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Intracoronary imaging guided percutaneous coronary intervention outcomes among individuals with cardiogenic shock

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Abstract

Background: Limited data exist around the utility of intracoronary imaging (ICI) during percutaneous coronary intervention (PCI) in patients with acute coronary syndrome (ACS) and cardiogenic shock (CS), who are inherently at a high risk of stent thrombosis (ST).

Methods: All PCI procedures for ACS patients with CS in England and Wales between 2014 and 2020 were retrospectively analysed, stratified into two groups: ICI and angiography-guided groups. Multivariable logistic regression analyses were performed to examine odds ratios (OR) of in-hospital outcomes, including major adverse cardiovascular and cerebrovascular events (MACCE; composite of all-cause mortality, acute stroke/transient ischaemic attack (TIA), and reinfarction) and major bleeding, in the ICI-guided group compared with angiography-guided PCI.

Results: Of 15,738 PCI procedures, 1240(7.9%) were ICI-guided. The rate of ICI use amongst those with CS more than doubled from 2014 (5.7%) to 2020 (13.3%). The ICI-guided group were predominantly younger, males, with a higher proportion of non-ST-elevation ACS and ST. MACCE was significantly lower in the ICI-guided group compared with the angiography-guided group (crude: 29.8% vs. 38.2%, adjusted odds ratio (OR) 0.65 95% confidence interval [CI] 0.56–0.76), driven by lower all-cause mortality (28.6% vs. 37.0%, OR 0.65 95% CI 0.55–0.75). There were no differences in other secondary outcomes between groups.

Conclusion: ICI use among CS patients has more than doubled over 6 years but remains significantly under-utilized, with less than 1-in-6 patients in receipt of ICI-guided PCI by 2020. ICI-guided PCI is associated with prognostic benefits in CS patients and should be more frequently utilized to increase their long-term survival.

KEYWORDS

cardiogenic shock, intravascular imaging, IVUS, OCT, outcomes

1 | INTRODUCTION

Cardiogenic shock is a strong indicator of poor prognosis amongst those presenting with an acute coronary syndrome (ACS) and is associated with high rates of mortality, as high as 50% in previous reports.[1–3] Percutaneous coronary intervention (PCI) is associated with a significant reduction in long-term mortality compared with medical management alone in those with cardiogenic shock.[4,5] However, the procedural risk of these patients is significantly higher than those without cardiogenic shock due their critical illness, including haemodynamic instability, life-threatening arrhythmias, and higher prevalence of multivessel disease.[3,6] One of the major causes of cardiac mortality amongst cardiogenic shock patients undergoing PCI is the significant increase in risk of stent thrombosis (ST); cardiogenic shock is associated with nearly a 12-fold increased risk of definite or probable ST.[7]

Intracoronary imaging (ICI) through intravascular ultrasound (IVUS) and optical coherence tomography (OCT) allows preprocedural assessment of lesion characteristics, vessel size, and post-procedural optimization of stent implantation, thereby minimizing the risk of stent-related complications, including ST.[8] While previous studies have examined the utility of ICI in reducing mortality and incident ST after PCI, there are little data around its utility and associated clinical outcomes in high-risk procedural groups, such as those with preprocedural cardiogenic shock.[9–12]

The present study sought to examine temporal trends in the rate of ICI in ACS patients presenting with cardiogenic shock and compare clinical outcomes between ICI and angiography-guided PCI, in a national procedural cohort in England and Wales over a 7-year period.

2 | METHODS

2.1 | Data source, study design, and population

All PCI procedures for patients with cardiogenic shock between April 1, 2014 and March 31, 2020 in England and Wales were retrospectively analysed from the British Cardiovascular Intervention Society (BCIS) registry, stratified by use of ICI (IVUS or OCT). The BCIS registry comprises clinical and procedural data, and in-hospital outcomes (death, bleeding, arterial complications) for all procedures undertaken in the England and Wales.[13] A diagnosis of cardiogenic shock in the BCIS registry required patients to have both (1) persistent systemic hypotension with a systolic BP of less than or equal to 90 mmHg with severe reduction in cardiac index (<1.8 L/min/m^2 without support or <2.0–2.2 L/min/m^2 with support) and adequate or elevated filling pressure and (2) evidence of peripheral hypoperfusion such as a weak pulse, pallor, cool peripheries or diaphoresis, and dependence on inotropes or mechanical left ventricular (LV) support to correct this situation.[13] Exclusion criteria included age <18 years and missing data for death and cardiogenic shock and ICI use (n = 834).

2.2 | Outcomes

The co-primary outcomes included in-hospital major adverse cardiovascular and cerebrovascular events (MACCE; composite of death, acute stroke/transient ischaemic attack [TIA], and reinfarction) and all-cause mortality. Secondary outcomes included individual MACCE components as well as bleeding academic research consortium (BARC) stage 3–5 bleeding, the definition of which has been previously published.[14]

2.3 | Statistical analysis

All statistical analyses were performed using Stata 16 MP. For exploratory analysis, patient and procedural characteristics were compared between the ICI and angiography-guided groups. Further modeling was performed to look at predictors of receipt of ICI. Continuous variables that were normally distributed and presented as mean values with standard deviation (SD), compared using the Kruskal–Wallis or t test wherever appropriate, while variables that were not normally distributed were presented as median with interquartile range (IQR) with comparisons using the Mann–Whitney test. Categorical variables are summarized as percentages and analysed using the χ^2 test. Multivariable logistic regression modeling was performed to examine the association between ICI and in-hospital outcomes (MACCE and all-cause mortality), using the angiography-guided group as the reference category. All associations are reported as odds ratios (OR) with corresponding 95% confidence intervals (CI).

All models were adjusted for the following variables: age, sex, race, clinical syndrome (ST-elevation myocardial infarction [STEMI] vs. non-ST-elevation myocardial infarction [NSTEMI]), ST indication, previous myocardial infarction (MI), previous PCI, previous coronary artery bypass graft surgery (CABG), diabetes mellitus, renal failure (creatinine >200 µmol/L and/or dialysis), cardiac transplant, LV function category (good [ejection fraction (EF) <50%], moderate [EF 30%–49%], poor [EF < 30%]), hypercholesterolaemia, peripheral vascular disease, previous cerebrovascular accident (including stroke or TIA), hypertension, smoking, out of hospital cardiac arrest (OHCA), mechanical ventilation, circulatory support (intra-aortic balloon pump or LV assist device), vascular access (radial vs. femoral), number of vessels and lesions attempted, calcium modification (rotablation, laser angioplasty), vessel attempted (left main [LM], proximal left anterior descending [LAD], and grafts). The following variables were only adjusted for in models comparing outcomes in the ICI versus no ICI groups: number of stents, drug eluting stent (DES) stent generation (first vs. second/third generation), in-hospital pharmacotherapy (including aspirin, clopidogrel, ticagrelor, prasugrel, warfarin, glycoprotein IIb/IIIa inhibitor [GP-2b3a], and bivalirudin).

Multiple imputation with chained equations was performed for variables with missing data (except coronary imaging use, cardiogenic shock, and the outcome variables) before model fitting, with a total of 10 imputations. Combined estimates, using Rubin's rules, were then used for analyses.[15]

3 | RESULTS

A total of 15,738 PCI procedures were performed on patients with cardiogenic shock between 2014 and 2020, including 1,240 procedures (7.9%) that were ICI-guided. Overall, the rate of ICI use amongst those with cardiogenic shock has more than doubled between 2014 (5.7%) and 2020 (13.3%) (Figure 1). The use of ICI per individual center is illustrated in Figure 2. There was a significant variation in ICI use among centers (0% to 50%) with many centers using ICI at rates lower than 10% in those with cardiogenic shock.

Several differences in baseline characteristics were noted between procedures with and without ICI guidance. Overall, patients in the ICI group were younger (median 66 vs. 69 years, $p < 0.001$), more likely to be males (75.3% vs. 71.7%, $p = 0.007$), non-White ethnicity, with a higher proportion of patients presenting with NSTE-ACS (32.6% vs. 18.8%, $p < 0.001$) and ST (14.6% vs. 4.9%, $p < 0.001$) (Table 1). Patients undergoing ICI-guided PCI had a worse cardiovascular risk profile with a higher prevalence of previous MI and PCI (34.4% vs. 19.6% and 31.5% vs. 14.0%, respectively, $p < 0.001$ for both), renal failure (7.4% vs. 5.6%, $p = 0.007$), hypertension (49.7% vs. 45.2%, $p = 0.002$). While the rates of circulatory support, including inotrope, intra-aortic balloon pump (IABP) and Impella (Abiomed, Danvers, Massachusetts, United States of America) use were high in both groups, there was no difference in between groups (No ICI vs. ICI: 33.4% vs. 35.2%, $p = 0.214$). The ICI group was also less likely to present with out of hospital cardiac arrest (30.5% vs. 34.3%, $p = 0.007$).

In terms of procedural characteristics, ICI group was more likely to be radial accessed (60.3% vs. 55.0%, $p < 0.001$) involve multiple vessels (single vessel 49.6% vs. 72.4%, $p < 0.001$) and lesions (single lesion 50.1% vs. 66.6%, $p < 0.001$) with a greater mean number of stents (1.85 [1.46] vs. 1.52 [1.17], $p < 0.001$) and LM or proximal LAD intervention (38.1% vs. 12.7% and 57.3% vs. 39.2%, respectively, $p < 0.001$ for both). Calcium modification therapy was more frequently utilized in the ICI group (6.6% vs. 2.4%, $p < 0.001$).

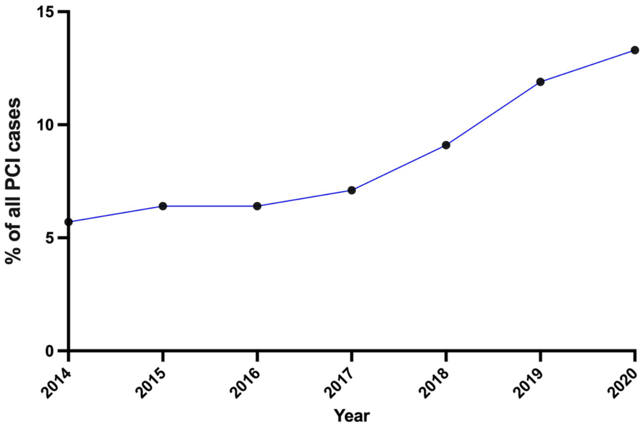


FIGURE 1 Trend of intracoronary imaging use among patients with cardiogenic shock undergoing PCI (2014–2020). $p_{trend} < 0.001$. PCI, percutaneous coronary intervention. [Color figure can be viewed at wileyonlinelibrary.com]

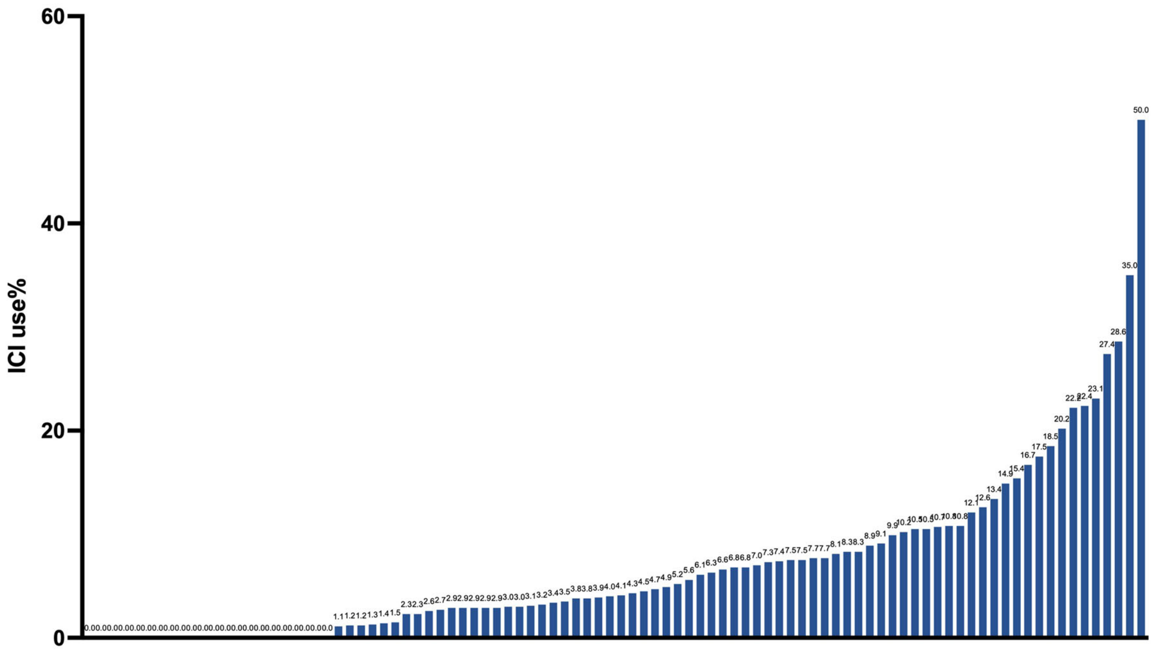


FIGURE 2 Rate of ICI use per individual participating center. ICI, intracoronary imaging. [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 1 Patient and procedural characteristics of cardiogenic shock patients undergoing PCI according to intracoronary imaging (ICI) use.

	No ICI (*n* = 14,498)	ICI (*n* = 1240)	*p* Value
Age, median (IQR)	69 (58,78)	66 (57,75)	<0.001
Age groups (years), %			<0.001
<60	28.3	32.0	
60–69	25.6	26.7	
70–79	26.7	26.7	
≥80	19.4	14.6	
Males, %	71.7	75.3	0.007
Ethnicity, %			<0.001
White	84.1	76.0	
Black	4.8	8.1	
Asian	7.2	9.2	
Other	3.9	6.8	
Clinical syndrome, %			<0.001
NSTE-ACS	18.8	32.6	
STEMI	81.2	67.4	
Stent thrombosis indication, %	4.9	14.6	<0.001
Previous MI, %	19.6	34.4	<0.001
Previous PCI, %	14.0	31.5	<0.001
Previous CABG, %	5.2	5.2	0.925
Previous CVA, %	4.8	4.1	0.252
Diabetes mellitus, %	23.3	25.5	0.080
Renal failure, %	5.6	7.4	0.007
LV function (ejection fraction), %[a]			0.072
Good (>50%)	22.3	19.5	
Moderate (30%–50%)	60.1	61.7	
Poor (<30%)	17.6	18.8	
Hypercholesterolaemia, %	34.8	40.6	<0.001
Peripheral vascular disease, %	6.4	7.2	0.304
Hypertension, %	45.2	49.7	0.002
Current/previous smoker, %	59.4	60.9	0.311
Valvular heart disease, %	2.2	3.0	0.066
Out of hospital cardiac arrest, %	34.3	30.5	0.007
Mechanical ventilation, %	38.2	36.7	0.291
Mechanical circulatory support, %	33.4	35.2	0.214
Access route[a]			
Radial, %	55.0	60.3	<0.001
Femoral, %	52.0	48.9	0.036
No. of vessels, %			<0.001
1	72.4	49.6	
2	19.4	28.7	
3	6.6	15.9	
4	1.6	5.8	
No. of lesions, %			<0.001
1	66.6	50.1	
2	22.9	28.9	
3	7.8	15.5	
4+	2.8	5.6	
No. of stents, mean (SD)	1.52 (1.17)	1.85 (1.46)	<0.001
Drug eluting stents (DES), %			
First generation DES, %[b]	38.7	40.0	0.350
Second/third generation DES, %[b]	60.4	60.6	0.884
Drug coated balloon, %	0.1	0.4	<0.001
Calcium modification, %	2.4	6.6	<0.001
LMS, %	12.7	38.1	<0.001
LAD proximal, %	39.2	57.3	<0.001
Grafts, %	1.8	0.8	0.009
Chronic total occlusion, %	2.1	1.7	0.385
Clopidogrel, %	51.5	47.8	0.002
Ticagrelor, %	41.9	46.6	0.001
Prasugrel, %	6.6	5.6	0.151
Warfarin, %	1.0	1.1	0.714
Glycoprotein 2b/3a inhibitor, %	42.1	41.9	0.847
Bivalirudin, %	2.5	1.3	0.008

Abbreviations: CABG, coronary artery bypass graft; CVA, cerebrovascular accident; DES, drug eluting stent; LAD, left anterior descending artery; LMS, left main stem; MI, myocardial infarction; PCI, percutaneous coronary intervention; SD, standard deviation.

[a]Patients had more than one access route in some cases.

[b]There was an overlap in stent generations in a subset of cases.

3.1 | In-hospital outcomes

The rate of MACCE was significantly lower in the ICI group compared with the No ICI group (29.8% vs. 38.2%, $p < 0.001$) as were the rates of all-cause mortality (28.6% vs. 37.0%, $p < 0.001$) (Table 2, Figure 3). There were no differences in the rates of acute stroke/TIA and BARC 3–5 bleeding between groups. After adjustment for baseline differences, the odds of MACCE and all-cause mortality in those undergoing ICI-guided PCI remained significantly lower than in the non-ICI group (OR 0.65 95% CI 0.56, 0.76 and OR 0.65 95% CI 0.55, 0.75, respectively, $p < 0.001$ for both) (Table 3).

TABLE 2 Unadjusted rates of in-hospital adverse outcomes according to intracoronary imaging (ICI) use.

	No ICI (*n* = 14,498)	ICI (*n* = 1240)	*p* Value
MACCE,[a] %	38.2	29.8	<0.001
All-cause mortality, %	37.0	28.6	<0.001
Acute stroke/TIA, %	1.7	1.8	0.762
BARC 3–5 bleeding, %	0.7	1.0	0.307

[a]MACCE, major acute cardiovascular and cerebrovascular outcomes: composite of death, acute stroke/transient ischaemic attack and reinfarction; BARC, bleeding academic research consortium.

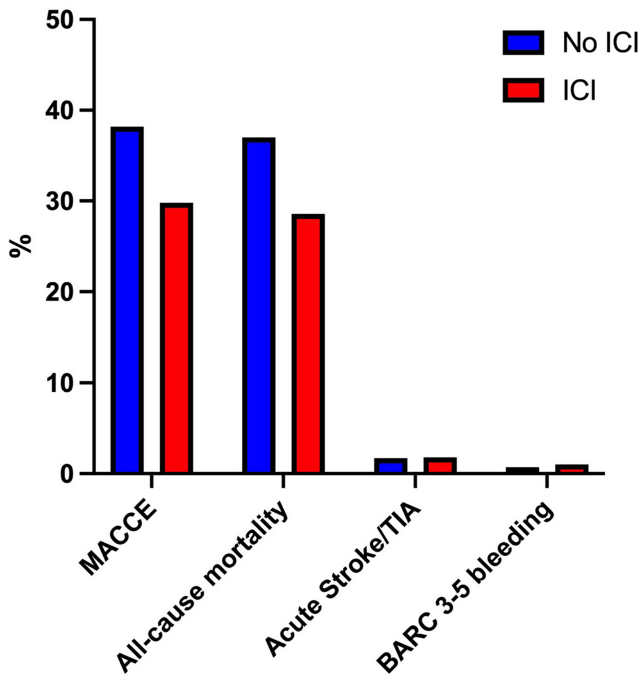


FIGURE 3 Unadjusted rates of in-hospital adverse outcomes according to intracoronary imaging (ICI) use. BARC, bleeding academic research consortium; MACCE, major acute cardiovascular and cerebrovascular outcomes: composite of death, acute stroke/transient ischaemic attack and reinfarction. [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 3 Adjusted odds ratio (OR)[a] and 95% confidence interval (CI) of in-hospital adverse outcomes in patients undergoing intracoronary imaging (ICI).

	OR (95% CI)	*p* Value
MACCE	0.65 (0.56, 0.76)	<0.001
All-cause mortality	0.65 (0.55, 0.75)	<0.001

Abbreviation: MACCE, major acute cardiovascular and cerebrovascular outcomes.

[a]Reference is no ICI use; adjusted for: Age, sex, race, clinical syndrome, stent thrombosis, previous MI, PCI, CABG, and CVA, diabetes, renal failure, LVEF category, hypercholesterolaemia, PVD, hypertension, smoking, valvular heart disease, out of hospital cardiac arrest, circulatory support, vascular access (radial, femoral), number of vessels and lesions attempted, number of stents, first/newer generation DES, drug eluting balloon, calcium modification (atherectomy, shockwave), vessel treated (LMS, proximal LAD, grafts), and in-hospital pharmacotherapy (aspirin, clopidogrel, ticagrelor, prasugrel, warfarin, GP2B3A, bivalirudin).

3.2 | Predictors of ICI use

In multivariable regression analysis, several patient and procedural factors were predictive of ICI-guided PCI compared with angiography guidance alone. Advanced age (OR 0.98 95% CI 0.98,0.99 per year) and STEMI presentation (OR 0.54 95% CI 0.47, 0.63) negatively correlated with ICI use (Table 4). In contrast, ST presentation (OR 2.66 95% CI 2.13, 3.32), previous PCI (OR 2.02 95% CI 1.66, 2.47), intervention of LM (OR 4.19 95% CI 3.56, 4.95) and proximal LAD lesions (OR 1.62 95% CI 1.39, 1.88), and the need for calcium modification (OR 2.13 95% CI 1.61, 2.81) positively correlated with increased ICI use.

4 | DISCUSSION

The present study is the first to examine the rates and predictors of ICI use, and subsequent outcomes, among ACS patients with cardiogenic shock in a contemporary national PCI cohort. Several findings can be concluded from our study. First, while ICI use has more than doubled over a 6-year period (5.7% in 2014 to 13.3% in 2020), it remains under-utilized in this high-risk procedural group. Second, we report several important predictors associated with increased ICI among those with cardiogenic shock, including ST and complex procedures involving LM and proximal LAD interventions, and calcium modification. Furthermore, we show that advanced age and STEMI presentation were negatively associated with ICI use. Finally, we found that ICI use among ACS patients with cardiogenic shock was associated with significantly lower odds of MACCE, driven by all-cause mortality, despite adjustment for patient and procedural differences between ICI and angiography-guided PCI groups (Central illustration 1).

Cardiogenic shock complicates nearly 10% of ACS cases, especially in STEMI presentations, and is associated a high rate of in-hospital and 1-year mortality.[1–3] PCI is the most utilized strategy

TABLE 4 Predictors of receipt of ICI among cardiogenic shock patients.

Predictor	OR [95% CI]	*p* Value
Age (per year)	0.98 [0.98, 0.99]	<0.001
Male	0.92 [0.80, 1.07]	0.276
Ethnicity		
White	Reference	-
Black	1.78 [1.40, 2.25]	<0.001
Asian	1.30 [1.04, 1.63]	0.023
Other	1.94 [1.50, 2.50]	<0.001
STEMI	0.54 [0.47, 0.63]	<0.001
Stent thrombosis	2.66 [2.13, 3.32]	<0.001
Previous PCI	2.02 [1.66, 2.47]	<0.001
Diabetes	0.87 [0.74, 1.01]	0.069
Renal failure	1.03 [0.80, 1.33]	0.833
LV ejection fraction		
Good (>50%)	Reference	-
Moderate (30%–50%)	1.05 [0.89, 1.23]	0.578
Poor (<30%)	0.82 [0.67, 1.01]	0.064
Hypercholesterolaemia	0.92 [0.80, 1.07]	0.276
PVD	0.91 [0.71, 1.17]	0.458
Hypertension	1.04 [0.90, 1.20]	0.579
Smoking	0.99 [0.87, 1.12]	0.835
Out of hospital cardiac arrest	1.14 [0.97, 1.34]	0.116
Ventilated	0.86 [0.74, 1.00]	0.050
Mechanical circulatory support	0.94 [0.82, 1.07]	0.328
Multivessel PCI (vs. single vessel)	1.12 [0.91, 1.38]	0.291
No of lesions		
1	Reference	-
2	1.10 [0.91, 1.33]	0.332
3	1.36 [1.06, 1.76]	0.017
4+	1.12 [0.76, 1.65]	0.559
Calcium modification	2.13 [1.61, 2.81]	<0.001
LMS	4.19 [3.56, 4.95]	<0.001
Proximal LAD	1.62 [1.39, 1.88]	<0.001
Chronic total occlusion	0.65 [0.41, 1.04]	0.074

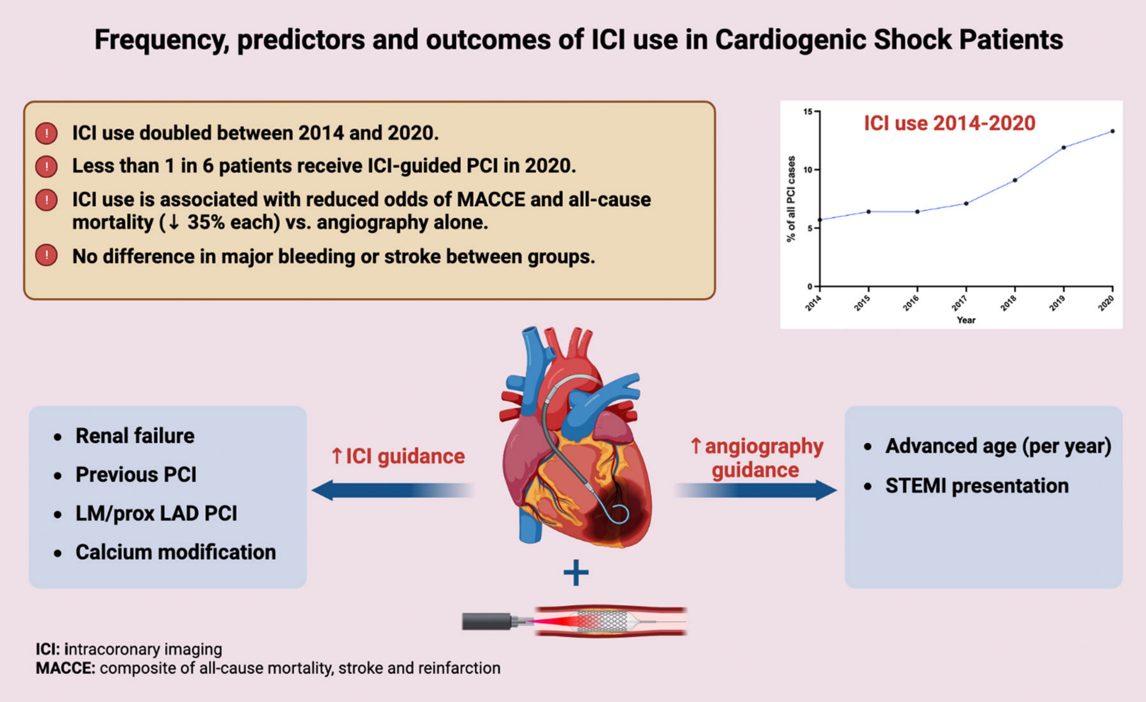
Abbreviations: LAD, left anterior descending; PCI, percutaneous coronary intervention.

for revascularisation in ACS and is associated with a significant reduction in in-hospital and postdischarge mortality. However, one of the most serious complications of PCI is ST, which is nearly 12-fold higher among those presenting with cardiogenic shock before PCI.[7] This is attributed to several factors including delayed absorption and reduced bioavailability of antiplatelet agents, especially thienopyridine inhibitors (e.g., prasugrel and clopidogrel), as well as the prothrombotic state during cardiogenic shock.[16–18] Furthermore, vasoconstriction among those with cardiogenic shock leads to stent under-sizing.

ICI has been shown to reduce the risk of ST and cardiac mortality by guiding preprocedural stent sizing and further postimplantation stent optimisation.[8,11,19] A finding of concern was the low rate of utilization of ICI in our national cohort (7.9%), although this has doubled over our 6-year study period. Even as of 2020, less than one in six procedures in cardiogenic shock patients were ICI-guided, despite their heightened risk of ST in those with cardiogenic shock and the established benefits of ICI guidance. Despite the lack of specific data on the rates of ICI use in the context of cardiogenic shock, previous studies have demonstrated under-utilization of ICI use. In a study by Smilowitz and colleagues the rate of ICI between 2013 and 2014 was 6.6% in their national analysis of all US PCI procedures, while our previous work showed only 17.5% of all PCI procedures in England and Wales in 2020 were ICI-guided.[20,21] Several reasons may explain the low rates of ICI use, especially in this patient group, including reluctance to prolong procedure time in unstable patients, catheterization laboratory time constraints and lack of staffing and device resources.

We observed a significant association between ICI use and clinical outcomes among ACS patients with cardiogenic shock, in terms of lower in-hospital MACCE, and mortality, both of which were 35% less in the ICI group in multivariable analysis. While there have been no studies examining the prognostic impact of ICI-guided PCI in the context of cardiogenic shock, previous studies have shown reduction in cardiac mortality and ST associated with ICI in other settings. In a study by Prati and colleagues OCT was associated with a significant reduction in cardiac death and MI at 1-year (OR 0.49 95% CI 0.25–0.96) compared with angiography guidance alone amongst a matched cohort of 670 patients undergoing PCI in a multicenter registry.[22] Similarly, in a network meta-analysis of 31 studies comprising 17,882 patients by Buccheri et al. demonstrated a significant reduction in cardiac mortality (OR 0.47 95% CI 0.32–0.66) and ST (OR 0.42 95% CI 0.20–0.72) in those undergoing IVUS-guided PCI versus angiography guidance alone.[9] Our findings demonstrate that the prognostic benefits of ICI use hold true even in the context of cardiogenic shock, and should prompt increased uptake in ICI-guided PCI by operators in efforts to mitigate the inherently high risk of mortality.

Our analysis highlights several predictors that correlated with increased use of ICI among cardiogenic shock patients, including young age, NSTE-ACS and ST presentations, and complex procedures involving LM and proximal LAD interventions, and calcium modification. While these factors are valid indications for ICI use based on current consensus, a significant proportion of the angiography-guided group also had complex disease that would benefit from ICI guidance, including nearly 40% proximal LAD disease, 12.7% LM disease and 4.9% with a ST indication.[8] This reflects a gap in current practice of managing these complex groups whose prognostic benefit



CENTRAL ILLUSTRATION 1 Summary of study findings. [Color figure can be viewed at wileyonlinelibrary.com]

from ICI is well established and where use is recommended by major national and international societies' guidelines.[8,23,24] ICI allows more optimal assessment of plaque characteristics and vulnerability and stent sizing in proximal LAD and LM PCI, and provides important insights in to mechanisms of stent failure, for example, strut malapposition, stent underexpansion, and neoatherosclerosis.[8,25–28] For example, a previous meta-analysis of nearly 5000 patients undergoing LM PCI by Wang and colleagues IVUS use was associated with a significant reduction in the risk of cardiac death (risk ratio [RR] 0.45 95% CI 0.32–0.62), and ST (RR 0.48 95% CI 0.27–0.84) compared with angiography guidance alone.[12]

4.1 | Limitations

There are several limitations to the present study. First, the observational nature of this study means that our findings should be viewed as associations that are not necessarily suggestive of causality and should be interpreted within this context. Second, while the BCIS data set captures a wide range of patient and procedural characteristics, it does not include measures of severity of cardiogenic shock, including number of inotropic agents used, which is known to influence postprocedural complications and mortality. Third, while our data set provides information on peri-procedural factors such as mechanical ventilation and circulatory support, including IABP, Impella, and inotrope use, there is limited data on the exact timing of mechanical circulatory support used in relation to the procedure as well as the management of these patients on intensive care units after their procedure. Furthermore, we note a higher rate of first-generation DES use in our cohort, which may impact longer-term rates of ST beyond the hospitalization phase. Finally, we only report in-hospital outcomes, and it is possible that differences between ICI and angiography groups may become more pronounced or eliminated on longer follow-up.

5 | CONCLUSIONS

In a national cohort of PCI procedures for ACS patients with cardiogenic shock, we report a rise in the rate of utilization of ICI over the last decade. However, ICI remains significantly under-utilized in this patient group, with less than one in six patients in receipt of ICI-guided PCI in 2020. Several patient and procedural factors were associated increased ICI use including younger age, NSTE-ACS (vs. STEMI) and ST, and complex procedures involving LM, proximal LAD, and calcium modification. Our findings indicate that ICI use is associated with a prognostic benefit in terms of lower in-hospital MACCE and all-cause mortality in this high-risk patient group and that greater utilization of ICI in this setting may translate into improved long term survival rates. The present findings highlight the need for a randomized controlled trial to examine the long-term benefits of ICI use in this population.

CONFLICT OF INTEREST STATEMENT

Dr Mintz has received honoraria from BostonScientific, SpectraWave, Gentuity, and Philips. Dr Zaman discloses receipt of research grants to her institution from Abbott Vascular, Biotronik Australia and, speaking/consulting honoraria from Novartis, Medtronic, Boehringer

Ingelheim and AstraZeneca. The remaining authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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