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## Cardiovascular Revascularization Medicine



## Variation in emergency percutaneous coronary intervention in ventilated patients in the UK: Insights from a national database <sup>☆,☆☆,★,★★</sup>

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## ABSTRACT

**Aims:** Pre-procedural ventilation is a marker of high risk in PCI patients. Causes include out-of-hospital cardiac arrest (OHCA) and cardiogenic shock. OHCA occurs in approximately 60,000 patients in the UK per annum. No consensus exists regarding the need/timing of coronary angiography ± revascularization without ST elevation. The aim was to describe the national variation in the rate of emergency PCI in ventilated patients.

**Methods and Results:** Using the UK national database for PCI in 2013, we identified all procedures performed as 'emergency' or 'salvage' for whom ventilation had been initiated before the PCI. Of the 92,589 patients who underwent PCI, 1342 (5.5%) fulfilled those criteria. There was wide variation in practice. There was no demonstrable relationship between the number of emergency PCI patients with pre-procedure ventilation per annum and (i) total number of PPCI in a unit ( $r = -0.186$ ), and (ii) availability of 24 h PCI, (iii) on-site surgical cover. **Conclusion:** We demonstrated a wide variation in practice across the UK in rates of pre-procedural ventilation in emergency PCI. The majority of individuals will have suffered an OHCA. In the absence of a plausible explanation for this discrepant practice, it is possible that (a) some patients presenting with OHCA that may benefit from revascularization are being denied treatment and (b) procedures may be being undertaken that are futile. Further prospective data are needed to aid in production of guidelines aiming at standardized care in OHCA.

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## 1. Introduction

Pre-procedure ventilation is a marker of high risk for emergency PCI [1]. The commonest reason for pre-procedure ventilation in these patients is presentation with OHCA. The majority of other cases that require ventilation occur due to pulmonary edema associated with an acute ischemic event, particularly STEMI with cardiogenic shock [1,2]. Out-of-hospital cardiac arrest (OHCA) occurs in approximately 60,000 patients in the UK per annum [3,4]. Only around half of cases have an attempt at resuscitation, and only 24% survive to hospital admission. Of these cases, under 10% survive to hospital discharge [5,6], and 50% of

these individuals will have sustained brain injury associated with demonstrable cognitive impairment [6,7].

Despite the frequency with which OHCA is encountered, the optimal management for patients who have initial resuscitation, and thus survive to reach hospital, is uncertain and contentious. Since the commonest cause of an unheralded OHCA in adults aged over 35 years is ischemic heart disease [8], a key part of the management algorithm is the decision whether to offer emergency coronary angiography and revascularization. It is this decision that will largely dictate the proportion of such cases performed within a PCI center and by an individual PCI operator. In cases where a post-resuscitation ECG demonstrates

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<sup>★★</sup> Impact on daily practice: This article serves to highlight the wide variation in practice in a commonly encountered clinical scenario – namely, emergency PCI in ventilated patients. Operators should consider this when faced with decisions making in this group of complex critically unwell patients. Further randomized trial data are required to assist in optimizing patient outcomes.

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ST-elevation, both the AHA and ESC guidelines advocate immediate reperfusion therapy [9,10], with coronary angiography and PCI where available. However, in patients without ST-elevation, the ideal management remains uncertain and the recommendations are ambiguous [11]. Around 25% of patients without ST-elevation will have a culprit obstructive coronary lesion [12]. If this can be successfully treated with PCI, then observational data suggest an association with improved survival at both 30 days and 1 year compared to those who do not receive PCI. [13] However, there remains no clear consensus regarding the need for, and/or timing of, angiography following an OHCA [14].

In the UK, immediate primary angioplasty for the management of acute ST-elevation myocardial infarction (STEMI) has been widely adopted [15]. However, in the group of patients who have suffered an OHCA and require mechanical ventilation, in whom a similar approach may offer a survival benefit, contemporary interventional practice remains variable. This is likely to be due to multiple factors, including the lack of randomized trial data and risk averse behavior that may be driven in part by publication of individual PCI operator outcomes, even those cases that are specifically excluded from public reporting in the UK to try to avoid potential adverse consequences for patients. Theoretically, there should not be a significant variation in the proportion of the overall number of PCI cases that are ventilated pre-procedure for these indications.

Regional variation in the management and survival rates of OHCA has recently been demonstrated in the United States [16]. Prior to 2014, no systematic registry data were available in the UK specific for OHCA. However, using the field “ventilated pre PCI”, allows collation of data relating to patients who have required mechanical ventilatory support for any reason prior to PCI, of which the majority will be patients presenting with OHCA. The need for mechanical ventilation has been identified as an independent predictor for adverse outcome in a number of historical and contemporary series of PCI conducted in ACS [1,2].

The aims of this analysis are to describe, for the first time, the national variation in rate of PCI in ventilated patients treated in an emergency setting, and to evaluate its correlation with (a) the absolute number of PCI undertaken in each center, (b) the availability of 24/7 PCI, and (c) the presence or absence of on-site surgical cover.

## 2. Methods

We performed a retrospective analysis of the national database of percutaneous coronary intervention (PCI) collected by the British Cardiac Intervention Society (BCIS) and collated by the National Institute of Cardiac Outcomes and Research (NICOR) [17]. All centers, and individuals, that perform PCI in the UK are obliged to return data on every PCI procedure to NICOR. The BCIS–NICOR database collects information on clinical, procedural and outcomes data and contains 113 variables with approximately 80,000 new records added each year. NICOR, which includes BCIS [16], has support under section 251 of the NHS Act 2006 to use anonymized patient information for medical research without consent. The study involved anonymous data and formal ethical approval was not required. Our cohort was defined by two fields in the dataset: ‘ventilated pre PCI’ to identify patients who had required mechanical ventilation during their PCI, and ‘procedure urgency’ recorded as ‘emergency’ or ‘salvage’. Two cohorts were identified: a total ventilated PCI sample and further subset comprising only procedures recorded with an ‘indication for intervention’ of ‘Primary PCI’ (PPCI). Patients in whom the field was missing/blank were treated as if ventilation had not been undertaken.

Centers were characterized according to (a) whether there is on-site cardiothoracic surgery and (b) whether they provide a primary PCI service for ST elevation myocardial infarction, based on the NICOR–BCIS annual survey of 2013 and the NICOR strategy template 2011 [18].

The raw dataset was cleaned and analyzed using R version 3.1.1 ([www.r-project.org](http://www.r-project.org)). The output tables were then collated and further analysis was performed using Numbers (v3.5) and Wizard for Mac

(V1.5.3). Distributions were tested for normality using the Kolmogorov–Smirnov test. Student’s *t*-test was used to compare means in normally distributed continuous variables, with the Mann–Whitney *U* test used in continuous data that were not normally distributed. Correlations were assessed using Fisher’s transformation test.

## 3. Results

Between Jan. 1st and December 31st 2013, 92,589 PCI procedures were carried out in 117 centers across the UK. In total, 24,379 procedures were conducted in the setting of primary PCI for STEMI. Forty-one centers were identified as being sites with cardiothoracic surgical cover, of which only a single site did not have data available for this analysis.

In total, 1342 emergency cases required ventilation pre PCI, representing 5.5% of the total number of PPCI in 2013. This has increased year on year from 3.5% in 2008 (Fig. 1). The demographics of this cohort are described in Table 1. The majority of patients in whom ventilation was required pre-emergency PCI were male ( $n = 1032$  (76.9%)), and had no previous history of MI ( $n = 963$  (71.8%)), previous PCI ( $n = 1096$  (81.7%)) or CABG ( $n = 1213$  (90.4%)). Cardiogenic shock was present in 811 (60.4%) cases.

The rate of ventilated emergency PCI as a proportion of the total number of procedures in the UK performed in 2013 ranged from 0 to 4.74% between PCI centers. Specifically, there was a weak, but statistically significant positive correlation between the total number PCIs performed within a unit and the number of emergency ventilated PCIs per annum (Fig. 2) ( $r = 0.386$ ). There was, however, no correlation between the number of PPCIs performed in a center and the relative percentage of emergency ventilated PCIs (Fig. 3) ( $r = -0.186$ ). The proportion of ventilated PCI patients did not vary in the presence of on-site surgical cover (median on-site surgery 4.4% vs. 4.9%,  $p = 0.535$ ). Overall, centers that offered 24/7 primary PCI had a significantly higher proportion of emergency PCI patients, relative to the total number of PCIs performed (24/7 vs. non 24/7: 1.6% vs. 0.5%,  $p < 0.001$ ; median 1.29% vs. 0.49%,  $p < 0.001$ ). However, no significant differences were observed between the proportions of emergency ventilated PPCI patients in centers offering 24/7 PPCI and those that were not (24/7 vs. non-24/7: median 4.08% vs. 4.76%,  $p = 0.924$ ).

## 4. Discussion

This paper describes for the first time the wide variation in PCI that is undertaken for patients requiring ventilation pre PCI across the UK. Specifically, the rate of PCI in emergency ventilated patients, as a proportion of total PCIs performed varies from 0.09% to 4.74% and there was only a weak correlation between the total number of PCIs performed at a center. Importantly, no association was demonstrated between the number of primary PCIs performed within a unit, and the relative proportion of emergency ventilated PCIs performed per annum.

In the absence of a plausible alternative explanation for this variation in practice, which is consistent with recent evidence from the United States [16], these data suggest that management decisions taken by individual PCI operators in relation to offering PCI to patients requiring mechanical ventilation are heterogeneous.

Based upon the wide variation in current practice that has been described here it seems likely that some patients in the UK, including those patients who present with OHCA, that could benefit from early revascularization are not being afforded such treatment, and it is also possible that a proportion of such patients are receiving revascularization which may be futile.

Our observations highlight the need for further data, preferably derived from large scale randomized trials that can be used to produce management guidelines for this group of patients in order to standardize their care and ensure equity of access to potentially life-saving treatment. Indeed, current guidelines suggest an appraisal of an individual

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