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ORIGINAL RESEARCH

Cost-Effectiveness of Ticagrelor Compared with Clopidogrel in Patients with Acute Coronary Syndrome from Vietnamese Healthcare Payers' Perspective

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ABSTRACT

Introduction: The PLATelet inhibition and patient Outcomes (PLATO) trial (NCT00391872) demonstrated that ticagrelor compared to clopidogrel significantly reduced the rate of death from cardiovascular causes, myocardial infarction or stroke in patients with acute coronary syndrome (ACS). The aim of this study is to analyze the long-term cost-effectiveness of ticagrelor compared to clopidogrel in ACS patients from a Vietnamese healthcare payers' perspective.

Methods: A two-part cost-effectiveness model was developed to estimate long-term costs and quality-adjusted life-years (QALY). Cardiovascular event rates, hospital bed days, interventions, investigations, study drug utilization and EuroQol 5 Dimension (EQ-5D) data were derived from the PLATO trial. Unit costs of medical services were derived from the Vietnamese governmental price list, and drug costs were based on the weighted average price from the Vietnamese social security report (in VND; 10.000 VND=0.405 USD). An annual discount rate of 3% was used. Probabilistic and deterministic sensitivity analyses were conducted to evaluate uncertainty of the results.

Results: Ticagrelor was associated with an incremental cost of VND 5.34 million (USD 216.49) and a QALY gain of 0.11. This resulted in a cost per QALY gained of VND 49.58 million (USD 2009.96) from the Vietnamese healthcare payers' perspective. Probabilistic sensitivity analysis indicates that ticagrelor has 59% probability of being cost-effective compared with clopidogrel when using a willingness-to-pay threshold of one gross domestic products (GDP) per capita. Deterministic sensitivity analysis using clinical outcomes from the Asian subpopulation of PLATO resulted in a cost per QALY of VND 42.25 million (USD 1712.80).

Conclusion: Ticagrelor can be considered a cost-effective treatment for ACS compared with clopidogrel from a Vietnamese healthcare payers' perspective.

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Keywords: Ticagrelor; Clopidogrel; Acute coronary syndrome; Cost-effectiveness analysis; Vietnam

Key Summary Points

The PLATO trial (NCT00391872) demonstrated that ticagrelor compared to clopidogrel significantly reduced the rate of death from cardiovascular causes, myocardial infarction or stroke in patients with acute coronary syndrome (ACS)

The aim of this study is to analyze long-term cost-effectiveness of ticagrelor compared to clopidogrel in ACS patients from a Vietnamese healthcare payers' perspective

Ticagrelor was associated with an incremental cost of VND 5.34 million (USD 216.49) and a QALY gain of 0.11, which resulted in a cost per QALY gained of VND 49.58 million (USD 2,009.96) from Vietnamese healthcare payers' perspective

The cost per QALY gained is less than one gross domestic product (GDP) per capita, which is the recommended threshold by the World Health Organization (WHO)

Ticagrelor can be considered a cost-effective treatment for ACS compared with clopidogrel from a Vietnamese healthcare payers' perspective

DIGITAL FEATURES

This article is published with digital features, including a summary slide, to facilitate understanding of the article. To view digital features for this article go to https://doi.org/10.6084/m9.figshare.14394398.

INTRODUCTION

Acute coronary syndromes (ACS), including unstable angina, non-ST-segment and ST-segment myocardial infarction (MI), are life-threatening cardiovascular disorders, which are associated with high rates of death, emergency care, hospitalization and readmission despite modern treatment [1, 2]. The primary goal of ACS treatment is to prevent recurrent thromboembolic events. Dual-antiplatelet therapy with aspirin and a $P2Y_{12}$ inhibitor is considered standard treatment and is recommended for up to 12 months after ACS [1–5]. Ticagrelor, a reversibly binding and direct-acting oral antagonist of the platelet adenosine diphosphate receptor $P2Y_{12}$, has been shown to be more effective than clopidogrel without increasing the risk of major bleeding events [6]. The PLATelet inhibition and patient Outcomes trial (PLATO) (NCT00391872) with 18,624 ACS patients showed that 12 months of treatment with ticagrelor compared to clopidogrel in combination with aspirin significantly reduced the risk of death by cardiovascular causes, myocardial infarction or stroke [hazard ratio (HR)=0.84; 95% confidence interval (CI) 0.77–0.92], without an increased risk of overall PLATO-defined major bleeding (HR=1.04; 95% CI 0.95–1.13) [7]. Ticagrelor in combination with aspirin is recommended in treatment guidelines and approved in Vietnam for the treatment of patients with ACS up to 12 months [1, 5, 8]. The reduction of cardiovascular events may offset a higher treatment cost of ticagrelor, which will be examined by evaluating the cost-effectiveness of ticagrelor compared to clopidogrel in the treatment of ACS. Several health economic evaluations have shown that ticagrelor is a cost-effective treatment compared to clopidogrel in patients with ACS in different jurisdictions [9–12]. This has also been shown in Vietnam [13]. However, that study used data from one hospital, which may not be representative for the whole country, while this study used data from five large representative hospitals in Vietnam. This study has been conducted to assess the long-term cost-effectiveness of ticagrelor versus clopidogrel in patients with

ACS from a Vietnamese healthcare payers' perspective to prioritize treatments among scarce healthcare resources.

METHODS

Cost-Effectiveness Analysis

The treatment strategies under investigation are ticagrelor 90 mg twice daily in addition to aspirin and clopidogrel 75 mg once daily in addition to aspirin, which is a commonly used treatment regimen for ACS in Vietnam. Long-term cost-effectiveness of these two treatment strategies was estimated using a two-component decision model developed by Nikolic et al. [9]. This model included a short-term decision-tree model for 1-year treatment according to the period of the PLATO trial and a long-term Markov model, extrapolating disease progression after 1 year of treatment [9]. The Markov model cycle length was 1 year; a life-time horizon has been applied using Vietnamese standard mortality rates, unit costs and 3% discount rates for cost and outcomes.

Patients were allocated to four different health states (no further event, non-fatal MI, non-fatal stroke and death from any cause) at the end of year 1 reflecting the PLATO trial outcomes. The risk equations for the health states were derived from the PLATO trial and differed because of observed treatment effects in the trial. From the second year onward, patients entered a Markov model, depending on which health state they belonged to at the end of year 1. The annual risk to get a non-fatal MI or non-fatal stroke for a patient that survived an ACS event and had no further event the first year is presented in Table 1. The increased risk of death for a patient that had no further cardiovascular event during the first year is presented in Table 1. The non-fatal MI and non-fatal stroke states are "tunnel states," in which patients only could remain for one cycle. There is an increased risk of death during the non-fatal MI and non-fatal stroke tunnel state compared to the risk of dying during the post-MI and post-stroke state, which is presented in Table 1.

Transition Probabilities

Survival analysis with Weibull distribution was performed to estimate the risk of events based on the PLATO data. Mortality risks from any cause after an ACS event were 0.046 for ticagrelor and 0.059 for clopidogrel. The risk of non-fatal myocardial infarction for patients treated with ticagrelor or clopidogrel was 0.050 and 0.058, respectively. The risk of non-fatal stroke for patients treated with ticagrelor or clopidogrel was 0.010 and 0.009, respectively [9].

Several assumptions have been used to simplify the model construction and parameter estimation to assess the long-term cost-effectiveness. First, the treatment duration was assumed to be 1 year and there was no treatment or rebound effect in the Markov model. Second, it was assumed that only one non-fatal MI or non-fatal stroke could occur in the Markov model. This assumption may underestimate the risk with multiple events. However, the Markov model makes it feasible to model costs, utility decrements and life expectancy for individuals who experienced an MI or stroke after initiating treatment. We assumed our cohort of ACS patients had similar characteristics to the patients in the PLATO trial with a median age of 62 years (Table 2). Physicians allocated patients to intended invasive or non-invasive treatment at randomization using an interactive voice randomization system [16].

Input Data

Cost

Cardiovascular event rate and resource utilization (hospital bed days, interventions, investigations, blood products and study drug utilization) were derived from the PLATO trial. Direct medical costs were estimated by multiplying collected resource utilization by unit costs of medical services in Vietnam. Retrospective data from five large representative hospitals for ACS treatment in Vietnam (Cho Ray Hospital, Institut du Coeur, Vietnam Heart Institute, Hanoi Heart Hospital and the Hospital of University of Medicine and Pharmacy at Ho

Table 1 Input parameters (probabilities) of the model

Health states	Ticagrelor	Clopidogrel	References
One-year decision-tree model			
No event	0.890	0.875	PLATO [9]
Non-fatal MI	0.050	0.058	PLATO [9]
Non-fatal stroke	0.010	0.009	PLATO [9]
Death	0.046	0.059	PLATO [9]
Markov model			
Annual risk of non-fatal MI in the no event state	0.019		PLATO [9]
Annual risk of non-fatal stroke in the no event state	0.003		PLATO [9]
Increased risk of death in the no event state	2.000		Norhammar [14]
Increased risk of death in the non-fatal MI state	6.000		PLATO [9]
Increased risk of death in the post MI state	3.000		Nikolic [9]
Increased risk of death in the non-fatal stroke state	7.430		Dennis [15]
Increased risk of death in the post stroke state	3.000		Dennis [15]

Chi Minh City) during January to December 2017 were used to evaluate the cost of Markov states in the Markov model including non-fatal MI and non-fatal stroke. A sample of MI and stroke cases has been selected, using the following selection criteria (ICD code I20, I21, I22 for MI and I63, I64, I69 for stroke), without non-cardiovascular-related comorbidities (cancer, chronic kidney disease, diabetes). Cost data for outpatient and inpatient treatment of the sample were derived from the electronic data of hospitals.

The study has been conducted from a healthcare payers' perspective, so only medical direct cost has been estimated, including cost for hospital bed days, interventions, investigations, blood products and drug utilization. Unit costs of medical services were derived from the governmental price list for all hospitals in Vietnam (Circular 37/2015/TT-BYT) and are presented in appendix Table 1. Drug costs were based on the weighted average price from the report of Vietnamese social security at the time of analysis. The applied daily cost of ticagrelor was VND 33968.00 (USD 1.38), and the weighted average daily cost of clopidogrel was VND 8238.00 (USD 0.33) (branded daily clopidogrel price was VND 22286.00 (USD 0.90) with a market share of 30%; the generic daily price was VND 2217.00 (USD 0.09) with a market share of 70%). A discount rate of 3% was used for cost-effectiveness following WHO guidelines for cost-effectiveness analysis [17]. Treatment costs as input parameters of the model are presented in Table 3.

Health Related Quality of Life

For cost-effectiveness analysis, quality-adjusted life-year (QALY) has been chosen as the measure of health outcome. The QALY estimates were based on the EuroQol 5 Dimension 3-level (EQ-5D-3L) questionnaire, which was collected at index, 6 and 12 months in the PLATO trial. QALY estimates were derived for each node of the decision tree at 12 months using the UK tariff and are presented in Table 4. Annual QALY decrements post non-fatal MI and non-fatal stroke were also derived and are presented in Table 4.

The incremental cost-effectiveness ratio (ICER) was calculated using the following formula and is presented in Table 4.

Table 2 Baseline characteristics of patients in the PLATO trial, by treatment group

Characteristic	Ticagrelor (*N*=9333)	Clopidogrel (*N*=9291)
Age—median	62.0	62.0
Age ≥ 75 years—no. (%)	1396 (15.0)	1482 (16.0)
Female sex—no. (%)	2655 (28.4)	2633 (28.3)
BMI—median (range)	27 (13–68)	27 (13–70)
Race—no./total no. (%)		
White	8566/9332 (91.8)	8511/9291 (91.6)
Black	115/9332 (1.2)	114/9291 (1.2)
Asian	542/9332 (5.8)	554/9291 (6.0)
Other	109/9332 (1.2)	112/9291 (1.2)
Cardiovascular risk factor—no. (%)		
Habitual smoker	3360 (36.0)	3318 (35.7)
Hypertension	6139 (65.8)	6044 (65.1)
Dyslipidemia	4347 (46.6)	4342 (46.7)
Diabetes mellitus	2326 (24.9)	2336 (25.1)
Final diagnosis of ACS—no. (%)		
ST-elevation MI	3496 (37.5)	3530 (38.0)
Non-ST elevation MI	4005 (42.9)	3950 (42.5)
Unstable angina	4005 (42.9)	1563 (16.8)
Other diagnosis or missing data	283 (3.0)	248 (2.7)
Planned treatment during index hospitalization—no. (%)		
Invasive	6732 (72.1)	6676 (71.9)
Non-invasive	2601 (27.9)	2615 (28.1)
Other medical history—no. (%)		
MI	1900 (20.4)	1924 (20.7)
Percutaneous coronary intervention	1272 (13.6)	1220 (13.1)
Congestive heart failure	513 (5.5)	537 (5.8)
Coronary-artery bypass grafting	532 (5.7)	574 (6.2)
Non-hemorrhagic stroke	353 (3.8)	369 (4.0)
Peripheral arterial disease	566 (6.1)	578 (6.2)

From Wallentin et al. [7]

Table 3 Input parameters (treatment cost) of the model (VND–USD)

Decision-tree model (1-year cost)	Ticagrelor	Clopidogrel	Source
No events	VND 57,134,249	VND 59,086,112	Detailed resource utilization recorded in the PLATO trial was multiplied with the unit costs of medical services in the governmental price list for all hospitals in Vietnam or the weighted average price of drugs from the report of Vietnamese social security
	USD 2316.20	USD 2395.33	
Stroke	VND 57,603,000	VND 59,554,863	
	USD 2335.21	USD 2414.33	
Myocardial infarction	VND 105,111,768	VND 107,063,631	
	USD 4261.20	USD 4340.32	
Dead	VND 58,391,202	VND 60,343,065	
	USD 2367.16	USD 2446.29	

Markov model (1-year cost)	Mean (SE) VND	Source
No event	VND 6,230,952.00 (452,831.00)	Clinical experts
	USD 252.60 (18.36)	
Stroke	VND 26,251,844.00 (2,427,610.00)	Retrospective data in 2017 at 5 main large hospitals in Vietnam
	USD 1064.24 (98.42)	
Post stroke	VND 15,418,016.00 (2,198,499.00)	
	USD 625.04 (89.13)	
Myocardial infarction	VND 91,498,875.00 (8,766,710.00)	
	USD 3709.33 (355.40)	
Post myocardial infarction	VND 21,174,672.00 (5,075,511.00)	
	USD 858.41 (205.76)	

$$\mathrm{ICER} = \frac{\Delta C}{\Delta Q} = \frac{\mathrm{Cost}_{\mathrm{ticagrelor}} - \mathrm{Cost}_{\mathrm{clopidogrel}}}{\mathrm{QALY}_{\mathrm{ticagrelor}} - \mathrm{QALY}_{\mathrm{clopidogrel}}},$$

where $C_{ticagrelor}$ and $C_{clopidogrel}$ are the estimated mean cost of treatment strategies with ticagrelor or clopidogrel; $QALY_{ticagrelor}$ and $QALY_{clopidogrel}$ are the estimated mean QALY of the treatment strategy with ticagrelor or clopidogrel [18].

The cost-effectiveness of the ticagrelor versus clopidogrel treatment strategy was assessed by comparing ICER with a willingness-to-pay threshold, which could be from one to three times the gross domestic product (GDP) per capita according to World Health Organization (WHO) recommendations [19]. In Vietnam, 1 GDP per capita (VND 54.63 million—USD 2365.62) [20] is considered an acceptable willingness-to-pay threshold for governmental decisions in the healthcare insurance system.

To assess the uncertainty of the estimated ICERs and the robustness of base case results, two types of sensitivity analyses have been used. First, a deterministic analysis has been performed to evaluate the change of estimated ICERs with the variation of input data. One of

Table 4 Input parameters (QALY) of the model

Decision-tree (QALY)	Ticagrelor	Clopidogrel	
No event	0.873	0.876	PLATO [9]
Non-fatal MI	0.811	0.814	PLATO [9]
Non-fatal stroke	0.735	0.738	PLATO [9]
Death	0.247	0.250	PLATO [9]
Markov model (QALY)			
No event (<70 years old)		0.875	PLATO [9]
No event (70–79 years old)		0.843	PLATO [9]
No event (>79 years old)		0.781	PLATO [9]
Annual QALY decrement non-fatal MI state		0.063	PLATO [9]
Annual QALY decrement post MI state		0.063	PLATO [9]
Annual QALY decrement non-fatal stroke state		0.138	PLATO [9]
Annual QALY decrement post stroke state		0.138	PLATO [9]

the sensitivity analyses used derived risks from the Asian subpopulation of PLATO. Kang et al. showed that there was an increased risk of stroke and all-cause death in Asian compared with non-Asian patients while there was no increased risk of PLATO major bleeding [21]. The derived risk for the sensitivity analysis was higher for all-cause death (0.088 for ticagrelor and 0.100 for clopidogrel) and non-fatal stroke (0.014 for ticagrelor and 0.016 for clopidogrel) compared to the derived risk for the full PLATO population (Table 1) while it was similar for non-fatal MI (0.059 for ticagrelor and 0.057 for clopidogrel) [21].

Second, a probabilistic analysis using the bootstrap method with 10,000 x repetition of the analysis was performed. The probability of ticagrelor being cost-effective compared to clopidogrel at different values of willingness to pay for an additional QALY was also analyzed in a cost-effectiveness acceptability curve.

The study protocol was approved by Human Research Ethics Committee of the University of Medicine and Pharmacy at Ho Chi Minh City. This study was performed in accordance with the Helsinki Declaration of 1964 and its later amendments. All participants provided written informed consent to participate in the study.

RESULTS

Base Case Analysis

Treatment with ticagrelor for 12 months was associated with an incremental cost of VND 5.34 million (USD 216.49) and a QALY gain of 0.11 or a LYG gain of 0.12 compared to clopidogrel based on the full PLATO population using a lifetime horizon. This resulted in a cost per QALY gained of VND 49.58 million (USD 2009.96) and a cost per LYG gained of VND 43.02 million (USD 1744.02) from a Vietnamese healthcare payer's perspective (Table 5). Patients who discharged with a NSTEMI or STEMI were associated with higher hospitalization-related costs compared to those with an unstable angina (UA) but a similar incremental

Table 5 Results of cost-effectiveness analysis

	Ticagrelor	Clopidogrel	Incremental	ICER (VND)	ICER (USD)
All ACS					
Costs	143,464,797	138,125,075	5,339,722		
Life-years	9.300	9.176	0.124	43,018,174.00	1743.94
QALYs	7.892	7.784	0.108	49,584,106.00	2010.12
Unstable angina					
Costs	119,152,090	113,776,916	5,375,174		
Life-years	9.434	9.330	0.104	51,578,130.00	2090.96
QALYs	7.878	7.791	0.087	61,672,159.00	2500.17
NSTEMI					
Costs	149,523,292	144,173,764	5,349,528		
Life-years	9.177	9.049	0.128	41,813,652.00	1695.11
QALYs	7.614	7.503	0.111	48,328,813.00	1959.23
STEMI					
Costs	149,992,150	144,734,846	5,257,304		
Life-years	9.410	9.291	0.119	44,166,591.00	1790.50
QALYs	8.256	8.152	0.104	50,360,251.00	2041.60
Invasive					
Costs	152,071,723	147,011,263	5,060,459		
Life-years	9.401	9.293	0.108	46,933,592.00	1902.67
QALYs	8.103	8.009	0.094	53,657,506.00	2175.25
Non-invasive					
Costs	122,432,626	116,564,505	5,868,121		
Life-years	9.024	8.860	0.164	35,678,475.00	1551.98
QALYs	7.345	7.207	0.138	42,445,002.00	1720.71
Diabetes					
Costs	152,540,186	146,681,683	5,858,504		
Life-years	8.915	8.740	0.175	33,479,970.00	1357.27
QALYs	7.334	7.184	0.150	39,129,762.00	1586.31
Non-diabetes					
Costs	140,580,873	135,382,357	5,198,516		
Life-years	9.427	9.321	0.106	48,945,907.00	1984.23
QALYs	8.077	7.985	0.092	56,434,902.00	2287.85

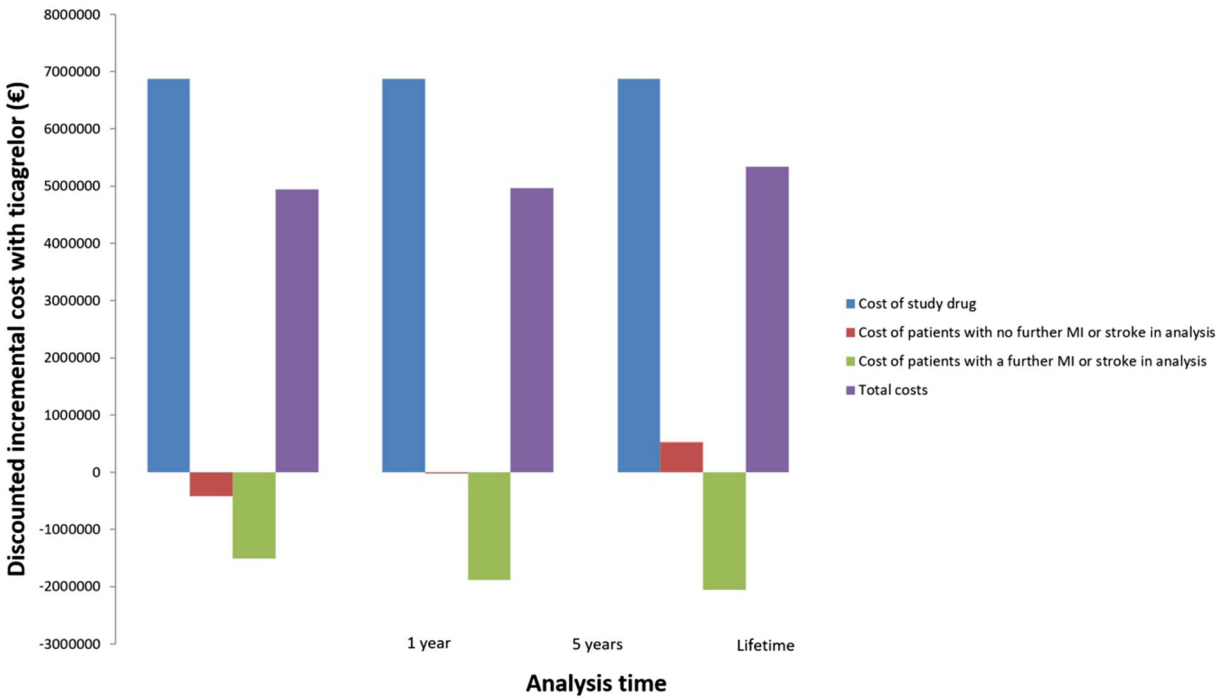

Fig. 1 Detailed incremental cost with ticagrelor over time

drug cost (Table 5). Cost-effectiveness results for pre-specified subgroups of the PLATO trial are presented in Table 5, which shows that the largest QALY gain and lowest ICER were observed in the diabetic subgroup followed by the subgroup with patients intended for non-invasive management. The difference in total costs at different time horizons is presented in Fig. 1.

Sensitivity Analysis

A deterministic sensitivity analysis showed that the increased risk of all-cause death in the Asian subgroup resulted in a QALY gain of 0.170 and incremental cost of VND 7.06 million (USD 286.21), which resulted in a cost per QALY of VND 42.25 million (USD 1712.80).

Probabilistic sensitivity analysis showed that the results are quite stable with the change of the input parameters. Most of the 10,000 stochastic iterations show that ticagrelor was associated with an increased effect (QALY gain) to a higher cost (Fig. 2). The red slope represents a willingness-to-pay threshold; hence, all dots below the red line indicate the iterations where ticagrelor is cost-effective. The probability of ticagrelor being cost-effective at different levels of willingness to pay, or threshold values, is presented in the cost-effectiveness analysis. Probabilistic sensitivity analysis indicated that ticagrelor has 59% probability of being cost-effective compared with clopidogrel if a willingness-to-pay threshold of 1 GDP per capita or VND 54.63 million (USD 2365.62) [20] per QALY was applied and more than 99% if a threshold of 3 GDP per capita or VND 163.89 million (USD 7096.86) per QALY was applied (recommended willingness-to-pay threshold of 1–3 GDP per capita by WHO) (Fig. 3).

The probability of ticagrelor being cost-effective was highest for the diabetic subgroup followed by the sub-group intended to be treated non-invasively and the Asian subpopulation when the conventional willingness-to-pay threshold of 1 GDP per capita was applied.

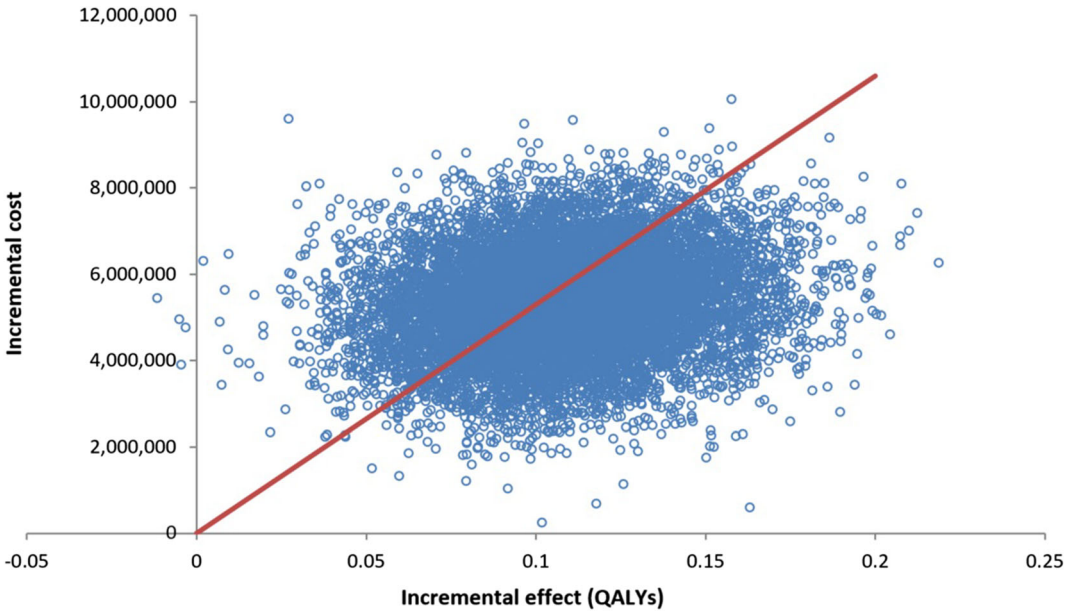

Fig. 2 Probabilistic sensitivity analysis

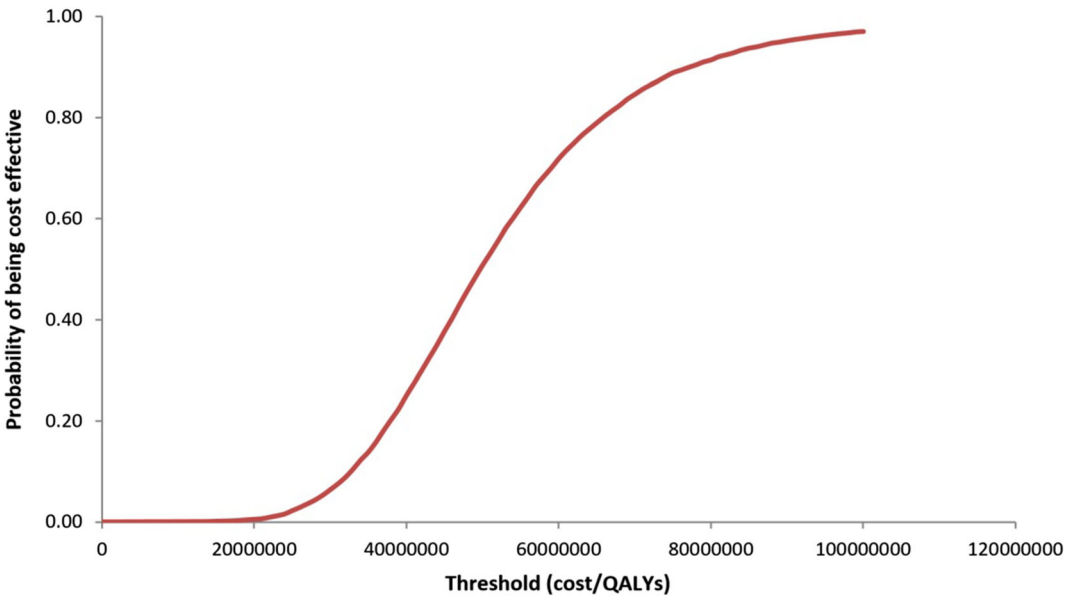

Fig. 3 Cost-effectiveness acceptability curve for ticagrelor

DISCUSSION

This article presents the cost-effectiveness analysis of ticagrelor compared to clopidogrel in patients with ACS based on the PLATO trial from a Vietnamese healthcare payers' perspective. This analysis demonstrated that ticagrelor could be a cost-effective treatment compared with clopidogrel in patients with ACS using the WHO recommended willingness-to-pay threshold of 1 GDP per capita. The result was consistent across pre-defined subgroups. Most of the estimated QALY gain was due to a reduction of all-cause mortality. The observed all-cause

mortality risk in the PLATO trial was highest in Asian patients, followed by patients with diabetes and those intended for non-invasive management [22, 23]. Subsequently, the highest QALY gain and lowest cost per QALY were estimated for these three subgroups. Ticagrelor has been shown to be cost-effective compared to clopidogrel in many different jurisdictions including Singapore [10], Sweden [9], Canada [23], Switzerland [24], Thailand [25], Colombia [26], Greece, Brazil and Germany [12]. The cost per QALY differs between the country-specific jurisdictions and analyses due to differing resource utilization costs, drug costs, standard mortality rates and discount rates. There have not been any studies on willingness to pay in Vietnam. Thus, the recommendation of the WHO was used in the study with a threshold of 1–3× the GDP per capita [19]. The evaluation was based on the healthcare payers' perspective; hence, only the direct medical cost was analyzed. The indirect cost such as productivity loss or caregiver burden was not analyzed, which could impact the cost per QALY.

This study has some strengths. First, this is one of the first studies in Vietnam to evaluate the cost-effectiveness of ticagrelor vs. clopidogrel in patients with ACS. The previous related study of T.T.T. Nguyen and others in Vietnam used data from one hospital [13], while this study used data from five large representative hospitals in Vietnam, which may be more representative for the whole country. Despite this difference, this study reached the same conclusion as the previous study of T.T.T. Nguyen related to the cost-effectiveness result of ticagrelor vs. clopidogrel in ACS treatment. Second, this cost-effectiveness analysis is based on prospectively collected resource utilization and EQ-5D data from more than 18,000 ACS patients in the PLATO trial with adjustment in cost data using the unit cost of Vietnam and retrospective data from five large representative hospitals in Vietnam. This approach helped to assess the long-term cost-effectiveness of ticagrelor from a Vietnamese setting. Third, two types of sensitivity analyses have been used to assess the uncertainty of the estimated ICERs and the robustness of base case results, including deterministic and probabilistic sensitivity analyses. One of those sensitivity analyses used derived risks from the Asian subpopulation of PLATO, which helped to assess the cost-effectiveness of ticagrelor in an Asian population such as Vietnam.

This study has some limitations. First, patients could only have one MI or stroke in the long-term Markov model, which might underestimate the risk of death, cost and QALY decrement for these patients. However, to accommodate this, an increased long-term risk of death, cost and utility decrement was applied for patients who experienced an MI or stroke. Second, resource utilization related to the first year of treatment after an ACS event was derived from the PLATO trial, which was conducted strictly by protocol and may not reflect the real clinical practice treatment of an ACS event in Vietnam. To accommodate that, we used the unit cost of medical services from Vietnamese data. Third, few Asian patients were included in the PLATO trial, which could have an impact on the QALY estimates. However one-way sensitivity analysis showed that the ICER appears to be insensitive to changes of the utility while the QALY gain and ICER were sensitive to the increased risk of all-cause death in Asian vs. non-Asian patients. Fourth, the cost of Markov states has been retrieved from retrospective data, selected by appropriate ICD code. Although non-cardiovascular comorbidities have been excluded, the presence of other cardiovascular comorbidities may affect the treatment cost of patients. To accommodate that, a sensitivity analysis was performed and showed the insensitivity of ICER to the changes of Markov state costs. Finally, this study was conducted based on the healthcare payers' perspective, whereas a societal perspective is preferred in many countries. In Vietnam, in the first step to approaching health economics in the decision-making process, the use of the healthcare payers' perspective is encouraged. Therefore, this study is suitable for the Vietnamese context.

CONCLUSIONS

Ticagrelor can be considered a cost-effective treatment for patients with ACS compared to clopidogrel from a Vietnamese healthcare payers' perspective based on the results of the PLATO trial.

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Data Availability. The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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