# Incidence of cardiac surgery following PCI: insights from a high-volume, non-surgical, UK centre

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**Percutaneous coronary intervention (PCI) has established itself as an effective alternative to coronary artery bypass graft surgery (CABG) in appropriate patients. However, the proportion of patients that undergo CABG and/or valve surgery (VS) following PCI in the short and long term is currently unknown.**

**We conducted a single-centre, retrospective study examining the indications and number of patients requiring CABG and or VS following successful PCI between 2009 and 2012. The surgical procedure was categorised as early (referred within <1 month of the index PCI), mid-term (referred 1–12 months after index PCI) and remote (referred >1 year and up to four years following the index PCI).**

**During each three-year period (2008–2010, 2009–2011), 5,244 PCIs were performed at our centre. The total number of patients referred for cardiac surgery post-PCI was 63 (1.2%). The number of patients referred for early, mid-term and remote cardiac surgery was 21 (0.4%), 14 (0.26%) and 28 (0.53%), respectively. Within the early group, eight patients had extensive three-vessel disease stabilised with emergency/urgent PCI to allow subsequent CABG, while 10 patients had failed PCI to a chronic total occlusion. In the mid-term group, the main reason for surgery was rapid progression in coronary disease. In the remote group, the majority of patients underwent surgery for progression of valve disease.**

**Our data suggest that the number of patients requiring CABG and/or VS following PCI is small, and the indications differ with time following the index PCI. We hope that these results will provide reassurance and interest to our interventional colleagues.**

## Introduction

It is accepted that coronary revascularisation with coronary artery bypass graft surgery (CABG) provides both symptomatic and prognostic benefit in patients with multi-vessel coronary artery disease (mvCAD).[1,2] Both percutaneous coronary intervention (PCI) and CABG provide better relief of angina symptoms than medical therapy alone.[1,3] Large, randomised-controlled trials (RCTs), in recent years, have demonstrated that CABG offers an improved outcome in patients with complex three-vessel coronary artery disease (CAD), especially in those with co-existing diabetes mellitus.[4,5] However, in patients with one- or two-vessel CAD, PCI outcomes are comparable with those achieved with CABG.[4,6] In 2012, 92,445 PCI procedures were performed in the UK; a ratio of 5.4 PCI procedures to each isolated CABG operation.[7] Furthermore, PCI operators are tackling increasingly complex CAD, previously deemed the domain of the cardiac surgeon. The last hurdle for PCI remains complex distal left main coronary artery (LMCA) disease, which generally is better treated with CABG.[6] Despite improvements in stent technology, the need for repeat revascularisation remains higher in PCI than CABG.

The Royal Bournemouth Hospital (RBH) is a medium-sized district general hospital, which houses the Dorset Heart Centre (DHC); a high-volume, non-surgical, cardiology department with five interventional cardiologists (four prior to September 2012) and a busy rapid access chest pain clinic. DHC covers a densely populated area of Dorset with a very high proportion of elderly patients. DHC has been performing PCI since 2005, and currently performs approximately 1,750 PCI procedures per year. All operators have extensive experience in complex calcific mvCAD, utilising rotational atherectomy, excimer laser

atherectomy and modern intra-coronary imaging. Two of the PCI operators are experts in chronic total occlusion (CTO) PCI. Cardiac surgical access is provided at Southampton General Hospital. A heart team multi-disciplinary team (MDT) meeting occurs weekly to discuss complex (i.e. left main stem, CTO) or multi-vessel cases. Often, surgery or PCI approach is technically possible, and the final decision is made after discussion with the patient and their relatives. All PCI procedures were performed at RBH.

As a reflection of the high proportion of elderly patients, who often carry significant comorbidity and more often choose PCI over CABG, we have a higher than average ratio of PCI to CABG at 8:1. We were interested to find out if our PCI practice provided effective management of CAD, or whether PCI deferred the timing of CABG referral. Furthermore, it is not unusual for elderly patients to have mild-to-moderate valvular heart disease and we wished to assess what proportion of our patients treated with PCI would subsequently require surgical intervention for valvular disease.

## Methods

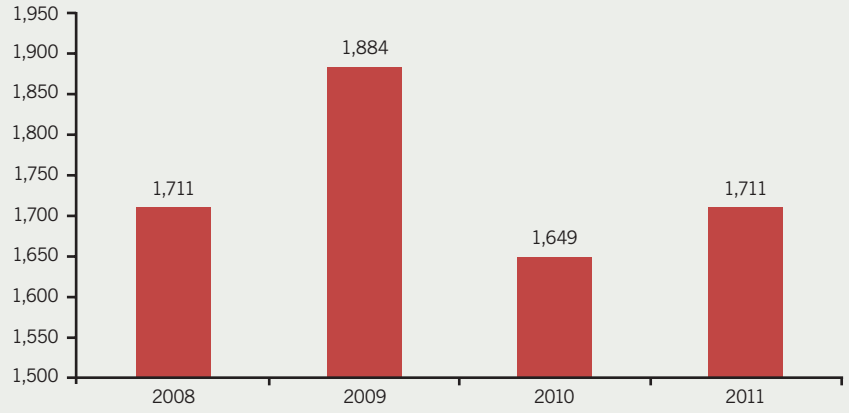
To obtain this real-world data in a population often excluded from large RCTs due to age, we performed a single-centre, retrospective analysis examining the indications and number of patients requiring CABG and/or valvular surgery (VS) over a four-year period spanning 2009 to 2012. We identified our cohort from an electronic database of all patients referred for cardiac surgical intervention maintained at DHC. From this we identified which patients had previously undergone PCI, and at what time point, by cross-referencing with a second electronic database of all PCI procedures. The medical records of these patients were reviewed to cross-check the data. The timing of the surgical intervention was then categorised as early (referred within one month of the index PCI), mid-term (referred between one month and one year of the index PCI), and remote (referred >1 year and up to four years from the index PCI).

We identified four main reasons why a patient may require CABG after PCI:

1. Emergency following initial PCI for stabilisation in mvCAD or LMCA disease.
2. *De novo* CAD progression.
3. Technical failure of PCI (unable to revascularise a CTO, undilatable lesions, development of re-stenosis, etc.).
4. Valvular disease (either unidentified severe disease or progression of previously moderate disease).

For early and mid-term cases the denominator used to calculate incidence of events was the number of cases performed over the three-year period 2009–2011, while for the remote events this was 2008–2010.

**Figure 1. Total number of percutaneous coronary intervention (PCI) cases per year at Dorset Heart Centre between 2008 and 2011**



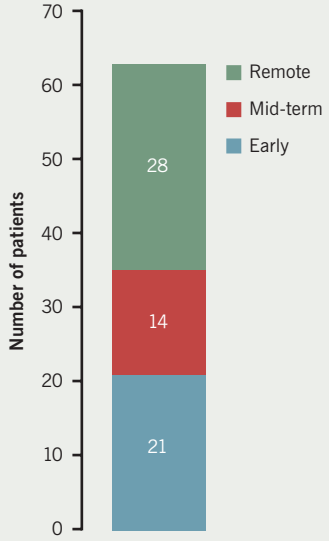

## Results

From 2008 to 2011 a total of 6,955 PCI procedures were performed at DHC (**figure 1**). During each three-year 'denominator' period (2008–2010 and 2009–2011), 5,244 PCI procedures were performed. The total number of patients referred for cardiac surgery post-PCI was 63 (1.2%). The median age of these 63 patients was 71 years: 35% of patients were aged >70 years, and 17% of patients were >80 years old. By referral time point the number of patients referred for surgery were 21 (0.4%) early, 14 (0.26%) mid-term, and 28 (0.53%) remote (**figure 2**). There were no cases of emergency/salvage CABG following complication of PCI.

### Early referral group (n=21)

Within the early referral group, eight patients had extensive three-vessel disease that was initially stabilised with emergency/urgent PCI followed by referral for CABG (**figure 3**). Six

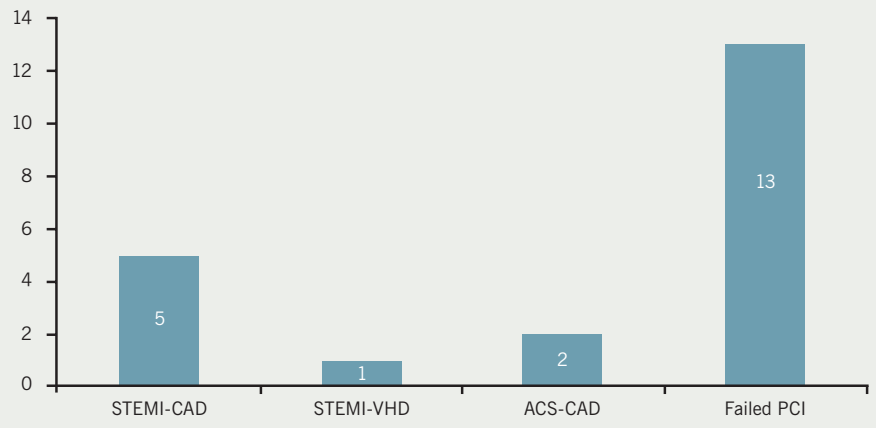
**Figure 2. Number of patients referred for cardiac surgery after PCI by time point**




Early: <1 month; Mid-term: 1 month to 1 year; Remote: 1 year to 4 years

(1.6% of all primary PCI [PPCI] cases) of these cases were ST-segment elevation myocardial infarction (STEMI), one of which was found to have severe aortic stenosis following the PPCI procedure. In five cases, the infarct related artery (IRA) was the right coronary artery (RCA), which was successfully treated with PPCI, but there was significant bystander disease. Two cases (0.08% of all stented acute coronary syndrome [ACS] cases) were non-ST elevation acute coronary syndromes (NSTE-ACS). These early referral patients were not

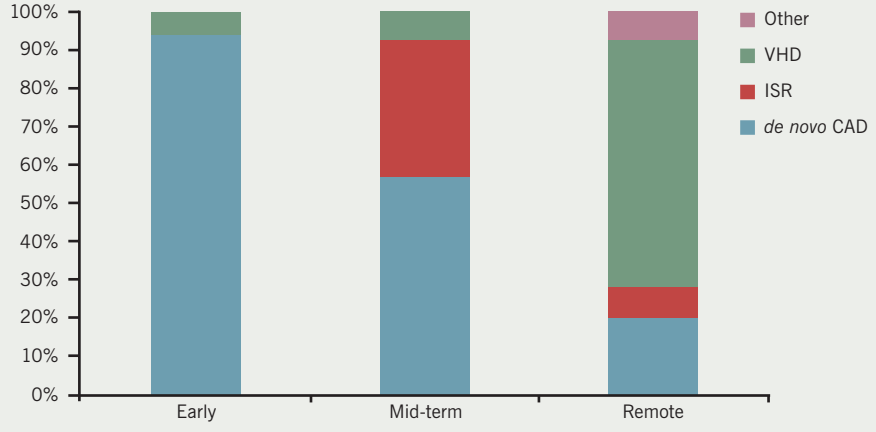
**Figure 3. Number of patients referred for surgical intervention within one month of PCI**




STEMI-CAD: PPCI patients with severe bystander CAD; STEMI-VHD: PPCI patients with severe valvular heart disease; ACS-CAD: ACS patients with severe CAD

**Key:** ACS = acute coronary syndrome; CAD = coronary artery disease; PCI = percutaneous coronary intervention; PPCI = primary PCI; STEMI = ST-elevation myocardial infarction; VHD = valvular heart disease

**Figure 4. Proportion of patients referred for surgical intervention by time point and reason for referral**




**Key:** CAD = coronary artery disease; ISR = in-stent re-stenosis; VHD = valvular heart disease

necessarily referred as acute inpatient cases, but the referral was made within one month of the index presentation event.

Within the elective PCI population, 13 patients were referred for CABG after unsuccessful PCI attempts: 10 of these were CTO cases (3.3% of all CTOs), one was a non-dilatable lesion, and two were due to other technical difficulties encountered during PCI attempts (**figure 3**).

### Mid-term referral group (n=14)

Seven patients in this group required CABG due to *de novo* disease progression. Three of this group were patients who had undergone PCI for ACS in the recent past, and had returned for further assessment of severe bystander disease. One patient was found to have a fracture of a recently implanted RCA stent plus severe left anterior descending (LAD) disease. One patient attended for intravascular ultrasound (IVUS) assessment of LMCA that confirmed severe disease. After a wire dissection of the left circumflex artery, emergency PCI was performed followed by outpatient referral for CABG. Five patients were referred for CABG due to re-stenosis (1.6% of all re-stenosis treated). One patient was found to have severe valvular heart disease.

### Remote referral group (n=28)

There were 18 patients (64%) who had undergone PCI between one and four years previously, who subsequently developed severe valvular heart disease prompting referral for VS. Of these, 17 were due to aortic stenosis, while one patient had severe mitral stenosis. At the time of the preceding PCI, the valve disease had been deemed moderate or less in severity. The median interval between index PCI and referral for VS was 23 months (range 12–52 months). One patient developed significant progressive aortic root dilatation and was referred for aortic root replacement surgery.

Six patients were referred for CABG due to progression in CAD, while two had developed severe in-stent re-stenosis (ISR). One patient, who had undergone ostial RCA stenting, began experiencing transient ischaemia attacks (TIA). Computed tomography (CT) suggested probable fracture of the RCA stent with approximately 1 cm of stent protruding into the aortic root. Following MDT discussion, the patient underwent successful CABG with resection of the stent.

## Discussion

Outside of a clinical trial setting, relatively few data exist demonstrating the natural history of coronary artery and valvular heart disease in patients who have undergone PCI. Decisions regarding the preferred revascularisation option for patients with co-existing CAD and mild-to-moderate valvular heart disease can be challenging, especially in older patients whose symptoms are related to their CAD rather than their valvular disease. Our data suggest that in a high-volume, non-surgical centre in the UK, the number of patients who require cardiac surgical intervention within a four-year period following PCI is low.

From our data, it would appear that the reason for surgical referral differs with time. Patients referred within an early or mid-term time point are more often referred for surgical management of CAD. Whereas those referred between one and four years post-PCI were mainly due to progression of valvular heart disease (**figure 4**).

The population served by DHC has a high proportion of elderly and co-morbid patients who carry higher surgical risk. While this may not be representative of all areas of the UK (or

worldwide), people are living longer, and the proportion of elderly patients will increase in all regions. In our experience, elderly patients, when given the choice, are more likely to opt for the least invasive revascularisation procedure, even if this carries higher rates of repeat revascularisation.

The rates of PCI failure were higher in 2008 than in current practice, reflecting improvements in stent technology alongside advances in complex PCI. However, despite this progression, ISR remains a concern in PCI, and careful decision-making with judicious use of PCI must be applied on an individual case basis with discussion at a heart team MDT meeting. We feel the majority of re-stenosis can be successfully treated with repeat PCI, which is reflected in the low incidence of referral for CABG in our data. Bioresorbable scaffolds may, with time, alter the incidence of re-stenosis and repeat revascularisation. The advent and rapid uptake of transcatheter valvular interventions is likely to reduce the need for conventional valve surgery in the future.

## Conclusion

Data from our high PCI volume, non-surgical centre demonstrate that the number of patients requiring cardiac surgery following PCI is small. Furthermore, the reason for referral for cardiac surgery differs by time point of referral, with problems relating to the PCI procedure occurring earlier and progression of valvular disease coming later. While we accept that these data are non-randomised and from a retrospective analysis, we believe they represent real-life practice that is relevant to populations throughout the UK and potentially worldwide, and may provide interest and reassurance to our colleagues

### Conflict of interest

None declared.

### Funding

No funding was sought or obtained for this work.

## Key messages

- There are well known randomised-controlled trials (RCTs) comparing percutaneous coronary intervention (PCI) with coronary artery bypass grafting (CABG) in multi-vessel coronary artery disease (CAD)
- Less is known about the contemporary natural history of real-world patients, especially the elderly, following PCI with regards to the incidence of cardiac surgery in the years after PCI
- This study demonstrates the incidence of referral for cardiac surgery in a real-world UK population from a busy, high-volume, non-surgical PCI centre
- The incidence (in our practice) of referral for cardiac surgery is low even in an elderly population who often have multi-vessel CAD and a degree of valvular heart disease
- The indication for cardiac surgery differs depending on the time of referral with CAD predominating early and valve disease later
- In the modern era of PCI, the subsequent need to refer a patient for cardiac surgery is low
- These data will reassure interventional cardiologists faced with an increasingly complicated, elderly and comorbid population, that good medium- and long-term results can be obtained with contemporary PCI

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