Review Article

Simultaneous acute cardio-cerebral infarction: is there a consensus for management?

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Abstract: Acute ischemic stroke (AIS) and acute myocardial infarction (AMI) are both life-threatening medical conditions with narrow therapeutic time-window that carry grave prognosis if not addressed promptly. The acute management of both condition is well documented in the literature, however the management of a simultaneous presentation of both AIS and AMI is unclear. A delayed intervention of one infarcted territory for the other may result in permanent irreversible morbidity or disability, and even death. In addition, the use of antiplatelet and anticoagulants that are inherently part of an AMI management may increase the risk for hemorrhagic conversion associated with intravenous thrombolysis used in AIS, and the use of a thrombolytic in AIS increases the risk of cardiac wall rupture in the setting of an AMI. Despite this ambiguity, there is no clear evidence-based guideline or clinical studies that have addressed the optimal management of this rare co-occurrence. This review paper examines the existing literature on the management of simultaneous acute cardio-cerebral infarction (CCI) and highlights the existing challenge to management.

Keywords: Acute stroke; endovascular procedure; myocardial infarction; percutaneous transluminal coronary angioplasty (PTCA); thrombectomy

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Introduction

Acute ischemic stroke (AIS) and acute myocardial infarction (AMI) are both life-threatening medical conditions that carry grave prognosis if not addressed promptly. The association between both conditions was recognized few decades ago from several studies, including a 3-year prospective study of AIS patients admitted to the geriatric unit (1). The study showed that 12.7% of these patients had associated AMI within 72 hours of admission. Over the years, the awareness of this association has increased, and the acute management of a metachronous presentation (infarction of one vascular territory precedes the other) of both conditions has obviously focused on the preceding event, with appropriate management of the subsequent event when it occurs. However, the approach to the immediate management of a simultaneous occurrence of both AIS and AMI, especially ST elevation myocardial infarction (STEMI), is unclear, and there is no clear evidence-based guideline or clinical studies that have addressed the optimal management of this rare co-occurrence.

Cardio-cerebral infarction (CCI), a term introduced by Omar *et al.* in 2010 (2), was used to describe the simultaneous occurrence of AIS and AMI. It is infrequently encountered, and poses a management challenge for physicians, and an increased risk of mortality for the patient. Both conditions have a narrow therapeutic time-window, such that acute management of one at the expense of the other may result in permanent irreversible disability from the infarcted area that received delayed intervention. In addition, the

use of antiplatelet and anticoagulants that are inherently part of a percutaneous coronary intervention (PCI) for AMI may increase the risk for hemorrhagic conversion associated with intravenous thrombolysis (3,4), and the use of a thrombolytic in AIS increases the risk of cardiac wall rupture in the setting of AMI (5). In fact, according to the guidelines for the early management of patients with AIS, AMI within the past 3 months is considered a relative contraindication to the use of a thrombolytic (*Class IIb*, *level of evidence C*) (6).

The present review examines the epidemiology, pathophysiology, and management of CCI in reported cases and case series, and the current existing literature.

Epidemiology

Early observation of an association between cerebrovascular disease and coronary artery disease (CAD) were reported in the literature in the 1970 and 1980s through both observational and prospective studies. In a prospective study published in 1984, Rokey *et al.* (7) reported the prevalence of CAD as 58% among patients presenting with transient ischemic attack and AIS compared with 7% in other age-matched patients in the same institution. Evidence over the years has subsequently reported the association between AIS and AMI. Chin *et al.* (1) reported the incidence of CCI as 12.7% in geriatric patients who were screened for AMI within 72 hours of admission for acute stroke. Findings from the Global Registry of Acute Coronary Event (GRACE) trial reported an incidence of in-hospital stroke as 0.9% in a cohort of patients presenting with acute coronary syndrome, and the incidence was much higher in patients with STEMI than the non-STEMI (8).

The reported prevalence and incidence have mostly been for the metachronous presentation of CCI. The incidence of a simultaneous CCI is currently unknown due to the rarity of this co-occurrence. The available evidence about this rare presentation has been mostly from reported case reports and case series. In their review paper, Yeo *et al.* (9) reported that 6% of patients with acute stroke had ST segment elevation, but a closer look at the cited study (10) showed that none of these patients with ST segment elevations had dynamic changes consistent with evolving MI on serial electrocardiogram, nor were the creatine phosphokinase levels higher than patients without ST elevations, therefore rendering the inference of AMI incidence in the setting of acute stroke from this study unreliable. An autopsy on a patient with anterior ST elevation in setting of subarachnoid hemorrhage in this study however revealed focal areas of myocardial necrosis.

Pathogenesis of CCI

There are several mechanisms reported in the literature that explain the occurrence of CCI. AMI, especially anterior and apical wall infarction associated with reduced left ventricular systolic function provide a substrate for the formation of left ventricular mural thrombus (11). These post AMI thrombi are particularly prone to increased risk of embolization (12,13), and may explain simultaneous CCI. The presence of a severely hypokinetic left ventricular myocardium segment also increases the risk of thrombus formation (14,15) which may embolize simultaneously to both coronary and cerebral arteries. Embolization to the coronary and cerebral arteries have also been reported in patients with atrial fibrillation (16), and likewise is the possibility of a paradoxical embolus of a right ventricular thrombus or a deep vein thrombosis through a patent foramen ovale (17,18).

The occurrence of a sudden hemodynamic compromise in patients presenting with AMI and long standing history of hypertension may result in reduction of cerebral blood flow to water-shed areas of the brain and subsequent infarction, especially if there is a failure of blood pressure auto-regulatory mechanisms (2). This mechanism was supported by a recent study that reported an association between hypotensive episodes and border zone cerebral infarction despite the patients being normotensive or hypertensive at baseline (19). In a study evaluating the relationship between low-normal systolic blood pressure levels (<120 mmHg) and the risk of recurrent stroke in patients with recent non cardio-embolic ischemic stroke, there was increased risk of recurrent stroke in patients with low-normal systolic blood pressure compared to normotensive patients (20).

Also, the extension of an ascending aortic dissection to the coronary ostia and a subsequent extension to the carotid or the vertebral and basilar arteries may explain the simultaneous occurrence of a cerebral and a coronary infarction. The occurrence of both events with ascending aortic dissection is rare but cases have been reported (21) and ascending aortic dissection remains a significant differential diagnosis in patients presenting with simultaneous CCI.

Other potential mechanism of a CCI is an AIS involving the left insular cortex. A prospective study of 32 patients with left insular stroke compared with 84 patients that had non-insular stroke, adverse cardiac outcomes, including myocardial infarction were higher in the left insular

stroke group (22). Left insular damage is thought to impair sympatho-vagal balance resulting in cardiac arrhythmias and wall motion abnormalities. In a similar fashion, adrenergic surge associated with AIS may result in catecholamine-induced myocardial stunning, a common cause of stress-induced cardiomyopathy (Takotsubo syndrome) that may mimic ST elevation AMI, and in turn favors formation of intra-cardiac thrombus that may embolize to the cerebral (23) and coronary arteries.

Management of simultaneous CCI

Simultaneous CCI is a rare presentation associated with increased risk of mortality but poses a management challenge for physicians. Both AMI, especially STEMI and AIS have a narrow therapeutic time-window, and a delayed intervention of one infarcted territory for the other may result in permanent irreversible morbidity or disability and even death. In addition to the dilemma of the sequence of management, the agents of management for each territory may complicate the extent of the other infarcted territory. Antiplatelet therapy (3,24,25), GPIIa/IIIb inhibitors (26) and anticoagulants (4) used in coronary intervention for AMI increase the risk for hemorrhagic conversion of AIS associated with thrombolytic, and the use of a thrombolytic in AIS increases the risk of cardiac wall rupture in setting of AMI (5). There are no clinical trials that have addressed this dilemma likely due to its rarity, and there are also no evidenced-based societal guidelines on the sequence of approach to management. Complicating the decision making process is the fact that the use of thrombolytic (a therapeutic option for both vascular territories) in AIS is relatively contraindicated if there is AMI within the past 3 months (6). However, this recommendation (*Class IIb*; *Level of evidence C*) is not evidenced-based (27) and the American Heart Association/American Stroke Association recommend further study of these circumstances (6). Moreover, several studies have reported higher risk of cardiac rupture with thrombolytic (28,29) but the risk is minimal (approximately 1%) according to a larger study, with old age, anterior wall AMI, female sex and increased time from symptom onset to treatment being predictors of cardiac wall rupture (5). Two large studies of thrombolysis for AIS, the Simplified Management of Acute Stroke using Revised Treatment (SMART) (30) and Safe Implementation of Thrombolysis in Stroke-Monitoring Study (SITS-MOST) (31) did not exclude patients with recent AMI, and there was no reported significant difference in outcomes between patients with and without AMI.

There are several anecdotal reports of simultaneous CCI with varying approach to management. Omar *et al.* (2) reported a 48-year-old patient presenting with infero-posterior and right ventricular transmural AMI and a massive cerebral infarction immediately after admission to the emergency room. Thrombolytic therapy was not administered because the calculated (National Institute of Health Stroke Scale) NIHSS score was >25, and primary percutaneous transluminal coronary angioplasty (PTCA) was not done due to patient's bad prognosis. The patient was treated conservatively with antiplatelet and anticoagulants but expired the second day. Maciel *et al.* (32) reported a 44-year-old male presenting with AIS and a NIHSS score of 11, and found to have an inferior AMI with a 2:1 atrioventricular block. The patient was treated with intravenously administered tissue plasminogen activator (0.9 mg/kg over 1 hour, total dose 80 mg) with improvement in the NIHSS score to 4. The transthoracic echocardiogram revealed the expansion of the infarcted territory to the right ventricle but without cardiac tamponade or depressed systolic function. The patient however had recurrent episodes of malignant refractory arrhythmias including ventricular fibrillation requiring multiple resuscitation efforts. He was discharged home with the degree of disability reported as Rankin 2 at 6 months after the stroke. Another case report described a 53-year-old male that presented with AIS due to left proximal middle cerebral artery (MCA) occlusion (NIHSS score of 23) and also found to have new onset atrial fibrillation and ST elevations in V2–V5 (9). He had refractory hypertension with blood pressure of 230/130 mmHg which precluded the use of intravenous thrombolysis, in addition to previously known occipital tricholemmal tumor. Due to the on-site availability of an interventional cardiologist, PCI and stenting of mid left anterior descending artery was done followed by endovascular embolectomy of MCA with solitaire device after the arrival of an interventional neuro-radiologist on site. Patient was wheelchair bound with expressive aphasia at 3 months. These case reports highlight the need to individualize treatment in patients presenting with simultaneous CCI.

The ideal management of simultaneous CCI is a treatment strategy that benefits both vascular territories. An important deciding factor in approach to management is the presentation of AMI. Simultaneous CCI with STEMI poses the greatest management challenge, and the management options suggested in present article will be more beneficial for simultaneous presentation of AIS and

STEMI. Intravenous thrombolysis, approved for the acute management of both conditions has been suggested as the best approach to the treatment of simultaneous CCI if there is no contraindication, and both presentations are within the time frame for the administration of a thrombolytic. Omar and colleague (2) who first described the term CCI in 2010 as a possible but rare association between the two pathologies rather than a mere coincidence suggest intravenous thrombolysis as a treatment option for both infarcted cerebral and coronary arteries, although this has not been studied in clinical trials nor supported by any societal guidelines (33). The challenge to this management approach is the different dosage and duration of thrombolytic administration recommended for treatment of acute infarction of these vascular territories. The American Stroke Association recommended 0.9 mg/kg (maximum of 90 mg) of intravenous alteplase (a recombinant tissue plasminogen activator (IV-tPA) approved for both presentations) to be infused for 60 minutes for selected patients who may be treated within 3 hours of ischemic stroke onset, with 10% of the total dose administered as an initial intravenous bolus for 1 min (33,34). An intravenous bolus of alteplase 15 mg followed by infusion of 0.75 mg/kg for 30 minutes (maximum 50 mg), then 0.5 mg/kg (maximum 35 mg) over the next 60 minutes, not to exceed a total of 100 mg can be given up to 12 hours for qualifying AMI presentations (35). The lack of a clear guideline on the unifying dose for simultaneous CCI is a source of great controversy due to the fact that studies have shown an increased risk of hemorrhagic conversion of AIS when thrombolytics are administered at higher doses (36-38), and administration of lower than recommended dose of a thrombolytic for AMI may be considered under-dosing (9).

A combined endovascular approach with the use of PTCA for AMI and thrombectomy devices for AIS have been suggested (9). Advantages of this approach include the visualization of both coronary and cerebral artery occlusions which confirms a definite CCI diagnosis, and the effectiveness in treating a proximal cerebral artery occlusion which carries significantly lower mortality than intravenous thrombolysis alone (9,39). While most clinical trials on endovascular therapy in AIS required the administration of IV-tPA alongside the use of endovascular therapy (40,41), the subgroup analysis of some clinical trials revealed that patients who received thrombectomy therapy without IV-tPA (due to contraindications) gained functional independence and had higher rates of recovery than patients receiving IV-tPA with endovascular therapy (42,43). Likewise, PCI is preferred over thrombolysis for AMI (35). However, the use of adjunctive antiplatelet therapy with PCI poses a significant risk of bleeding with endovascular treatment for AIS. There are presently no clinical trials evaluating the safety, outcomes and the role of dual antiplatelet therapy with endovascular treatment for AIS, but a retrospective study conducted by Broeg-Morvay *et al.* (44), evaluating the use of aspirin + IV-tPA + endovascular therapy versus IV-tPA + endovascular therapy without aspirin showed no increase in intracranial hemorrhage between the groups, and outcomes at 3 months did not differ. Further trials are needed to assess the safety of antiplatelet therapies with cerebral endovascular procedures.

The statement from the American Heart Association/American Stroke Association on the scientific rationale for the inclusion and exclusion criteria for IV-tPA in AIS recommended treatment with IV-tPA at the dose appropriate for AIS, followed by PTCA and stenting if indicated (*Class IIa*, *Level of Evidence C*), based on the fact that pretreatment with IV-tPA does not decrease the coronary benefit of PTCA and stenting (34). This statement however was silent on the use of antiplatelet therapy with IV-tPA in the setting of simultaneous CCI. It recommended against starting antiplatelet (mono- or dual-therapy) or glycoprotein IIb/IIIa inhibitors in addition to IV-tPA in isolated AIS cases. Several studies have suggested increased risk of intracranial hemorrhage with the use of antiplatelet, especially dual antiplatelet therapy with IV-tPA, but have not shown to adversely influence clinical outcome (45-48). The increased risk of intracranial hemorrhage with these antiplatelet is likely balanced by the beneficial effect of increased reperfusion or decreased risk of vessel re-occlusion, and these antiplatelets may not by themselves increase the risk of intracranial hemorrhage but makes one worse if it occurs (47). Dual antiplatelet therapy is also not an exclusion for IV-tPA administration.

A reasonable approach to the acute management of simultaneous CCI is a combined treatment of both vascular territories with administration of IV-tPA at 0.9 mg/kg (maximum of 90 mg) infused for 60 minutes, with 10% of the total dose administered as an initial intravenous bolus for 1 min, followed by PTCA with possible PCI if indicated. The need for a cerebral endovascular procedure can then be assessed by a cerebral angiogram. It is important to exclude the possibility of an aortic dissection extending to both the coronary ostia and the carotid or vertebral and basilar arteries.

Conclusions

There is presently no clinical trial or a consensus guideline for the management of simultaneous CCI. There is need to identify a unifying dose of intravenous thrombolytic, the optimal duration of administration, the role of antiplatelets and combined percutaneous coronary and cerebral endovascular procedures. However, given the current knowledge limitations, the approach to management should be individualized as outlined above. We propose the establishment of a national registry for simultaneous CCI presentation to facilitate a consensus statement on the optimal approach to management.

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Footnote

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References

1. Chin PL, Kaminski J, Rout M. Myocardial infarction coincident with cerebrovascular accidents in the elderly. Age Ageing 1977;6:29-37.
2. Omar HR, Fathy A, Rashad R, et al. Concomitant acute right ventricular infarction and ischemic cerebrovascular stroke; possible explanations. Int Arch Med 2010;3:25.
3. Zinkstok SM, Roos YB. Early administration of aspirin in patients treated with alteplase for acute ischaemic stroke: A randomised controlled trial. Lancet 2012;380:731-7.
4. Sandercock PA, Counsell C, Kane EJ. Anticoagulants for acute ischaemic stroke. Cochrane Database Syst Rev 2015;(3):CD000024.
5. Patel MR, Meine TJ, Lindblad L, et al. Cardiac tamponade in the fibrinolytic era: analysis of >100,000 patients with ST-segment elevation myocardial infarction. Am Heart J 2006;151:316-22.
6. Jauch EC, Saver JL, Adams HP Jr, et al. Guidelines for the early management of patients with acute ischemic stroke: a guideline for healthcare professionals from the American heart association/American stroke association. Stroke 2013;44:870-947.
7. Rokey R, Rolak LA, Harati Y, et al. Coronary artery disease in patients with cerebrovascular disease: a prospective study. Ann Neurol 1984;16:50-3.
8. Budaj A, Flasinska K, Gore JM, et al. Magnitude of and risk factors for in-hospital and postdischarge stroke in patients with acute coronary syndromes: Findings from a global registry of acute coronary events. Circulation 2005;111:3242-7.
9. Yeo LL, Andersson T, Yee KW, et al. Synchronous cardiocerebral infarction in the era of endovascular therapy: Which to treat first? J Thromb Thrombolysis 2017;44:104-11.
10. Goldstein DS. The electrocardiogram in stroke: Relationship to pathophysiological type and comparison with prior tracings. Stroke 1979;10:253-9.
11. Gianstefani S, Douiri A, Delithanasis I, et al. Incidence and predictors of early left ventricular thrombus after ST-elevation myocardial infarction in the contemporary era of primary percutaneous coronary intervention. Am J Cardiol 2014;113:1111-6.
12. Delewi R, Zijlstra F, Piek JJ. Left ventricular thrombus formation after acute myocardial infarction. Heart 2012;98:1743-9.
13. Vaitkus PT, Barnathan ES. Embolic potential, prevention and management of mural thrombus complicating anterior myocardial infarction: A meta-analysis. J Am Coll Cardiol 1993;22:1004-9.
14. Loh E, Sutton MSJ, Wun CC, et al. Ventricular dysfunction and the risk of stroke after myocardial infarction. N Engl J Med 1997;336:251-7.
15. Warsz-Wianecka A, Mizia-Stec K, Lasek-Bal A, et al. Segmental left ventricular hypokinesis is associated with embolic signals in transcranial doppler. Pol Arch Med Wewn 2012;122:531-6.
16. Chlapoutakis GN, Kafkas NV, Katsanos SM, et al. Acute myocardial infarction and transient ischemic attack in a patient with lone atrial fibrillation and normal coronary arteries. Int J Cardiol 2010;139:e1-e4.
17. Kleber FX, Hauschild T, Schulz A, et al. Epidemiology of myocardial infarction caused by presumed paradoxical embolism via a patent foramen ovale. Circ J 2017;81:1484-9.
18. Steiner MM, Di Tullio MR, Rundek T, et al. Patent foramen ovale size and embolic brain imaging findings among patients with ischemic stroke. Stroke 1998;29:944-8.
19. Ryan DJ, Kenny RA, Christensen S, et al. Ischaemic stroke or TIA in older subjects associated with impaired dynamic blood pressure control in the absence of severe large artery stenosis. Age Ageing 2015;44:655-61.
20. Ovbiagele B. Low-normal systolic blood pressure and secondary stroke risk. J Stroke Cerebrovasc Dis

2013;22:633-8.
21. Kawano H, Tomichi Y, Fukae S, et al. Aortic dissection associated with acute myocardial infarction and stroke found at autopsy. Intern Med 2006;45:957-62.
22. Laowattana S, Zeger SL, Lima JA, et al. Left insular stroke is associated with adverse cardiac outcome. Neurology 2006;66:477-83; discussion 463.
23. Bersano A, Melchiorre P, Moschwitis G, et al. Tako-tsubo syndrome as a consequence and cause of stroke. Funct Neurol 2014;29:135-7.
24. Lee M, Saver JL, Hong K, et al. Risk–benefit profile of long-term dual-versus single-antiplatelet therapy among patients with ischemic stroke. a systematic review and meta-analysis. Ann Intern Med 2013;159:463-70.
25. Luo S, Zhuang M, Zeng W, et al. Intravenous thrombolysis for acute ischemic stroke in patients receiving antiplatelet therapy: a systematic review and meta-analysis of 19 studies. J Am Heart Assoc 2016;5:10.
26. Ciccone A, Abraha I, Santilli I. Glycoprotein IIb-IIIa inhibitors for acute ischaemic stroke. Cochrane Database Syst Rev 2006;(4):CD005208.
27. De Silva DA, Manzano JJ, Chang HM, et al. Reconsidering recent myocardial infarction as a contraindication for IV stroke thrombolysis. Neurology 2011;76:1838-40.
28. Bueno H, Martínez-Sellés M, Pérez-David E, et al. Effect of thrombolytic therapy on the risk of cardiac rupture and mortality in older patients with first acute myocardial infarction. Eur Heart J 2005;26:1705-11.
29. Chang RY, Tsai HL, Hsiao PG, et al. Comparison of the risk of left ventricular free wall rupture in taiwanese patients with ST-elevation acute myocardial infarction undergoing different reperfusion strategies: A medical record review study. Medicine (Baltimore) 2016;95:e5308.
30. Laino C. More relaxed tPA criteria increases pool of eligible patients, with good outcomes. Neurology Today 2010;10:8-9.
31. Wahlgren N, Ahmed N, Dávalos A, et al. Thrombolysis with alteplase for acute ischaemic stroke in the safe implementation of thrombolysis in stroke-monitoring study (SITS-MOST): An observational study. Lancet 2007;369:275-82.
32. Maciel R, Palma R, Sousa P, et al. Acute stroke with concomitant acute myocardial infarction: Will you thrombolyse? J Stroke 2015;17:84-6.
33. Omar HR, Mangar D, Camporesi EM. Simultaneous thrombosis of 2 vascular territories: Is thrombolytic therapy a better option? Am J Emerg Med 2013;31:1412-3.
34. Demaerschalk BM, Kleindorfer DO, Adeoye OM, et al. Scientific rationale for the inclusion and exclusion criteria for intravenous alteplase in acute ischemic stroke: a statement for healthcare professionals from the American heart association/American stroke association. Stroke 2016;47:581-641.
35. American College of Emergency Physicians, Society for Cardiovascular Angiography and Interventions, O'Gara PT, et al. 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction: A report of the american college of cardiology foundation/american heart association task force on practice guidelines. J Am Coll Cardiol 2013;61:e78-140.
36. Álvarez-Sabín J, Maisterra O, Santamarina E, et al. Factors influencing haemorrhagic transformation in ischaemic stroke. Lancet Neurol 2013;12:689-705.
37. Brott TG, Haley EC Jr, Levy DE, et al. Urgent therapy for stroke. part I. pilot study of tissue plasminogen activator administered within 90 minutes. Stroke 1992;23:632-40.
38. Messé SR, Tanne D, Demchuk AM, et al. Dosing errors may impact the risk of rt-PA for stroke: The multicenter rt-PA acute stroke survey. J Stroke Cerebrovasc Dis 2004;13:35-40.
39. Dalyai RT, Chalouhi N, Singhal S, et al. Stent-assisted endovascular recanalization of extracranial internal carotid artery occlusion in acute ischemic stroke. World Neurosurg 2013;79:143-8.
40. Campbell BC, Mitchell PJ, Kleinig TJ, et al. Endovascular therapy for ischemic stroke with perfusion-imaging selection. N Engl J Med 2015;372:1009-18.
41. Saver JL, Goyal M, Bonafe A, et al. Stent-retriever thrombectomy after intravenous t-PA vs. t-PA alone in stroke. N Engl J Med 2015;372:2285-95.
42. Goyal M, Demchuk AM, Menon BK, et al. Randomized assessment of rapid endovascular treatment of ischemic stroke. N Engl J Med 2015;372:1019-30.
43. Jovin TG, Chamorro A, Cobo E, et al. Thrombectomy within 8 hours after symptom onset in ischemic stroke. N Engl J Med 2015;372:2296-306.
44. Broeg-Morvay A, Mordasini P, Slezak A, et al. Does antiplatelet therapy during bridging thrombolysis increase rates of intracerebral hemorrhage in stroke patients? PloS One 2017;12:e0170045.
45. Bravo Y, Marti-Fabregas J, Cocho D, et al. Influence of antiplatelet pre-treatment on the risk of symptomatic intracranial haemorrhage after intravenous thrombolysis. Cerebrovasc Dis 2008;26:126-33.
46. Uyttenboogaart M, Koch MW, Koopman K, et al. Safety

of antiplatelet therapy prior to intravenous thrombolysis in acute ischemic stroke. Arch Neurol 2008;65:607-11.
47. Cucchiara B, Kasner SE, Tanne D, et al. Factors associated with intracerebral hemorrhage after thrombolytic therapy for ischemic stroke: Pooled analysis of placebo data from the stroke-acute ischemic NXY treatment (SAINT) I and SAINT II trials. Stroke 2009;40:3067-72.
48. Dowlatshahi D, Hakim A, Fang J, et al. Pre admission antithrombotics are associated with improved outcomes following ischaemic stroke: A cohort from the registry of the Canadian stroke network. Int J Stroke 2009;4:328-34.

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