data cleaning and analysis and to ensure that data are supplied to NICOR accurately and on time. NCAP is working on processes to improve these issues.

Recognising these aspects of data quality are particularly important to understand when considering the outcomes of the various analyses so as to ensure that the results are not misunderstood. It is the responsibility of the participating hospitals to ensure the quality of the data to NICOR is as good as possible – with a focus on case ascertainment, data accuracy, completeness and validity.

This requires hospitals to provide the clinical teams with the appropriate IT and audit team support to ensure optimal data quality. NICOR provides various tools to support data quality on entry and prior to publication. Historically, these have varied within each specialty but work continues to identify tools that work well and to standardise these across each of the clinical domains.

There are a number of other cardiovascular-related datasets and analyses that fall outside the scope of this report

In addition to NCAP, NICOR also gathers data on patients undergoing transcatheter aortic valve implantation (TAVI) and other new technologies, but as this programme is currently outside the scope of the NCAP programme only minimal detail is provided in this report.

Two other non-NICOR national cardiovascular data collection programmes are:

- the National Audit of Cardiac Rehabilitation, coordinated by the British Association for Cardiac Rehabilitation and sponsored by the British Heart Foundation
- the National Audit of Pulmonary Hypertension, delivered by NHS Digital, commissioned by NHS England and supported by NHS Scotland, NHS Wales (GIG Cymru), the Pulmonary Hypertension Association (PHA-UK) and the National Pulmonary Hypertension Centres of United Kingdom and Ireland Physicians' Committee.

Data are also collected separately by the NHS Blood and Transplant (NHS BT) Service on patients treated with cardiac transplantation and ventricular assist devices.

Finally, it is also worth noting that just because something is measurable does not necessarily mean it is an important determinant of healthcare quality. Equally, not everything that is important can be measured. So things like improved patient understanding, a willingness to listen, compassion and friendliness are all considered to contribute to optimal healthcare but are often intangible. Although methods are being developed to measure these elements of care, the NCAP programme does not currently utilise these.

Appendix C: NICE guidelines

The NICE Clinical Guidance, Quality Standards, Technology Appraisals and Interventional Procedures covered by NCAP (https://www.nice.org.uk/guidance)

NICE ref	Title
CG87	Acute heart failure: diagnosis and management (2014)
CG180	Atrial fibrillation (2014)
CG108	Chronic heart failure: management of chronic heart failure in adults in primary and secondary care (2010)
CG126	Stable angina: management (2011) NICE guideline
CG167	Myocardial infarction with ST-segment elevation (2013)
CG172	Myocardial infarction: cardiac rehabilitation and prevention of further MI (2013)
QS9	Chronic heart failure in adults (2011, updated 2016)
QS21	Stable angina (2012)
QS68	Acute coronary syndromes in adults (2014)
QS93	Atrial fibrillation: treatment and management (2015)
QS99	Secondary prevention after a myocardial infarction (2015)
QS103	Acute heart failure: diagnosis and management in adults (2015)
TA152	Drug-eluting stents for the treatment of coronary artery disease
TA88	Dual-chamber pacemakers for symptomatic bradycardia due to sick sinus syndrome and/or atrioventricular block
TA324	Dual-chamber pacemakers for symptomatic bradycardia due to sick sinus syndrome without atrioventricular block
TA134	Implantable cardioverter defibrillators and cardiac resynchronisation therapy for arrhythmias and heart failure (review of TA95 and TA120) (2014)
IPG067	Balloon dilatation of pulmonary valve stenosis
IPG074	Balloon angioplasty with or without stenting for coarctation or recoarctation of aorta in adults and children
IPG075	Balloon angioplasty of pulmonary vein stenosis in infants
IPG076	Balloon dilatation with or without stenting for pulmonary artery or non-valvar right ventricular outflow tract obstruction in children
IPG077	Balloon dilatation of systemic to pulmonary arterial shunts in children
IPG078	Balloon valvuloplasty for aortic valve stenosis in adults and children
IPG086	Endovascular atrial septostomy
IPG095	Radiofrequency valvotomy for pulmonary atresia
IPG096	Endovascular closure of atrial septal defect
IPG097	Endovascular closure of patent ductus arteriosus
IPG128	Totally endoscopic robotically assisted coronary artery bypass grafting
IPG168	Percutaneous radiofrequency catheter ablation for atrial fibrillation
IPG246	Hybrid procedure for interim management of hypoplastic left heart syndrome in neonates
IPG286	Thoracoscopic epicardial radiofrequency ablation for atrial fibrillation
IPG294	Percutaneous (non-thoracoscopic) epicardial catheter radiofrequency ablation for atrial fibrillation
IPG295	Percutaneous (non-thoracoscopic) epicardial catheter radiofrequency ablation for ventricular tachycardia
IPG309	Percutaneous mitral valve leaflet repair for mitral regurgitation
IPG336	Transcatheter endovascular closure of perimembranous ventricular septal defect
IPG370	Percutaneous closure of patent foramen ovale for recurrent migraine
IPG371	Percutaneous closure of patent foramen ovale for the secondary prevention of recurrent paradoxical embolism in divers
IPG377	Off-pump coronary artery bypass grafting

IPG399	Percutaneous endoscopic catheter laser balloon pulmonary vein isolation for atrial fibrillation
IPG421	Transcatheter aortic valve implantation for aortic stenosis
IPG427	Percutaneous balloon cryoablation for pulmonary vein isolation in atrial fibrillation
IPG436	Percutaneous pulmonary valve implantation for right ventricular outflow tract dysfunction
IPG454	Insertion of a subcutaneous implantable cardioverter defibrillator for prevention of sudden cardiac death
IPG456	Sutureless aortic valve replacement for aortic stenosis
IPG472	Percutaneous closure of patent foramen ovale to prevent recurrent cerebral embolic events
IPG481	Optical coherence tomography to guide percutaneous coronary intervention
IPG492	Bioresorbable stent implantation for treating coronary artery disease
IPG494	Endoscopic saphenous vein harvest for coronary artery bypass grafting
IPG504	Transcatheter valve-in-valve implantation for aortic bioprosthetic valve dysfunction
IPG505	Telemetric adjustable pulmonary artery banding for pulmonary hypertension in infants with congenital heart defects
IPG516	Implantation of a left ventricular assist device for destination therapy in people ineligible for heart transplantation
IPG541	Transapical transcatheter mitral valve-in-valve implantation for a failed surgically implanted mitral valve bioprosthesis

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Glossary

ACE-i	**Angiotensin-converting enzyme inhibitor**: a class of drug used after a heart attack, and other causes of weakening of the heart muscle, to treat and prevent heart failure. They stop the body's ability to produce angiotensin II, a hormone which causes blood vessels to contract, thus dilating blood vessels and this reduces the work the heart needs to do.
Acute coronary syndrome	Covers all episodes that result from sudden and spontaneous blockage or near blockage of a coronary artery, including heart attack and unstable angina.
Angina	Covers 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, allowing decisions to be made regarding treatment, such as primary percutaneous coronary intervention or coronary artery bypass grafting.
Angiography	The technique of producing angiograms.
Angioplasty	A procedure used to treat the narrowed coronary arteries of the heart and angina in patients. Nowadays, the expression PCI is used.
Aortic stenosis	One of the most common and most serious valve disease problems. Aortic stenosis is a narrowing of the aortic valve opening and restricts the blood flow from the left ventricle to the aorta. It may also affect the pressure in the left atrium. The condition mainly develops during aging, as calcium or scarring damages the valve and restricts the amount of blood flowing through the valve.
ARB	**Angiotensin II receptor antagonist/angiotensin receptor blocker**: a group of medicines usually prescribed for those patients who are intolerant of ACE-Is. Rather than lowering levels of angiotensin II, they instead prevent the chemical from having any effect on blood vessels.
Atherosclerosis	A process where the walls of the arteries develop fatty deposits called atheroma.
Atrial fibrillation	A heart condition that causes an irregular and often abnormally fast heart rate. A normal heart rate should be regular and between 60 and 100 beats a minute when resting. In atrial fibrillation, the heart rate is irregular and can sometimes be very fast. In some cases, it can be considerably higher than 100 beats a minute.
Bare metal stents	Stents without a coating or covering, made of a mesh-like tube of thin wire.
BCCA	**British Congenital Cardiac Association**
BCIS	**British Cardiovascular Intervention Society**
BCS	**British Cardiovascular Society**
Beta blockers	A group of medicines that slow the heart rate, decrease cardiac output and lessen the force of heart muscle and blood vessel contractions. They are used to treat abnormal or irregular heart rhythms and abnormally fast heart rates, help prevent attacks of angina and are a key treatment for patients with heart failure.
BHRS	**British Heart Rhythm Society**
BPT	**Best Practice Tariff**
BSH	**British Society for Heart Failure**
CABG	**Coronary artery bypass grafting:** a surgical procedure where blood is bypassed around narrowed or blocked arteries by connecting or grafting a healthy artery or vein in its place.
Call-to-balloon time	The interval between the call for help to the emergency service and the beginning of the PCI procedure – an expression of the overall response of the healthcare system.
Call-to-door time	The interval between the call for help to the emergency service and the time the ambulance stops outside the hospital – an expression of the ambulance service response including the prioritisation of the call, the ambulance response time, the diagnosis and treatment at scene and the transport time.
Cardiac rehabilitation	A programme of exercise and information sessions designed to help patients who have had a heart attack and reduce their risk of a further heart event.
Cardiogenic shock	Occurs if the heart suddenly cannot pump enough oxygen-rich blood to the body. The most common cause is damage to the heart muscle from a severe heart attack.

Case mix	Refers to the different types of patients treated by a hospital or an operator.
CCAD	**Central Cardiac Audit Database**
Chronic total occlusions	Complete or almost complete blockage of a coronary artery for three months or more, caused by a heavy build-up of atherosclerotic plaque within the artery.
COP	**Clinical Outcomes Publication**: an NHS England initiative, managed by HQIP, publishing quality measures at the level of individual consultant doctors.
Coronary heart disease	A group of diseases that includes stable and unstable angina, myocardial infarction and sudden coronary death. It results from the narrowing or blockage of the coronary arteries, usually caused by atherosclerosis.
CQC	**Care Quality Commission**
CRT	**Cardiac resynchronisation therapy** (also known as biventricular pacing): aims to improve the heart's pumping efficiency by making the chambers of the heart pump together. 25–50% of all heart failure patients have hearts whose walls do not contract simultaneously. CRT involves implanting a CRT pacemaker or ICD with leads positioned to stimulate both ventricles. Most devices also include a third lead positioned in the right atrium to ensure that the atria and ventricles contract at the right times.
CRT-D	CRT with defibrillator.
CRT-P	CRT with pacemaker function only.
CVA	Cerebrovascular accident is the medical term for a stroke. A stroke is when blood flow to a part of your brain is stopped either by a blockage or the rupture of a blood vessel.
CVD	**Cardiovascular disease**: a general term for conditions affecting the heart or blood vessels. It is usually associated with a build-up of fatty deposits inside the arteries – known as atherosclerosis – and an increased risk of blood clots. There are different types of CVD, including coronary heart disease and other causes of heart damage such as valve disease.
DAPT	**Dual anti-platelet therapy**: using two drugs that inhibit platelet function by different mechanisms, thus enhancing the effect that can be achieved with just one drug.
Diuretic	A group of medicines that help to remove extra fluid from the body by increasing the amount of water passed through the kidneys. Loop diuretics are often used in heart failure patients to ease symptoms of oedema and breathlessness.
Door-to-balloon time	The interval between the time the ambulance stops outside the hospital (or the patient 'self-presents' at the hospital) and the beginning of the PCI procedure. This is an expression of the 'hospital' response, though the performance of an ECG before arrival at hospital and early warning by the ambulance service can alert the receiving hospital and so reduce this interval.
Drug-eluting stents	Metal stents that have been coated with a pharmacologic agent (drug) that is known to suppress restenosis (the reblocking or closing up of an artery after angioplasty due to excess tissue growth inside or at the edge of the stent).
ECG	**Electrocardiogram**: a diagnostic test that records the rhythm and electrical activity of the heart.
Echocardiogram	A diagnostic test that uses ultrasound to create two-dimensional images of the heart. This allows clinicians to examine the size of the chambers of the heart and its pumping function in detail, as well as examine valves and the myocardium (heart muscle).
EF	**Ejection fraction**: the left ventricle is the heart's main pumping chamber that pumps oxygenated blood through the ascending (upward) aorta to the rest of the body, so the ejection fraction is usually measured only in the left ventricle (LV). An LV ejection fraction of 55 percent or higher is considered normal.
Elective patients/surgery/ procedure	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.
ESC	**European Society of Cardiology**: a professional association for cardiologists across Europe, which aims to facilitate improved diagnosis and treatment of cardiovascular disease in Europe. It runs numerous education and training events, and edits and publishes nine journals on cardiology. The ESC has produced numerous Clinical Practice Guidelines, which the audit uses, along with NICE guidance, as benchmarks for good practice.

Heart failure	A syndrome characterised by the reduced ability of the heart to pump blood around the body, caused by structural or functional cardiac abnormalities. The condition is characterised by symptoms such as shortness of breath and fatigue, and signs such as fluid retention. Acute heart failure (AHF) refers to the rapid onset of the symptoms and signs of heart failure, often resulting in a hospitalisation, and more common with a first presentation. Chronic heart failure (CHF) describes more stable symptoms, often following effective treatment for acute heart failure, or a more insidious deterioration, where the slow development of symptoms can more easily be missed. People with heart failure are characterised by periods of stability (CHF) when at best they are rendered asymptomatic, and a susceptibility to acute deteriorations or episodes of AHF. Effective treatment of the underlying cause and regular informed review will minimise or even abolish these episodes.
HES	**Hospital episode statistics**: a database containing details of all admissions, A&E attendances and outpatient appointments at NHS hospitals in England. Initially, these data are collected during a patient's time at hospital as part of the Commissioning Data Set (CDS). This is submitted to NHS Digital for processing and is returned to healthcare providers as the Secondary Uses Service (SUS) dataset and includes information relating to payment for activity undertaken. It allows hospitals to be paid for the care they deliver. These same data can also be processed and used for non-clinical purposes, such as research and planning health services. Because these uses are not to do with direct patient care, they are called 'secondary uses'. https://digital.nhs.uk/data-services/hospital-episode-statistics
HFrEF	**Heart failure with reduced ejection fraction**: the most common type of heart failure due to left ventricular systolic dysfunction, where there is impaired contraction of the left ventricle.
HFpEF	**Heart failure with preserved ejection fraction**: heart failure with impaired filling of the left ventricle when the heart muscle is thickened, often as a result of long-standing high blood pressure.
HLHS	**Hypoplastic left heart syndrome**: a type of congenital heart defect that affects normal blood flow through the heart. As the baby develops during pregnancy, the left side of the heart does not form correctly.
HQIP	**Healthcare Quality Improvement Partnership**: established in April 2008 to promote quality in healthcare, and in particular to increase the impact that clinical audit has on healthcare quality improvement. It is an independent organisation led by the Academy of Medical Royal Colleges, The Royal College of Nursing and National Voices. www.hqip.org.uk
ICD	I**mplantable cardioverter defibrillator**: a small device placed in the chest or abdomen to help treat irregular heartbeats called arrhythmias.
Interventional centre	A hospital equipped with catheter laboratories and trained staff to perform percutaneous coronary interventions (normally available around the clock); also known as a Heart Attack Centre or PCI hospital.
ITU	**Intensive therapy unit**
JAMA	**Journal of the American Medical Association**
LAuNCHeS	**Linking Audit and National datasets for improvement in Congenital Heart Services**
Lesion	Build-up of atheromatous debris on the internal walls of the artery that can be stable and unstable.
MINAP	**Myocardial Ischaemia National Audit Project**: a national clinical audit of the management of heart attacks.
MRA	**Mineralocorticoid receptor antagonists**: a group of diuretic medicines, whose main action is to block the response to the hormone aldosterone, which promotes the retention of salt and the loss of potassium and magnesium. MRAs increase urination, reduce water and salt, and retain potassium. They help to lower blood pressure and increase the pumping ability of the heart.
NACRM	**National Audit of Cardiac Rhythm Management**
NACSA	**National Adult Cardiac Surgery Audit**
NAHF	**National Audit of Heart Failure**
NAPCI	**National Audit of Percutaneous Coronary Intervention**
NCAP	**National Cardiac Audit Programme**
NCHDA	**National Congenital Heart Disease Audit**
NHS	**National Health Service**
NHS BT	**National Health Service Blood and Transfusion**
NIAP	**National Infarct Angioplasty Project**: a feasibility study looking at how primary angioplasty could be rolled out as the main treatment for heart attack in place of clot-busting drugs.

NICE	**National Institute for Health and Care Excellence**: the official body in England that provides national guidance and advice to improve health and social care.
NICOR	**National Institute for Cardiovascular Outcomes Research**
NSF	**National Service Framework**: a ten-year strategy, published in 2000, setting quality standards for coronary heart disease care, aiming to reduce coronary heart disease and stroke-related deaths.
NSTEMI	**Non ST-elevation myocardial infarction**: a heart attack that occurs without ST-segment elevation on the ECG. It usually means a coronary artery is partly blocked, so emergency treatment to restore the blood flow may not be needed, but the long-term prognosis is actually worse than for STEMI.
OHCAO	**Out of hospital cardiac arrest outcomes**
Pacemaker	A small electrical device used to treat some abnormal heart rhythms.
PEDW	**Patient Episode Database for Wales**
PCI	**Percutaneous coronary intervention**: a technique to reopen a blocked coronary artery, also called angioplasty. Primary PCI means it is carried out as an emergency treatment for a heart attack, in which case it must be performed as soon as possible after the STEMI is diagnosed to prevent loss of heart muscle.
PHA UK	**Pulmonary Hypertension Association**
PPCI	Primary percutaneous coronary intervention (also known as primary angioplasty): used as an emergency treatment for patients who have had a heart attack.
PRAiS2	**Partial Risk Adjustment in Surgery 2** model
RCT	**Randomised controlled trial**: a type of scientific (often medical) experiment which aims to reduce bias when testing a new treatment.
Revascularisation	The restoration of perfusion (blood flow) to a body part or organ that has suffered ischemia (inadequate blood supply). Cardiac surgery and angioplasty are the two primary means of revascularisation.
Reperfusion	The treatment that improves the blood supply to the heart, including PCI or thrombolysis, when a vessel has been suddenly blocked by a blood clot.
SCP	**Surgical care practitioner**
SCTS	**Society for Cardiothoracic Surgery in Great Britain and Ireland**
Sinus node disease	A group of abnormal heart rhythms (arrhythmias) caused by a malfunction of the sinus node, the heart's primary pacemaker; also called sinus node dysfunction, or sinoatrial disease.
STEMI	**ST-elevation myocardial infarction**: a heart attack characterised by a specific abnormal appearance on the ECG (ST-segment elevation), which usually means a coronary artery is completely blocked.
Stents	Metal mesh tubes used to open up a narrowed or blocked coronary artery to restore or improve blood flow to the heart.
TAVI	**Transcatheter aortic valve implantation**: a non-surgical alternative to open heart surgery to replace the aortic valve.
Tertiary centre	A hospital that provides tertiary care, which is healthcare from specialists with specific expertise in a given field, in a large hospital after referral from primary and secondary care. All major paediatric and adult heart surgery, and most new transcatheter procedures are undertaken at tertiary centres.
TGA	**Transposition of the great arteries**: a condition characterised by the aorta arising from the right ventricle and the pulmonary artery from the left ventricle; often associated with other cardiac abnormalities (e.g. ventricular septal defect). Newborns with transposed great arteries are very likely to die without an arterial switch operation. The operation, as the name implies, involves switching the aorta and pulmonary arteries back to their correct positions.
TGA-IVS	**Transposition of the great arteries with an intact ventricular septum**
Thrombolysis	An intravenous medication used to break down a clot in a coronary artery to restore the blood flow to the heart. Formerly the standard treatment for STEMI but now primary PCI is preferred as it is more effective.
Unstable angina	A sudden episode of chest pain, caused by a lack of oxygen supply to the heart, which is unpredictable and can occur when the patient is at rest. It is a type of acute coronary syndrome and should be treated as an emergency.
VLAD	**Variable life adjusted display**

List of figures and tables

About us

NICOR (National Institute for Cardiovascular Outcomes Research)

NICOR is a partnership of clinicians, IT experts, statisticians, academics and managers that manage six cardiovascular clinical audits and a growing portfolio of new health technologies, including the UK TAVI registry. NICOR collects, analyses and translates vital cardiovascular data into relevant and meaningful information to drive sustainable improvements in patient well-being, safety and outcomes. NICOR has been hosted by Barts Health NHS Trust since 1st July 2017. NICOR is commissioned by the Healthcare Quality Improvement Partnership (HQIP) to deliver the National Cardiac Audit Programme (NCAP).
https://www.nicor.org.uk

Barts Health NHS Trust

With a turnover of £1.4 billion and a workforce of around 16,000, Barts Health is the largest NHS trust in the country, and one of Britain's leading healthcare providers. The Trust's five hospitals – St Bartholomew's Hospital in the City, including the Barts Heart Centre, The Royal London Hospital in Whitechapel, Newham University Hospital in Plaistow, Whipps Cross University Hospital in Leytonstone and Mile End – deliver high quality compassionate care to the 2.5 million people of East London and beyond.
https://www.bartshealth.nhs.uk

The Healthcare Quality Improvement Partnership (HQIP)

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 in patient outcomes, and in particular, to increase the impact that clinical audit, outcome review programmes and registries have on healthcare quality in England and Wales. HQIP holds the contract to commission, manage and develop the National Clinical Audit and Patient Outcomes Programme (NCAPOP), comprising around 40 projects covering 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 projects, other devolved administrations and crown dependencies.
www.hqip.org.uk/national-programmes

UCLPartners

UCLPartners is a leading academic health science partnership that brings together people and organisations to transform the health and well-being of the population. Working in partnership and at pace, its members from the NHS and higher education support the healthcare system serving over six million people in parts of London, Hertfordshire, Bedfordshire and Essex. UCLP has supported NICOR in the preparation of this report.
https://uclpartners.com/

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