**The Association between the Public Reporting of Individual Operator Outcomes with patient profiles, procedural management and mortality after Percutaneous Coronary Intervention (PCI): An observational study from the Pan-London PCI (BCIS) Registry using an Interrupted Time-Series analysis**

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**Abstract**

**Aims:** The public reporting of healthcare outcomes has a number of potential benefits however unintended consequences may limit its effectiveness as a quality improvement process. We aimed to assess whether the introduction of individual operator specific outcome reporting after PCI in the UK was associated with a change in patient risk factor profiles, procedural management or 30 day mortality outcomes in a large cohort of consecutive patients.

**Methods and Results:** This was an observational cohort study of 123,780 consecutive PCI procedures from the Pan-London (United Kingdom) PCI registry, from January 2005 to December 2015. Outcomes were compared pre (2005-2011) and post (2011-2015) public reportingincluding theuse of an Interrupted Time-Series (ITS) analysis.

Patients treated after public reporting was introduced were older and had more complex medical problems. Despite this, reported In-hospital MACCE rates were significantly lower after the introduction of public reporting (2.3% vs 2.7%, p<0.0001), ITS analysis demonstrated evidence of a reduction in 30-day mortality rates after the introduction of public reporting, which was over and above the existing trend in mortality before the introduction of public outcome reporting (35% decrease RR 0.64; 95% CI: 0.55-0.77; P < 0.0001).

**Conclusion** The introduction of public reporting has been associated with an improvement in outcomes after PCI in this dataset, without evidence of risk adverse behavior. However the lower reported complication rates might suggest a change in operator behavior and decision-making confirming the need for continued surveillance of the impact of public reporting on outcomes and operator behaviour.

**Condensed Abstract**

This study investigated the effects of public reporting of operator outcomes after PCI on 30-day mortality in a large observational patient cohort. Outcomes were compared pre (2005-2011) and post (2011-2015) public reporting.Patients treated after public reporting were older, had more complex medical problems but lower procedural complications. Interrupted Time-Series (ITS) analysis demonstrated a reduction in 30-day mortality rates after the introduction of public reporting, which was over and above the existing trend before the introduction. The introduction of public reporting was associated with an improvement in outcomes after PCI in this dataset, with no evidence of risk adverse behavior.

**Background**

The publication of healthcare system and provider performance data into the public domain is now established in many healthcare settings. In 2012, as part of a national initiative from NHS England, across multiple specialities (1), the public reporting of individual PCI operator outcomes was adopted by the British Cardiovascular Intervention Society (BCIS) in collaboration with the National Institute of Cardiovascular Outcomes Research (NICOR). Despite the growth of Public Reporting of outcomes data in medicine the actual impact on outcomes and behaviours of operators is still debated (2) (3). However, a recent systematic review evaluating the effect of public reporting on mortality, demonstrated that the effect of public reporting on clinical outcomes was mostly positive (3). However this mainly involved patients from North America with significant heterogeneity seen between included studies limiting the generalizability of the results (3).

The public reporting of outcomes for coronary revascularization remains controversial (4, 5), especially the reporting of individual operator PCI outcomes (4). Proponents believe that operator specific outcome reporting facilitates transparency, allows patients to make informed choices, and may drive quality improvement. Critics argue that the public reporting of perceived negative outcomes encourages risk-averse behaviour, whereby operators are less likely to offer procedures to patients at higher risk (5). Several studies have indicated that interventional cardiologists (amongst other specialties) may exhibit risk-averse behaviour in the selection of patients to undergo procedures (9) (10). This was observed in New York (11, 12) and Massachusetts (13) when after the public reporting of outcomes commenced there was an association with a fall in complication rates post-PCI. Patient outcomes are closely linked to patient demographics (e.g. age) and the severity of the presenting syndrome, (e.g. cardiogenic shock and cardiac arrest) all being strong markers for increased risk and potentially adverse outcomes. Data may therefore be manipulated to increase patients’ predicted risk or to make patients ineligible for public reporting (8). Rates of AMI patients treated with PCI are lower in states with public reporting compared with non-reporting states with the greatest differences seen in the sickest patients who are actually the patient groups who potentially have the most to benefit (6, 7). Supporting this hypothesis, when patients with cardiogenic shock were excluded from public reporting in New York, the rates of PCI for shock increased (8). This is likely to translate to better patient outcomes and revascularisation is the only intervention in cardiogenic shock that has been shown to improve prognosis in a randomised trial (9). This highlights the need for careful implementation of public reporting and the need for surveillance and study of patient risk profiles after public reporting has been introduced. So far, the evidence that reporting of operator specific outcome leads to improvements in the quality of patient care is surprisingly weak with very little data outside of North America regarding the impact of public reporting on patient risk profiles and outcome after PCI.

In this study, we assess whether or not the introduction of public reporting of individual PCI operator outcomes has been associated with a change in patient risk factor profiles, procedural management and outcomes in a large cohort of consecutive patients undergoing PCI in London, UK. In view of the significant risk of bias inherent in retrospective observational studies we used an Interrupted Time Series (ITS) analysis. ITS analysis is a quasi-experimental methodology used to investigate the longitudinal effects of interventions (10) (11) and has been used for the evaluation of a wide range of public health interventions (12) (13).

**Methods**

# This was an observational cohort study of 123,780 consecutive PCI procedures from the Pan-London (United Kingdom) PCI registry. This is a prospectively collected data set that includes all patients treated by PCI in London, United Kingdom over a study period of January 2005 to December 2015. This includes all patients undergoing PCIs performed for stable angina and ACS (ST-elevation myocardial infarction (STEMI), non-ST elevation myocardial infarction (NSTEMI) and unstable angina).

# Pan-London PCI Registry

# The UK BCIS audit collects data from all hospitals in the UK that perform PCI, recording information about every procedure performed (14). The database is part of the suite of datasets collected under the auspices of the National Institute for Cardiovascular Outcomes Research (NICOR) and is compliant with UK data protection legislation. The Pan-London (United Kingdom) PCI registry, includes all patients treated by PCI in the 9 PCI Centers within the London, England, area, which covers a population of 8.2 million. The nine tertiary cardiac centres in London are Barts Heart Centre (Barts Health NHS Trust), St Georges Hospital (St Georges Healthcare NHS Foundation Trust), Kings College Hospital (King’s College Hospital NHS Foundation Trust), Royal Brompton and Harefield Hospitals (Royal Brompton & Harefield NHS Foundation Trust), Hammersmith Hospital (Imperial College Healthcare NHS Foundation Trust), Guys & St. Thomas Hospital (St Thomas' NHS Foundation Trust), Royal Free Hospital (Royal Free NHS Foundation Trust) and the Heart Hospital (UCL Hospitals NHS Foundation Trust). The registry included 123,780 patients who underwent PCI between 2005, and 2015. We merged the anonymised databases of the 9 London centres, who collect data based on the British Cardiac Intervention Society (BCIS) dataset. This audit is part of a national mandatory audit in which all UK PCI centres participate. PCI is defined as the use of any coronary device to approach, probe or cross one or more coronary lesion, with the intention of performing a coronary intervention (14). Data is collected prospectively at each hospital, electronically encrypted and transferred online to a central database. Every patient entry offers details of the patient journey, including the method and timing of admission, inpatient investigations, results, treatment and outcomes. Patients’ survival data is obtained by linkage of patients' National Health Service (NHS) numbers to the Office of National Statistics (ONS), which records live/death status and the date of death for all deceased patients. Patient and procedural details were recorded at the time of the procedure and during the admission into each centre’s local BCIS database. Anonymous datasets with linked mortality data from the Office of National Statistics were merged for analysis from the 9 centres.

# Public Reporting

The Public Reporting of individual PCI operator and hospital based outcomes were introduced in the UK in January 2012. Prior to this BCIS collected similar data on all procedures but no public reporting was in place. This public reporting involves the online publication of each individual consultant PCI operator’s activity over a rolling three-year period (numbers per year split by indication) and outcomes (15). The outcomes consist of self-reported in-hospital major adverse cardiovascular and cerebrovascular event (MACCE) rates, comprising of death, stroke, myocardial infarction caused by PCI, the need for emergency cardiac surgery due to a complication of PCI. In addition 30-day survival post PCI rate is provided independently by crosslinking the dataset with the life status statistics held by the UK Office of National Statistics. Both of these figures are compared to the rates of these complications that would be predicted by a risk model, NQWIP for In Hospital MACCE (16), and the BCIS 30 day mortality model for 30 day mortality analysis (17) and outliers are identified based on these models. The dataset was therefore split and analysed into pre (2005-2011) and post (2012-2015) public reporting periods.

**Study Population and Procedures**

# Patient demographic characteristics were collected, including age, smoking status, left ventricular function, previous myocardial infarction (MI), previous revascularisation (PCI and Coronary Artery Bypass Grafting), indications for PCI, and New York Heart Association classification, as well as the presence of hypertension, diabetes mellitus, cardiogenic shock, hypercholesterolemia, peripheral vascular disease (PVD), pre-procedural cardiac arrest and chronic kidney disease (CKD, defined as Creatinine >200umol/L, or renal replacement therapy). The technical aspects of the PCI procedure were also recorded, as well as adverse outcomes, including complications up to the time of hospital discharge. Patients undergoing PCI were loaded with anti-platelet drugs prior to their procedures (clopidogrel (300-600 mg), prasugrel 60mg or ticagrelor 180mg) and aspirin (300 mg)). The clopidogrel, ticagrelor or prasugrel were typically continued for one month post implantation of a BMS or one year if DES implantation occurred or if the procedure was performed for an MI. The use of adjunctive pharmacology (GPIIb/IIIa inhibitors, bivalirudin, heparin and thrombolysis) was left to the discretion of the interventional cardiologist performing the procedure. Coronary artery disease was classified by severity of luminal narrowing (0%, 1-49%, 50-74%, 75-94%, 95-99%, or 100%) and by vessel effected (e.g. Left anterior descending).

# Clinical outcomes

# The primary clinical outcome was all-cause mortality, using tracked data obtained from the UK Office for National Statistics. Secondary outcomes were in-hospital MACCE defined as a composite of all-cause mortality, myocardial infarction (new ischaemic pain with new ST elevation, and elevation of enzymes whether treated with further revascularisation therapy or not), stroke and re-intervention PCI. Non-MACCE or procedural complications included arterial complications, aortic dissection, coronary dissection (dissection defined as unintentional intimal disruption using the National Heart, Lung, and Blood Institute classification system for intimal tears (18) and coronary perforation. Arterial complications were defined as any pseudoaneurysm or any access site haemorrhage requiring intervention or delaying discharge. Bleeding was defined as any gastrointestinal bleed, intracerebral bleed, retroperitoneal bleed, or transfusion of a blood product as per BCIS (19) (20)

# Ethics

# The data collected were part of a mandatory national cardiac audit and all patient identifiable fields were removed prior to merging of the datasets and analysis. The local ethics committee advised that formal ethical approval was not required for this study.

**Statistical Analysis**

Clinical, demographic, and procedural characteristics are summarised by year from 2005-2015 using percentages or means and standard deviations as appropriate and compared by year (for trends) using One Way Anova for continuous variables (expressed as mean ± SD) and Chi-square tests or Fisher’s exact tests for categorical variables (expressed as count and percentage). For the purposes of statistical analysis to assess the effect of public reporting, the study sample was divided into two groups: patients treated pre public reporting (Control group) and patients treated post public reporting (Intervention group).

**Interrupted Time Series**

To assess the effect of public reporting on outcomes two statistical approaches were used, Interrupted Time Series (ITS) analyses and logistic regression. The main analysis performed was the ITS analyses. In the context of quality improvement, ITS is best understood as a simple but powerful tool used for evaluating the impact of a policy change or quality improvement program on the rate of an outcome in a defined population of individuals e.g effect of public reporting on 30 day mortality in patients undergoing PCI. A time series—repeated observations of a particular event collected over time—is divided into 2 segments in the simplest case. The first segment comprises rates of the event before the intervention or policy, and the second segment is the rates after the intervention. “Segmented regression” is used to measure statistically the changes in level and slope in the post-intervention period compared to the pre-intervention period. In other words, segmented regression is used to measure immediate (level) changes in the rate of the outcome as well as changes in the trend (slope) (21). This is a useful quasi-experimental design with which to evaluate the longitudinal effects of interventions (10) (13) and has been used for the evaluation of a wide range of public health interventions (13). For the non-randomised assessment of the impact of public reporting on outcome ITS in one of the most useful methods available (13). Rates of 30-day mortality (obtained via the UK Office of National Statistics) were analysed using ITS to compare the periods before and after introduction of public reporting, adjusting for seasonality and long-term trends as is standard with the use of this statistical tool (11). Models were based on time-series of age-adjusted 30-day mortality rates for monthly PCI procedures between 2005–2015. Standard methods for interrupted time-series were adopted to assess the impact of public reporting effects; the level and trend of the pre-reporting segment (2005–2011) served as the control for the post-reporting segment (2012–2015). The rolling window chosen was 1 month with no change in non-linear association with longer periods (i.e quarterly), with no wash out period included based on the likely time of intervention effect. The difference between pre- and post-reporting slopes and the effect on 30-day mortality after its introduction were estimated.

Time-series data are often auto-correlated (events closer together in a time series tend to be more similar than events further apart in time), therefore, the model residuals are not independent (a key assumption when using ordinary least-squares regression) (22). We therefore corrected for autocorrelation effects by including a term in the regression model for the lagged residuals (i.e., the residual of the regression model moved to the previous time points in the time series) (23).

In addition to the ITS approach a logistic regression was also adopted to assess the association of public reporting on 30-day mortality. Multivariable analysis of significant predictors selected by univariable analysis was performed to identify predictors of 30-day mortality and to estimate odds ratios (OR) and 95% confidence intervals (CI). The discriminative performance of the models was assessed using the C-statistic using bootstrapping methods in Stata/MP statistical software (version 14, Stata Corp., College Station, Texas). All tests were two-sides and performed at the 5% level of statistical significance.

**Results**

There were 123,780 PCI procedures performed over the study period. The patient demographics and risk factor profiles were as expected for an unselected PCI registry (table 1). Patients had a mean age of 64.3±12.1 years and 25.2% were female. 22.4% of patients were diabetic and 27.3% had a history of previous myocardial infarction. Of the 123,780 procedures 83,894 procedures (67.8%) were performed between 2005-2011 (pre-Public Reporting) and 39,886 (32.2%) performed between 2012-2015 (post Public Reporting).

**Baseline and Procedural characteristics**

Changes in clinical demographics, and procedural characteristics over the study period are summarized in Table 1 and 2. We observed a reduction in elective PCI procedures over the period with the dominant indication becoming ACS. During this period of time, the average age of patients increased; their clinical risk factor profile worsened and the proportion of PCI procedures on patients with cardiogenic shock or requiring ventilatory/circulatory support increased. Radial access grew to become the default access site used for PCI in 73.5% of procedures in 2014, with the use of GPIIb/IIIa inhibitors decreasing during the study period. These trends were apparent prior to the introduction of public reporting.

In keeping with these trends patients treated post introduction of public reporting were older and more likely to have type II DM, CKD and previous revascularisation (PCI and CABG). Post public reporting patients were also more likely to present acutely, have poor left ventricular function and have suffered out of hospital cardiac arrest or cardiogenic shock pre procedure (Table 1). Additionally post reporting, patients were more likely to undergo the procedure from the radial access route, undergo the insertion of drug-eluting stents, have adjunctive intravascular imaging (OCT or IVUS) and have a successful procedure compared to patients treated pre public reporting (Table 2).

**Procedural Complications**

Procedural complications were significantly lower post the introduction of public reporting (2.4% vs 3.3%, p<0.0001), mainly driven by reduced arterial and bleeding complications, however, this is likely to reflect the increased radial access rates seen across the study period (Table 3). Despite this, the difference persisted after multivariable adjustment; age-adjusted OR 1.40 [95% CI 1.21–1.63], adjusted OR 1.59 [95% CI 1.31–1.94]).

**MACCE**

Overall In-hospital MACCE were significantly lower post the introduction of public reporting (2.3% vs 2.7%, p<0.0001), this was true whether the procedures were performed electively (0.15 vs 0.3%, p<0.0001) or after ACS (2.15% vs 2.4%, p<0.0001). This difference persisted after multivariable adjustment (OR: 0.65 95% CI 0.60-0.81).

**30 day Mortality**

After the introduction of public reporting 30-day mortality rates were overall, not significantly different from the pre public reporting cohort (2.3%±0.1% vs 1.9%±0.6%, p=0.285). This was consistent whether procedures were performed for stable (0.4%±0.1% vs 0.3%±0.1%), ACS (5.0%±0.7% vs 4.9%±0.8%) and cardiogenic shock subgroups (52.5%±9.3% vs 50.3%±11.1%). However, after adjustment for confounding variables, the introduction of public reporting was associated with reduced 30-day mortality rates (OR: 0.46 (0.28-0.72). This was seen in both stable (OR: 0.72 (0.42-0.93) and ACS subgroups (0.42 (0.23-0.69) and was also maintained when the year of study was included in the adjusted analysis (HR 0.56, 95% CI: 0.35-0.83). Further variables associated with 30-day mortality were age (OR: 1.05 (1.04-1.06), procedural urgency (OR: 3.48 (2.51-7.20), cardiogenic shock (OR: 6.48 (4.51-8.20), multi-vessel disease (OR: 2.2 (1.5-3.3) and renal disease (CKD) (OR: 3.18 (2.51-4.32) as would be expected clinically (Table 4). The adjusted C-statistic for this model was 0.84 (0.82 to 0.88) after bootstrapping.

**Time series analysis**

The scatter plot of 30-day mortality over the study period is displayed in figure 1. In the pre public reporting era, 30-day mortality rates increased significantly, from 2005 to 2011 from 17 per 1000/procedures (CI 13.1-21.2) to 32 per 1000 procedures (CI 24.3-39.1) respectively (p=0.026), consistent with the increased patient risk profile and co-morbidity seen over this time period (Baseline trend ITS co-efficient 0.3 events per 1000, standard error 0.02). After the introduction of public reporting there was a downward step change seen in 30-day mortality rates of −8.8 per 1000 events (p = 0.003). This change meant a decrease of 35% (RR 0.64; 95% CI: 0.55-0.77; P < 0.0001) associated with the introduction of the public reporting, as demonstrated in Figure 3 with the counterfactual line. The counterfactual line seen in figure 3 demonstrates the predicted or hypothesized trend expected in 30-day mortality rates, without the introduction of public reporting. Post the step change seen with the introduction of public reporting, similar rates of increasing mortality to that predicted by the preexisting trends (counterfactual line) were seen over time for the remaining study period. This increased mortality rate is visualized at a similar trend/rate (0.31 events per 1000) to that prior to the introduction of public reporting. The final model was run following correction for seasonal variations as is standard with ITS analysis (using the month as a categorical variable). Over-dispersion was allowed for and adjustment made for autocorrelation with no differences seen in the effect observed (Appendices, Figures A1-A3).

**Discussion**

This large prospective, observational, multi-center registry analysis represents one of the first analyses outside North America assessing the impact of public reporting of operator-specific outcomes related to PCI, and the first to look at this practise in the UK. This study included over 120,000 patients and suggests that public reporting after PCI has been associated with improved outcomes with a lower incidence of both in hospital MACCE and reduced mortality at 30 days. This was seen both in the quasi-experimental analyses and multivariate regression analyses that corrected for the differences in both the baseline demographics and lesion characteristics, between the different study groups.

**Step-Change in Mortality and complications**

With the introduction of operator level reporting, it seems clear that adjusted mortality and MACCE took a step downwards (Figure 3). This is despite the risk profile of the patients increasing gradually over time. It is possible that public reporting resulted in a greater focus on capturing clinical variables within the database. However we do not think this can explain the gradual change in risk factor profile seen over time or indeed the results of the ITS.

**Risk Aversive Behaviour**

Despite the reduction in corrected mortality after the introduction of public reporting, the risk profile of cases undertaken post public reporting appears greater than those undertaken pre introduction (Table 1). This is likely to reflect the changing profile of patients undergoing PCI over the time period and it is reassuring that there was no observed decrease in the case risk profile associated with the start of public reporting which may have reflected risk-averse behaviour. Both patient risk factors e.g. age, type II DM, CKD, poor LV function and procedural risk factors (greater OOHCA, shock and STEMI) are seen with increasing frequency. While this probably represents a genuine increase in risk profile, because the trend was seen pre reporting, more assiduous reporting of risk profiles after the introduction of public reports might explain some of the apparent increase especially as this trend has not always been reported over this time period (7). It is also important to emphasise that data was not available for patients not offered PCI due to their perceived risk, and therefore a definitive assessment of risk-averse behaviour is not possible based on the data in our study.

**In-Hospital MACCE rates**

Despite significant increases in both patient complexity and procedural risk, overall self-reported MACCE rates were lower post the introduction of public reporting. This observation may be explained by improvements in medical care (such as better monitoring, access routes), pathways (heart team approach), technology (drug-eluting stents) and operators skill over this time period. However, it is important to acknowledge there is a theoretical risk of the under-reporting of adverse events when relying on the self-reporting of adverse outcomes. All of the MACCE reported are raw data, not risk-adjusted and therefore self-reported, unaudited data reported to a governmental agency for the sole purpose of consumer information may well be biased. Interestingly the hard clinical event of in-hospital mortality is shown to be higher post reporting which coupled with an observed increase in procedural risk, means that the self-reported rates of MI, CVA and PCI are relatively lower. This may suggest potential under-reporting of these outcomes. There was also an observed reduction of bleeding complications post reporting, an effect independent of the increased radial access routes. These data are consistent with other published studies assessing PCI complication rates post the introduction of public reporting with similar falls in complications in both New York (24, 25) and Massachusetts (26).

**Is mortality the correct outcome?**

There are multiple outcomes available to assess healthcare quality and mortality is only one variable of many that can be used. Current public reporting strategies, such as used in the UK, use outcome measures such as mortality as a quality marker. This type of variable can be perceived as being a powerful marker of quality in view of the hard clinical outcome it describes, the fact that it can be provided independently of the healthcare provider (so not dependant on the robustness of their data collection processes), and its obvious significance to patients and healthcare providers. However, when comparing outcomes between institutions or providers, risk adjustment is required to ensure that these outcomes are comparable. The probability of a patient dying is much more likely to be related to a patient’s age, risk factors, comorbidities and presentation rather than the operator’s skills and technique. Risk adjustment is used to correct for differences in risk among specific patients and although this does generally enable a comparison of operators performance, it’s true discriminatory ability remains controversial (27) (28) as most of the variance in outcome is likely due to patient related factors rather than the operator. There are data to indicate that when the highest risk patients are included in analyses this does not adversely affect an individual’s outcomes (4,5). However, risk averse behaviour as a potential cause for case selection has been described, with suitable patients not offered appropriate procedures. Presumably this is due to concerns of the implications of having a high mortality rate published in the public domain. It has therefore been suggested that publicly reporting case mix profiles of operators may reduce the likelihood that this will occur, although the general public’s ability to assess this rather than just look at the absolute mortality has not be verified (29). For this study, the approach taken by BCIS had been to derive a specific risk-adjusted model, based on collected data, correcting for high-risk individuals (STEMI, shock) whilst currently excluding those at the greatest risk (ventilated patients) (17). In addition the case mix and risk profile of operators are also reported to provide context.

While risk adjustment addresses the issue of patient risk factors it does not address the issue of accuracy of reported cause of death. Health services are only partially responsible for outcomes such as mortality as they are influenced more by other factors (e.g., natural history of the disease). This is especially true of outcomes such as mortality after PCI, with a recent analysis of deaths after nearly 5,000 PCI procedures demonstrating that cardiac causes contributed to only 58% of all deaths after PCI, and only 42% could be attributed to complications associated with the procedure (30). This highlights the limitations of 30-day mortality reporting and emphasizes the need for identifying PCI-related deaths rather than cardiac deaths alone.

Concerns about attributing deaths to an individual operator have also been raised (31), (32). The quality of health care is dependent on a variety of factors as are clinical outcomes. Focusing the study of deaths based on named individual operators, can mean that opportunities to describe, understand and improve deficiencies within other parts of the healthcare system can potentially go unrecognized. This may therefore deprive services from the opportunity to improve outcome by looking at the effect of other variables such as timing of medication (e.g aspirin administration), regionalized transfer networks, the care provided on the coronary care unit or secondary preventative medication adherence leading to system wide changes (32). Analyses after 1558 cardiac surgical procedures demonstrated that most of the deaths could not have been prevented by the operating surgeon and were related to issues of patient comorbidity, lack of process or infrastructure (32). This study still demonstrates that public reporting can highlight deficiencies within the healthcare system and BCIS and NICOR also report each individual centre’s outcome although variation in centre outcomes was not part of this study.

**Limitations**

The study has several limitations. This was an observational study and therefore the study has all the limitations of a registry with all the potential bias and unmeasured confounding associated with non-randomised analyses. However, differences in baseline and clinical characteristics were adjusted in a multivariable analysis and the use of the recognised quasi-experimental interrupted time series design enabled us to control for pre-existing levels and trends to detect any discontinuities in the outcomes studied at the point public reporting was implemented. Adjusting for baseline trends in this way helps to control for most threats to internal validity. However, it is important to emphasise that angiographic data associated with outcome such as SYNTAX score was not available to allow adjsutment nor data for patients who were not offered PCI, and therefore a definitive assessment of risk-averse behaviour is not possible. While mortality was provided independently, risk profile and in hospital complications were reported by the PCI centres. These data are not subject to external validation, however every centre is provided with their analyses on validation rounds so they that have the opportunity to internally recheck their data prior to publication. Thus the internal governance processes of all the centres has been brought to bear on the accuracy of these data. Finally no operator specific outcomes have been reported in this manuscript, nor trends in their individual behaviour over time, this is an important consideration but not one we can address in this analysis.

**Conclusion**

The introduction of public reporting has been associated with an improvement in outcomes after PCI in this dataset, without evidence of risk adverse behavior.. Despite the promising nature of these results the lower reported complication rates might still suggest a change in operator behavior and decision-making confirming the need for further studies and the continued surveillance of the impact of public reporting on outcomes and operator behaviour.

**Figure Legends**

**Figure 1. 30 Day mortality rates after PCI by month**

Scatter plot of 30-day mortality rates over time. Each point represents the 30 day mortality per month, The red line indicates the introduction of public reporting after PCI within the UK. PCI = Percutaneous Coronary Intervention UK= United Kingdom

**Figure 2. Interrupted Time Series of 30-day mortality after PCI**

Time series data with regression lines drawn for pre and post public reporting periods (introduction indicated by red line at the start of 2012). Scatter plot of 30-day mortality rates over time (rate 1). Each point represents the 30 day mortality per month, A level change in predicted mean mortality after the introduction end of 2011 is demonstrated by the regression line.

**Figure 3. Interrupted Time Series of 30-day mortality after PCI with counterfactual line**

Scatter plot of 30-day mortality rates over time (rate 1) with each point representing the 30 day mortality per month, Time series data with regression lines drawn for pre and post public reporting periods (introduction indicated by red line). A level change after the introduction end of 2011 is demonstrated with the predicted mortality rate based on pre-reporting trends demonstrated by the dotted red line.

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