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Research paper

Access route selection for percutaneous coronary intervention among Vietnamese patients: Implications for in-hospital costs and outcomes☆

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ABSTRACT

Background: Little is known about rates of access site (transradial (TRI) or transfemoral (TFI)) preference for percutaneous coronary intervention (PCI) and in-hospital costs of patients undergoing these procedures in lower-and middle-countries. Here, we report on access site use, in-hospital costs and outcomes of patients undergoing PCI in Vietnam.

Methods: Information from 868 patients were included in the cohort of 1022 patients recruited into the first PCI registry in Vietnam. The total hospital costs and in-hospital outcomes of patients undergoing TRI and TFI were compared. Hospital costs were obtained from the hospital admission system, and major adverse cardiac events, major bleeding events and length of stay were identified through review of medical records.

Findings: TRI was the dominant access site for interventionists (694/868 patients). The TFI group reported more lesions of the left main artery, more previous coronary artery bypass grafts and previous PCI in comparison with the TRI group (all $p < 0.05$). The TRI group was associated with a lower overall cost of admission (the adjusted difference was -1526.3 USD, 95% confident interval CI (-1996.2; -1056.3), shorter length of hospital stay (-2 days, CI (-2.8; -1.2)) and lower rates of major bleeding post-procedure. Procedural factors such as radial access site, left main disease, PCI $\geq$2 stents, and PCI $\geq$ 2 lesions having the most impact on the in-hospital cost of patients undergoing PCI.

Interpretations: Among patients undergoing PCI, TRI was associated with lower costs and favourable clinical outcomes relative to TFI

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Abbreviations: BARC, Bleeding Academic Research Consortium; CABG, Coronary artery bypass grafts; CHD, Coronary heart disease; LOS, Length of stay; MACE, Major adverse cardiac event; PCI, Percutaneous coronary intervention; TFI, Transfemoral intervention; TRI, Transradial intervention; VNHI, Vietnam National Heart Institute.

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Research in context

- Evidence before this study: Choosing the optimal access location for percutaneous coronary intervention (PCI) has been controversial for many years. Despite accumulating studies on the differences between trans-radial access

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(TRI) and trans-femoral access (TFI), data addressing the cost difference between TRI and TFI is scarce. Few numbers of previous studies conducted largely in high-income countries reported using TRI is low-cost relative to TFI. While the use of PCI is of growing interest in Asia, the impact of PCI access site on hospital cost has not been clearly understood in this region.

- Added value of this study: Based on a pilot PCI registry in Vietnam, this study provides the first insight into the cost and outcome differences between TRI and TFI and identified factors associated with hospital cost of PCI patients in a low and middle-income country.
- Implications of all the available evidence: In low-resource settings, TRI is likely a choice of cardiologists to perform PCIs due to its cost savings and favourable clinical outcomes compared with TFI. The findings may help inform clinical practice and fill the gap in the literature on PCI cost in developing countries.

1. Introduction

Percutaneous coronary intervention (PCI) has been recognized as an effective treatment for individuals with coronary heart disease (CHD). While transfemoral access (TFI) is the traditional approach in cardiac catheterization, the use of transradial access (TRI) has grown significantly in the last two decades [1]. A number of randomized clinical trials and literature reviews have demonstrated favourable cardiac outcomes, shorter hospital stay, and better patient satisfaction for TRI relative to TFI [1–4]. Nonetheless, data regarding differences in hospital cost incurred by PCI patients according to PCI entry sites are limited. The few studies that have examined this issue have been conducted in high and upper-middle -income countries and have suggested a cost saving associated with TRI in comparison with TFI, mostly because of the reduction in length of hospital stay [5–7]. As healthcare practice varies greatly by regions, it is unclear that the evidence from these cost evaluations can be generalized to other countries, especially those less economically developed for which there are limited data, and potentially quite significant differences in standards of care. Investigating the cost saving for PCI procedures is also crucial in those countries as it can contribute to reducing the very high economic burden of CHD patients and potentially reform the current PCI practices. Being aware of the cost differences in clinical practice, cardiac interventionists can make their choices about access routes of PCI to reduce the financial burden on patients and healthcare systems.

In Asia, where CHD is the leading cause of death [8,9] the use of PCI for CHD patients is of growing interest in the region [10]. The widespread use of TRI in PCI procedures has been documented in recent studies [7,11], while the impact of PCI access sites on hospital cost and procedural outcomes has not been adequately reported. This paper, uses data from the first PCI registry in Vietnam, assessed in-hospital costs and post-procedural outcomes according to access sites and identified potential factors associated with in-hospital costs among patients undergoing PCI

2. Methods

2.1. Study population

The study population was derived from a consecutive cohort of patients undergoing PCI from September 2017 to May 2018 at the Vietnam National Heart Institute (VNHI), Hanoi, Vietnam. Full details of the registry have been described elsewhere [12,13]. A total of 1,022 patients were recruited in the registry from among 2,800 patients undergoing PCI at VNHI in the same period. Briefly, information on demography, cardiac status, procedure, and in-hospital cost of the participants was recorded by interviewing patients, extracting medical records, reading procedural discs and exploring the admission system. From the total pool of patients, those who underwent >1 PCI (n = 78) were excluded, as it is difficult to attribute the bleeding events to a single procedure with certainty. Patients with cardiogenic shock (n = 11) and those with missing cost data (n = 66) were also excluded as these groups were associated with extremely high outlier costs or no information on total cost, respectively. When >1 entry location was used in one PCI, the primary access site was the one allowing the completion of the procedure. After these exclusions, our study population consisted of 868 patients with 694 TRIs and 174 TFIs.

2.2. In-hospital cost and outcomes

The primary outcome was total in-hospital costs from the day of admission to discharge. Our cost data were obtained from the hospital admission system and classified under the following categories: PCI costs (guide wire, IVUS, balloons and stents); medication costs; examination/ laboratory costs; hospital bed costs; operation costs (electrocardiogram in the ward and angiography); and medical supplies (syringes and needles).

In-hospital outcomes were defined as major adverse cardiac events (MACE), major bleeding events and length of stay (LOS, measured in days). MACE was a composite of in-hospital death, myocardial infarction, and coronary revascularisation. Bleeding events were classified by the Bleeding Academic Research Consortium-BARC (2) indicating bleeding into five types according to clinical, laboratory, imaging evidence and health care required. Major bleeding was defined as BARC 3. Medical records were extracted to document these in-hospital outcomes.

2.3. Statistical analysis

Categorical variables (e.g., clinical, procedures, cost and outcomes) were presented as numbers and percentages, while continuous variables were expressed as mean ± SD unless otherwise specified. Unlike the randomized clinical trials, the choice of access point in real-world practice is often based on numerous factors, including patients' clinical characteristics and prognostic factors, therefore characteristics of study participants according to the two access sites were compared to see if there were any differences, using chi-square or Fisher exact tests and Independent samples t-test as appropriate. Median in-hospital costs and LOS were compared between TRI and TFI with the Mann-Whitney U test, the unadjusted and adjusted differences were obtained by Median regressions. Characteristic variables with statistical significance (p-value < 0.05) were selected for adjusting the cost differences. Logistic regression analyses were undertaken for two binary outcomes (major bleeding and MACE). Costs were converted into US Dollars, based on June 2019 exchange rates where 1USD = 23,350 Vietnamese Dong. These costs were then log transformed due to the likely skew in cost data, and the normality of this logged data was explored by both graphical and analytical methods such as skewness, kurtosis, box plot, Shapiro-Wilk and Kolmogorov-Smirnov test [14]. Multiple linear regressions were performed to identify the influence of different independent variables on the independent variable-log total in-hospital cost. Independent variables included age (year, continuous), sex (male vs. female), level of support from health insurance (>80 and ≤80%), acute coronary syndrome (yes vs. no), hypertension (yes vs. no), diabetes (yes vs. no), current smoking (yes vs. no), prior stroke (yes vs. no), prior coronary artery bypass grafting (CABG) (yes vs. no), prior PCI (yes vs. no); transradial PCI (yes vs. no), left ventricular ejection fraction (<40% vs.

Table 1
Clinical and procedural characteristics of the study population.

	TRI (n = 694)	TFI (n = 174)	P value
Age (year), mean ± SD	68.3 ± 9.7	69.3 ± 10.6	0.209[a]
Male	469 (67.6)	117 (67.2)	>0.999
Percentage of health insurance (HI) support			0.337
Non-HI	13 (1.9)	4 (2.3)	
<60%	24 (3.5)	2 (1.1)	
60-80%	133 (19.2)	39 (22.4)	
>80%	524 (75.5)	129 (74.1)	
BMI ≥ 23.0 kg/m^2	264 (38.0)	73 (42.0)	0.390
Presentation			
ST-elevation myocardial infarction	93 (13.4)	18 (10.3)	0.341
Non-ST-elevation myocardial infarction	105 (15.1)	24 (13.8)	0.746
Unstable angina	165 (23.8)	42 (24.1)	0.999
Non-acute coronary syndrome	331 (47.7)	90 (51.7)	0.386
Medical history			
Hypertension	462 (66.6)	122 (70.1)	0.423
Diabetes mellitus	191 (27.5)	59 (33.9)	0.116
Hyperlipidaemia	209 (30.1)	62 (35.6)	0.189
Current smoking	75 (10.8)	19 (10.9)	>0.999
Prior cerebral vascular disease	94 (13.5)	25 (14.4)	0.874
Prior peripheral vascular disease	4 (0.6)	2 (1.1)	0.761
Previous CABG	4 (0.6)	5 (2.9)	0.024
Previous PCI	218 (31.4)	75 (43.1)	0.005
Tests prior to PCI			
Left ventricular ejection fraction <40%	68 (11.1)	14 (8.9)	0.513
Moderate to severe renal impairment[b]	12 (1.7)	6 (3.4)	0.268
Procedural characteristics			
Left main disease	45 (6.5)	35 (20.1)	<0.001
Restenotic lesions	30 (4.3)	11 (6.3)	0.478
PCI with ≥ 2 lesions	49 (7.1)	11 (6.3)	0.860
PCI with ≥ 2 stents	257 (37.0)	76 (43.7)	0.127
Drug-eluting stent use	683 (100.0)	168 (100.0)	_
Balloon only	7 (1.0)	2 (1.1)	0.871
Intravascular ultrasound	28 (4.0)	12 (6.9)	0.13

[a] Independent samples T test.
[b] Creatinine > 200 µmol/L; Otherwise were Fisher exact or chi-square tests; TRI = Transradial intervention; TFI = Transfemoral intervention; BMI = body mass index; CABG = Coronary artery bypass grafts.

≥40%), moderate to severe renal impairment (yes vs. no), intravascular ultrasound (yes vs. no), left main disease (yes vs. no), PCI with ≥ 2 lesions (yes vs. no), PCI with ≥ 2 stents (yes vs. no), major bleeding (yes vs. no), and MACE (yes vs. no). Variables with $p < 0.1$ in univariate regression analyses were included in the multivariable regression model. To assess potential predictors of in-hospital costs percentage changes were computed by exponentiating unstandardized coefficients and subtracting one from the resultant number and multiplying by 100. Relative importance of possible predictors of total hospital costs was evaluated using standardised regression coefficients. Subgroup analyses according to the presence or absence of acute coronary syndromes (ACS) were also conducted to evaluate cost and outcome differences All p-values were two-tailed with statistical significance being defined as $p \leq 0.05$. All statistical analyses were performed in SPSS (SPSS Version 20.0 for Windows; SPSS Inc., Chicago, IL).

2.4. Ethics approval

The study received ethical approval from the Curtin University Human Research Ethics Committee (HRE 2017-0378) and Vietnam National Heart Institute provided reciprocal approvals for the study to be conducted and data analysed in Australia. A Patient Information Sheet was provided for every participant, which described clearly the purpose of the study, activities and rights of participants. It was voluntary to participate in the study and it is the right of participants to decline their participation or withdraw from the study via an ‘opt-out’ consent. The withdraw could occur at any time without any consequence. Each participant was assigned a unique ID which linked to the private information such as name, age, address, and phone numbers for follow- ups. All information that could be used to identify participants was coded and stored confidentially.

2.5. Role of the funding source

The funding source had no role in either study design, data collection, data analysis or interpretation and drafting the report. The corresponding author have full access to all data obtained from the study and have the final responsibility for publication submission.

3. Results

3.1. Clinical and procedural characteristics

Among the 868 patients in the eligible study population, TRI was the dominant access for PCI in our registry (694 patients, 79.9%). Table 1 compares demographic, clinical and procedural characteristics of TRI and TFI. Overall, the two target comparison groups had few differences in medical history and procedural characteristics. Patients undergoing TRI were relatively less likely to have previous coronary revascularization such as PCI and CABG ($p = 0.024$ and $p = 0.005$). They also tended to have less disease in the left main artery ($p < 0.001$).

3.2. In-hospital cost and outcomes

The median total hospital costs were 4132 and 5910 USD for patients undergoing TRI and TFI in our study (unadjusted cost difference: -1778 USD, approximately 30%). After accounting for baseline differences between the two groups (i.e. history of CABG and PCI, and left main disease), the adjusted difference was -1526.3 USD,

Table 2
Hospital costs and clinical outcomes between transradial (TRI) and transfemoral (TFI) percutaneous coronary intervention (PCI).

	TRI (n = 694)	TFI (n = 174)	Unadjusted differences (95% CI) (TRI versus TFI)	Adjusted differences[d] (95% CI) (TRI versus TFI)	P value
Hospital cost (USD[c]), Median					
Total hospital cost	4132.0	5910.1	−1778.1 (-2253.3; -1302.8)	−1526.3 (-1996.2; -1056.3)	<0.001
Out of pockets	1093.4	1980.6	−887.2 (-1130.3; -644.3)	−830.4 (-1075.7; -585.0)	<0.001
Health insurance support	3047.3	3661.2	−613.9 (-723.9; -503.8)	−506.1 (-649.7; -362.4)	<0.001
PCI cost	3482.9	5077.8	−1594.9 (-2053.1; -1136.5)	−1397.5 (-1875.7; -919.2)	<0.001
Medication cost	37.6	56.2	−18.6 (-28.3; -9.0)	−18.4 (-26.2; -10.5)	<0.001
Examination/ laboratory cost	96.5	107.9	−11.4 (-22.0; -1.3)	−12.2 (-24.1; -0.3)	0.020
Operation cost	293.0	296.2	−3.2 (-5.0; -1.2)	−2.9 (-4.7; -0.9)	<0.001
Hospital bed cost	59.9	102.8	−42.9 (-56.9; -28.7)	−38.8 (-50.5; -27.1)	<0.001
Medical supplies cost	30.6	31.4	−0.8 (-1.7; -0.0)	−0.7 (-1.3; -0.1)	0.011
Length of stay (day), Median	4.0	6.0	−2.0 (-2.9; -1.0)	−2.0 (-2.8; -1.2)	<0.001
Major adverse cardiac events (MACE)[b], n (%)	4 (0.6)	0 (0.0)	_	_	0.589
Major bleeding, n (%)	5 (0.7)	14 (8.0)	−7.3 (-11.4; -3.2)	−7.2 (-11.4; -2.9)	<0.001

[b] MACE was the composite of death, myocardial infarction, and coronary revascularisation.
[c] One US dollar is approximately equivalent to 23,350 Vietnam dong (20 June 2019).
[d] Factors adjusted for the difference: previous coronary artery bypass grafts; previous percutaneous coronary intervention; left main disease.

Table 3
Impact of clinical, procedural and outcomes on in-hospital total cost.

Characteristics[a]	Percentages changes of total hospital cost (%)	Standardized Coefficients β	P value
Age (5-year increment)	0.7	0.084	0.003
Hypertension	0.4	0.011	0.702
Diabetes	1.9	0.052	0.066
Prior CABG	9.5	0.056	0.048
Transradial PCI	−10.0	−0.252	<0.0001
Left main disease	7.1	0.121	<0.0001
PCI with ≥ 2 lesions	10.7	0.156	<0.0001
PCI with ≥ 2 stents	15.3	0.417	<0.0001
Major bleeding	−0.2	−0.002	0.954

CABG: coronary artery bypass grafting; PCI: percutaneous coronary intervention.
[a] With the exception of *age* variable, all variables are dichotomous and the absence of each variable is taken as the reference.

indicating that the cost of TRI is lower than that for TFI by 25.8% ($p < 0.001$) (Table 2). While health insurance contribution was high (60-70%) in both groups, the out of pocket expenses of participants were 1093 and 1980 USD in TRI and TFI groups, respectively. The majority of in-hospital cost was driven by the particular PCI cost (over 80%) in both groups (Table 2). TFI was associated with higher costs in all particular cost categories such as PCI cost, medication cost, laboratory cost, hospital bed cost and medical supplies cost ($p < 0.001$). Additionally, patients undergoing TFI were also more likely to have longer LOS, and procedural complications such as major bleeding ($p < 0.001$).

3.3. Impact of clinical, procedural and outcomes on in-hospital total cost

Procedural characteristics had the largest impact on total hospital cost, including trans-radial PCI, left main disease, PCI with ≥ 2 lesions and PCI with ≥ 2 stents (the standardized coefficients were -0.252; 0.121; 0.156; and 0.417, respectively) (all $p < 0.05$) (Table 3). Additionally, patient's age and prior CABG also had an impact on total in-hospital costs ($p < 0.05$).

3.4. Subgroup analyses

Of 868 patients, the number of patients with ACS and without ACS who underwent PCI was 447 and 421, respectively (Table 4). Results of subgroup analyses by ACS status were consistent with those obtained from the analysis of all subjects. Compared with patients undergoing PCI through TFI, those who received TRI consumed lower in-hospital costs, had a shorter hospital stay and experienced less major bleeding in either ACS or non-ACS (all $p < 0.05$).

4. Discussion

This study is the first to quantify in-hospital costs and outcomes between TRI and TFI in Vietnam. TRI was significantly associated with a lower cost of 1526.3 USD than TFI (25.8%), a shorter hospital stay and less major bleeding post procedure. The findings are important evidence in PCI cost saving, especially in this lower-middle-income country, where patients endure hardship for healthcare expenses. The result of this study can also contribute to amending clinical practice guidelines and assisting clinicians in making their decisions on the use of PCI.

4.1. In-hospital cost and post procedural outcomes according to the entry sites

Compared with TFI, the use of TRI in PCI practice has received more support partly because it was shown to reduce the bleeding associated with access sites and PCI complications [1,15,16]. Although few studies have investigated cost differences between two different entry sites, among those reporting costs, similar results were reported. Early previous findings reported that TRI was associated with significant reduction in total hospital costs, e.g., up to 15% reduction relative to TFI [17,18]. Recent data, both in countries where TFI has been the dominant access such as the USA, and countries where TRI was more preferred such as China and UK, also confirmed the favourable cost advantage of TRI relative to TFI [5–7,19]. Despite differences in the data analysis approach across

Table 4
Cost and outcomes differences between ACS and non-ACS group.

	TRI	TFI	Unadjusted difference (95% CI)	Adjusted difference[d] (95% CI)	P value
ACS (n = 447)					
Total hospital cost (USD[c]) median	4407.5	5422.4	−1014.9 (-1619.5; -410.3)	−1257.7 (-1833.6; -681.7)	<0.0001
Length of stay (day), median	4.0	6.0	−2.0 (-2.9; -1.1)	−1.0 (-1.9; -0.1)	<0.0001
Major bleeding, n (%)	3 (0.8)	8 (9.5)	−8.7 (-15.1; -2.4)	−8.9 (-15.7; -2.1)	<0.0001
MACE, n (%)	3 (0.8)	0 (0.0)	_	_	>0.9999
Non-ACS (n = 421)					
Total hospital cost (USD [c]) median	4006.9	6159.3	−2152.4 (-2839.1; -1465.7)	−1965.2 (-2626.5; -1303.9)	<0.0001
Length of stay (day), median	4.0	7.0	−3.0 (-3.9; -2.1)	−2.0 (-2.9; -1.1)	<0.0001
Major bleeding, n (%)	2 (0.6)	6 (6.7)	−6.1 (-11.2; -0.8)	−5.9 (-11.4; -0.5)	0.002
MACE, n (%)	1 (0.3)	0 (0.0)	_	_	>0.9999

ACS: acute coronary syndrome; MACE was the composite of death, myocardial infarction, and coronary revascularisation.
[c] One US dollar is approximately equivalent to 23,350 Vietnam dong (20 June 2019).
[d] Factors adjusted for the difference: previous coronary artery bypass grafts; previous percutaneous coronary intervention; left main disease.

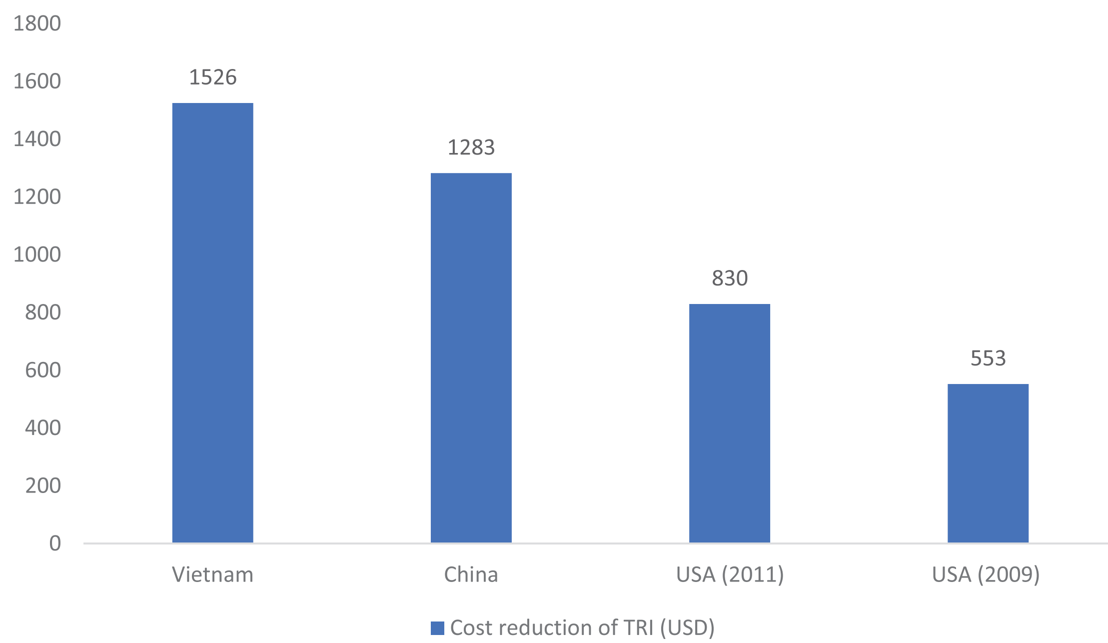

Fig. 1. Cost reduction of trans-radial in total hospital cost.
Comparison was made between Vietnam, China and USA [5–7].

studies, our findings were concordant with these results, suggesting the finding to be robust. The difference in in-hospital costs for the TRI group in our study was among the highest, compared with other studies in China and USA [5–7] (Figure 1). The characteristics of the two access site groups might be part of the explanation for this difference. Unlike these previous studies, our TFI patient group was likely to have more stents per lesion than the TRI group, probably due to more left main diseases in the former group. This difference subsequently increased the procedure cost, the major component of hospital cost.

The health care system in Vietnam includes both public and private sectors and health care is not free for all people. Our study was conducted in a public hospital where health insurance can cover some components of total expenses that patients incurred in hospital. While health insurance contributed a large proportion of hospital cost of all PCIs (60-70%), the cost difference in out of pocket expenditure was extremely significant in terms of the economic burden on patients, especially given the average monthly income per capita of Northern Vietnamese people was low (approximately 168 USD in 2016) [20]. Depending on the clinical presentation, diagnosis and prognosis of CHD patients, cardiologists will consider the appropriate care and treatment methods, such as PCI or medical therapy. In some very high cost health care such as PCI, the ability to pay might affect the treatment provided, especially in patients with low income and/or no health insurance. Therefore, identifying the in-hospital costs of patients undergoing PCIs using the two access points is an important consideration for future implementing TRI programs.

Regarding post-procedural outcomes in hospital of patients undergoing PCI, similar findings were found in our study. While the reduction advantage of TRI in bleeding complications was reported in most previous studies [5–7,16,21], significant reduction of cardiovascular outcomes such as in-hospital mortality and MACE were also found in TRI group [7,16]. Additionally, patients undergoing TRI in India, China, Australia and USA were found to discharge earlier than their TFI counterparts (from 0.2 day to 2.3 days), which also contribute to the cost reduction [5,7,16,21]. Thus, our findings empirically support the recommendations of recent guidelines on adopting TRI in clinical and add economic evidence to promote the use of this approach in the community practice [22,23].

4.2. Factor associated with hospital cost of patients undergoing PCI

Previous studies reported that the cost saving of TRI was related strongly with a reduced LOS and/or a lower rate of post procedural bleeding complication [6,7,19]. Similar findings were found in our study. Beside the main component of hospital cost (i.e. PCI cost), other cost differences were seen in terms of hospital bed costs, medication and laboratory tests, which indicated the significant contribution of LOS to the total hospital cost. Thus, to explore the potential effect of other factors associated with total hospital cost, we eliminated LOS in our analysis as LOS seemed to be affected by other factors such as post procedural complications. The result revealed total hospital cost was likely to be driven mostly by procedural characteristics, especially PCI with $\geq$ 2 stents and the PCI access sites. This result reinforced the highest contribution of PCI cost to total hospital costs observed in Table 2. Findings from a study in China also supported our study, indicating that total hospital cost differences of PCI patients were related mostly to procedural cost, e.g., vascular closure devices [7], while two studies in USA indicated that the cost saving of TRI was found only in terms of post procedural costs [5,6]. This observation might be explained by the differences in health care systems in Western and Asian countries, which need to be investigated in further studies. Thus, our study reported that the procedural factors such as number of stents per lesion ($\geq$ 2), PCI access sites having the most impact on the in-hospital cost of patients undergoing PCI. By reporting this finding, we believe that our study made a significant impact on clinical practice of PCI in the country. Even though TRI is the current preferred approach, the valued cost saving of TRI relative to TFI was reported for the first time in a reliable study, which supports the use of this location access in PCI practice at VNHI. The interventionists and cardiologists might consider the result of this study in managing their practice at VNHI to provide the cost-effective care for patients, especially the ones who have financial hardship or no health insurance. This strategy can also be followed at lower level hospitals in Vietnam given the training and educational roles of VNHI.

There are some limitations in our study. First, cost data were obtained from the hospital admission system, which can reflect only cost incurred by patients during hospitalization, but not indirect costs such as food supplied or accommodation for the patient's families who came to care for the patient. Other costs prior to and after discharge was also not investigated. Second, despite adjustment of the cost and outcome differences, selection bias cannot be ruled out due to the nature of non-randomisation of access sites. In fact, most of the participants characteristics are similar between the TRI and TFI group. Another concern is that our data were only derived from the leading cardiac centre in Vietnam, where the highest technology might be applied, then findings might not be considered as representative for the whole nation, but provided important insight of PCI practices. More dedicated studies should be conducted to give full insights of in-hospital cost for the PCI practices in Vietnam.

5. Conclusion

Our study based on the first Vietnamese PCI registry provides an opportunity to understand current insights of in-hospital cost and outcomes of patients undergoing PCI according to entry sites in Vietnam. TRI was the most preferred access site and overall, patients undergoing TRI were associated with lower in-hospital costs, shorter LOS and favourable post-procedural outcomes in comparison with TFI. Procedural factors such as PCI with $\geq$2 stents and PCI access sites had the most impact on in-hospital cost of PCI patients.

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Declaration of Competing Interest

There is no conflict of interest for all authors.

CRediT authorship contribution statement

Hoa T.T. Vu: Data curation, Formal analysis, Writing - original draft, Conceptualization, Methodology, Supervision. **Richard Norman:** Writing - review & editing, Supervision. **Ngoc M. Pham:** Writing - review & editing, Supervision. **Hung M. Pham:** Conceptualization, Methodology, Supervision. **Hoai T.T. Nguyen:** Conceptualization, Methodology, Supervision. **Quang N. Nguyen:** Conceptualization, Methodology, Supervision. **Loi D. Do:** Conceptualization, Methodology, Supervision. **Rachel R. Huxley:** Conceptualization, Methodology, Supervision. **Crystal M.Y. Lee:** Conceptualization, Methodology, Supervision. **Tu M. Hoang:** Conceptualization, Methodology, Supervision. **Christopher M. Reid:** Writing - review & editing, Supervision.

Data sharing statement

After publication, the data will be made available to others. All data requests will be considered by the corresponding author for approval. Access to unidentified participant data may be granted following review.

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