DR. NICOLAS MARTINEZ-MAJANDER (Orcid ID : 0000-0001-8489-7051)

DR. GEORGE NTAIOS (Orcid ID : 0000-0002-0629-9248)

DR. SALVATORE RUDILOSSO (Orcid ID : 0000-0002-8775-6884)

DR. LUIS PRATS-SÁNCHEZ (Orcid ID : 0000-0002-3192-4631)

Article type : Original Article

RIVAROXABAN VERSUS ASPIRIN FOR SECONDARY PREVENTION OF ISCHEMIC STROKE IN PATIENTS WITH CANCER: A SUBGROUP ANALYSIS OF THE NAVIGATE ESUS RANDOMIZED TRIAL

Nicolas Martinez-Majander, MD[1]; George Ntaios, MD[2]; Yan Yun Liu, MD[3]; Pauli Ylikotila, MD[4]; Heikki Joensuu, MD[5]; Jukka Saarinen, MD[6]; Kanjana Perera, MD[3]; Joan Marti-Fabregas, MD[7]; Angel Chamorro, MD[8]; Salvatore Rudilosso, MD[8]; Luis Prats-Sanchez, MD[7]; Scott D. Berkowitz, MD[9]; Hardi Mundl, MD[10]; Ellison Themeles, MD[3]; Marjaana Tiainen, MD[1]; Andrew Demchuk, MD[11]; Scott E. Kasner, MD[12]; Robert G Hart, MD[3]; Turgut Tatlisumak, MD[13,14], on behalf of the NAVIGATE ESUS Investigators*

*NAVIGATE ESUS Investigators are listed in an appendix in the article reporting main results of the trial (DOI: 10.1056/NEJMoa1802686)

[1]Department of Neurology, Helsinki University Central Hospital, Helsinki, Finland

[2]Department of Internal Medicine, University of Thessaly, Larissa, Greece

[3]Population Health Research Institute, McMaster University, Hamilton, Ontario, Canada

[4]Division of Clinical Neurosciences, Turku University Hospital, Turku, Finland.

[5]Department of Oncology, Helsinki University Hospital, Helsinki, Finland

[6]Department of Neurology, Vaasa Central Hospital, Vaasa, Finland

[7]Department of Neurology, Hospital de la Santa Creu i Sant Pau, Biomedical Research Institute, IIB-Sant Pau, Barcelona, Spain

[8]Department of Neuroscience, Comprehensive Stroke Center, Hospital Clinic, University of Barcelona, Spain

[9]Bayer U.S., LLC, Whippany, New Jersey, USA

[10]Bayer Pharma AG, Wuppertal, Germany

[11]Calgary Stroke Program, Departments of Clinical Neuroscience and Radiology and Hotchkiss Brain Institute, University of Calgary, Calgary, Alberta, Canada

[12]Department of Neurology, University of Pennsylvania, Philadelphia, PA, USA

[13]Department of Neurology, Sahlgrenska University Hospital, Gothenburg, Sweden

[14]Department of Clinical Neuroscience, Institute of Neuroscience and Physiology, Sahlgrenska Academy at University of Gothenburg, Gothenburg, Sweden

Correspondence to: Nicolas Martinez-Majander, Helsinki University Central Hospital, Haartmaninkatu 4, 00290 Helsinki, Finland; Tel: +358947172662, E-mail: nicolas.martinez-majander@hus.fi

Running title: Cancer patients in the NAVIGATE ESUS trial

Words: 3499

Tables/figures/supplementary tables/references: 3/1/2/22

Keywords: ischemic stroke, cancer, aspirin, rivaroxaban, ESUS, NAVIGATE ESUS

ABSTRACT

Background: Cancer is a frequent finding in ischemic stroke patients. We investigated the frequency of cancer among participants in NAVIGATE ESUS randomized trial and the distribution of outcome events during treatment with aspirin and rivaroxaban.

Methods: Trial participation required a recent embolic stroke of undetermined source (ESUS). Patients´ history of cancer was recorded at time of study entry. During a mean follow-up of 11 months, the effects of aspirin and rivaroxaban treatment on recurrent ischemic stroke, major bleeding, and all-cause mortality were compared between patients with cancer and without cancer.

Results: Among 7213 randomized patients, 543 (7.5%) had cancer. Of all patients, 3609 were randomized to rivaroxaban (254[7.0%] with cancer) and 3604 patients to aspirin (289[8.0%] with cancer). The annual rate of recurrent ischemic stroke was 4.5% in non-cancer patients in rivaroxaban arm and 4.6% in the aspirin arm (hazard ratio, HR 0.98 [95% CI 0.78-1.24]). In cancer patients, the rate of recurrent ischemic stroke was 7.7% in the rivaroxaban arm and 5.4% in the aspirin arm (HR 1.43 [95% CI 0.71-2.87]). Among cancer patients, the annual rate of major bleeds was nonsignificantly higher for rivaroxaban than aspirin (2.9% versus 1.1%; HR 2.57 [95% CI 0.67-9.96], *P* for interaction 0.95). All-cause mortality was similar in both groups.

Conclusions: Our exploratory analyses show that patients with ESUS and a history of cancer had similar rates of recurrent ischemic strokes and all-cause mortality during aspirin and rivaroxaban treatments and that aspirin appeared safer than rivaroxaban in cancer patients regarding major bleeds. www.clinicaltrials.gov(NCT02313909).

Embolic stroke of undetermined source (ESUS) is a subset of cryptogenic stroke, and a diagnostic label proposed for an ischemic stroke that occurs without an identifiable and specifically treatable underlying stroke etiology [1]. The New Approach riVaroxaban Inhibition of Factor Xa in a Global trial vs. ASA to prevenT Embolism in Embolic Stroke of Undetermined Source (NAVIGATE ESUS) trial is an international randomized phase III trial. The design of the trial and the baseline characteristics of the 7213 enrolled individuals have recently been reported [2,3]. Rivaroxaban was not superior to aspirin in preventing recurrent ischemic strokes in the NAVIGATE ESUS trial [4]. Moreover, it was associated with a higher risk of bleeding [4]. While the NAVIGATE ESUS participants share a common diagnosis of ischemic stroke and ESUS, they vary with respect to the underlying potential embolic sources.

Previous studies have demonstrated a correlation between cancer and hypercoagulability, an important factor predisposing not only to ischemic stroke but also other thromboembolisms [5,6]. The prevalence of prior cancer can be up to 16% in ischemic stroke patients [7]. Moreover, a nation-wide US-based study reported that 10% of hospitalized ischemic stroke patients had comorbid cancer [8]. Several factors such as elevated D-dimer and specific cancer types are associated with recurrent strokes [9,10]. Not surprisingly, both short-term and long-term overall mortality are higher in stroke patients with active cancer [11,12]. Patients with lung cancer showed a doubled risk for ischemic stroke within 1 year of cancer diagnosis compared to matched controls, and the highest risk for ischemic stroke was in patients with very advanced cancer reaching a 10-fold risk compared to controls [13]. Embolic strokes are the commonest type of stroke in this patient group [14], while also cancer-associated cryptogenic stroke might be associated with reduced survival [15]. Active cancer can also predispose to intracranial hemorrhage, often from unique mechanisms such as intratumoral hemorrhage or coagulopathy [16].

The optimal secondary prevention in cancer patients with acute ischemic stroke has been unclear with a few studies demonstrating reduction in recurrent events, D-dimer levels, and transcranial Doppler microembolism with anticoagulant treatment [17]. However, increased risk of bleeding might outweigh these potential benefits. Thus, both the high prevalence of cancer among ischemic stroke patients and the several-fold risk of stroke in cancer patients lead to the important question of optimal long-term antithrombotic treatment in this subgroup of patients. Here, in a post-hoc exploratory analysis of the large NAVIGATE ESUS trial we investigated the baseline characteristics of participants with a history of cancer and the differences of outcome events under rivaroxaban or aspirin treatment.

PATIENTS AND METHODS

The design of NAVIGATE ESUS trial (clinicaltrials.gov.NCT02313909) and the characteristics of the trial patient population have been described previously [2,3]. Briefly, the NAVIGATE ESUS trial is an international randomized phase III trial comparing rivaroxaban (an oral factor Xa inhibitor) versus aspirin in patients with recent ESUS. After qualifying for ESUS according to the trial protocol, the patients were enrolled no later than six months after the index stroke, and randomized to receive either rivaroxaban 15 mg or aspirin 100 mg once daily.

In addition to relevant baseline characteristics, a history of cancer was solicited, the type of cancer, and whether the diagnosis was made within the previous year before the date of randomization or earlier. Of note, life expectancy of <6 months was an exclusion criterion in the trial. The diagnosis and the type of cancer were based mainly on participant self-report and were not confirmed. No information about staging or anti-cancer treatment were collected. Because superficial skin cancers are not expected to present an increased risk for recurrent ischemic strokes, major bleeding, or death, these patients were grouped together with non-cancer patients. Definitions of relevant outcomes were described previously [2].

In our study, we compared the baseline characteristics and the annual rate of recurrent ischemic strokes, major bleeds, self-reported quality-of-life measured with a five-dimensional three-level generic measure (EQ-5D) recorded at the beginning and first recurrent ischemic stroke or end of the study, and all-cause mortality between cancer and non-cancer patients, as well as between cancer patients in the rivaroxaban and the aspirin arms.

Written informed consent was obtained from all participants. NAVIGATE ESUS has been approved by the local research ethics committees at each recruiting institution.

Statistical analyses

Normally distributed continuous variables are summarized using the mean and the standard deviation (SD), and comparisons between such variables were performed using the t-test. Non-normally distributed continuous variables are summarized using the median and the interquartile range (IQR), and the comparisons between such variables were performed using the Wilcoxon test. Frequency tables were analyzed with the Pearson Chi-square test or the Fisher's exact test as appropriate. Life tables regarding recurrent ischemic stroke, major bleeds, and overall survival between the treatment groups were analyzed using a Cox proportional-hazards model, the hazard ratio (HR) and the 95% confidence interval (CI) are reported. All tests are 2-sided and conducted at the 0.05 level of significance. All statistical analyses were conducted using the SAS 9.4 statistical package (SAS Institute Inc., Cary, North Carolina).

RESULTS

Baseline characteristics

We enrolled 7213 patients from 459 sites located in 31 countries between December 24, 2014 and September 20, 2017, of whom 543 (7.5%) had cancer (mean age, 72.1±8.2; 41% were females). The baseline characteristics of the whole study population have been reported in detail elsewhere [3]. Of them, 3609 patients were randomized to rivaroxaban (254 [7.0%] with cancer) and 3604 patients were randomized to aspirin (289 [8.0%] with cancer).

Frequent cancer types included prostate (107 [19.7%]), breast (101 [18.6%]), colon (66 [12.2%]), and lung (30 [5.5%]) cancers. Cancer was diagnosed less than one year prior to the index stroke in 49 (9%) cases. Most of the patients with prior cancer were recruited in the U.S.A., Canada, and Western Europe (Table 1).

Cancer patients were older, had a lower body mass index (BMI), and were less frequently current smokers than non-cancer patients. Moreover, they more often had infarcts in multiple vascular territories. Comparison between cancer and non-cancer patients showed no differences in sex (male 59% and 62%, P=0.1436, respectively) or in relevant comorbidities such as diabetes, heart failure, and previous TIA, but hypertension was slightly more frequent in non-cancer patients. The arterial territory of the index stroke was similar in both groups, but non-cancer patients had more subcortical infarcts as their only ischemic lesion. Furthermore, cancer patients had a lower NIHSS score at randomization but no difference in modified Rankin Scale. The self-reported health status, was also similar between the two groups. These comparisons are summarized in Table 1.

Baseline patient characteristics by the site of cancer

Comparisons according to the site of cancer showed that patients with lung cancer had been diagnosed in the last year more frequently and had more comorbidities [heart failure (13%) and prior stroke or TIA (30%)]. Lung cancer was associated with multiple ischemic lesions (27%), while colon cancer patients had more frequently anterior circulation strokes (80%). There were no differences in sex, other comorbidities, or the NIHSS score at randomization, or in the modified Rankin Scale score at randomization between subgroups of cancer patients. (Table 2).

Outcomes by the presence of cancer, duration of cancer diagnosis and treatment allocation

In non-cancer patients the annualized rate of recurrent ischemic stroke was 4.6% in the aspirin group and 4.5% in the rivaroxaban arm (HR 0.98, 95% CI 0.78-1.24), whereas in the subset of cancer patients the rate of recurrent ischemic stroke was 5.4% in the aspirin arm and 7.7% in the rivaroxaban arm (HR 1.43, 95% CI 0.71-2.87, *P*=0.31 for interaction) (Table 3). Cancer patients in the rivaroxaban arm had a nonsignificantly higher risk for major bleeding compared to the aspirin arm, similarly to the overall trial population (HR 2.57, 95% CI 0.67-9.96, *P* for interaction 0.9539). Finally, also all-cause mortality showed no difference between these subgroups (Table 3). The cumulative risks of these major outcomes are depicted in Figure 1. There was no association between the duration since cancer diagnosis and the recurrence rate of ischemic stroke (Table s1). The anatomic distribution of recurrent ischemic strokes did not differ between cancer and non-cancer patients. Furthermore, the difference between self-reported health status (EQ-5D score) at baseline and after first ischemic stroke was similar between cancer and non-cancer patients (Table s2). Cancer patients' health status was also similar between aspirin and rivaroxaban arms (Table s3).

Rate of new cancer diagnosis in ESUS patients

In the whole study population, 124 (1.7%) had a newly diagnosed cancer during the 11-month follow-up. Supplementary table s4 shows the frequency of newly diagnosed cancers during the 11-month follow-up in patients with no prior cancer history. Seventy (2.1%) patients in the rivaroxaban arm and 54 (1.6%) in the aspirin arm were diagnosed with a first-ever cancer and the rate of first recurrent ischemic stroke was similar in both treatment arms.

DISCUSSION

Our exploratory subgroup analyses suggest that ESUS patients with history of cancer did not receive additional benefit from rivaroxaban (an anticoagulant) for the prevention of recurrent ischemic strokes compared with aspirin (an antiplatelet agent), but as reported in the total population aspirin was safer regarding major bleedings. Overall mortality was similar in both treatment arms. Thus, the outcomes in this subgroup analysis of rivaroxaban compared to aspirin are consistent with the overall trial results.

The most frequent cancer types in our study were prostate, breast, colon, and lung cancers. Previous studies have shown the high frequency of these types, but also pancreatic cancer, in first-ever and recurrent strokes [5,9,10,14]. Cancer patients had more frequently multiple acute cerebral ischemic lesions, which is also supported by previous studies [14,18]. Patients with cancer were also older than non-cancer patients and they were less frequently current smokers, but no other relevant differences were seen in other comorbidities between cancer and non-cancer patients except for a slightly higher prevalence of hypertension in the latter group. Non-cancer patients also had a higher NIHSS score at randomization but no difference in modified Rankin Scale. A history of cancer was not an independent predictor of a higher rate of recurrent ischemic stroke after adjustment for age and other factors [19]. Interestingly, self-reported health status EQ-5D score data collected at baseline did not differ between cancer and non-cancer patients probably reflecting that a major portion of the patients with cancer were already healed or under control with treatment and that the patients with cancer and expectedly poor prognosis were left out of the study.

Our study suggests that there was no difference in cancer patients' rate of recurrent ischemic stroke between the rivaroxaban and aspirin arms, which is in agreement with the results of the overall NAVIGATE ESUS population [4]. Also, patients with ESUS and cancer had similar serious complications and all-cause mortality under rivaroxaban and aspirin and treatments compared to the overall population, but showed a higher rate of major bleeds in the rivaroxaban arm. The difference did not reach significance in patients with cancer, but is in line with the total population.

Only a few previous studies have compared antithrombotic treatments in stroke patients with cancer. The TEACH pilot trial randomized 20 cancer patients to enoxaparin or aspirin arms and showed no differences in the cumulative rates of major bleeding, thromboembolic events and survival between the groups [20]. Furthermore, a recent study comparing direct oral anticoagulants and low-molecular-weight heparin in treatment of 48 cryptogenic ischemic stroke patients with active cancer also showed similar clinical outcomes between the treatment arms [21]. However, these studies were limited by their small size. Jang et al found in a retrospective single center observational study that enoxaparin may be more effective for

lowering the serum D-dimer levels compared to warfarin in patients with cancer-associated strokes, but no difference was seen in the rates of major bleeding [22]. In our study, both treatment arms had a similar frequency of newly diagnosed cancers during the 11-month follow-up. All new cancers were reported as adverse events in trial, but we did not have data on cancer stage or treatments.

The most notable strength of our study is the large size of the cohort in an international randomized phase III trial. Furthermore, it is one of the largest studies comparing secondary preventive strategies in ischemic stroke patients. Data of prior cancers, primary events, serious complications, and new cancers were systematically reported by investigators. However, despite the large size of the NAVIGATE ESUS cohort, it represents patients who are willing, able, and invited to participate in a clinical trial and, therefore, may be subject to limitations on generalizability, both overall and within subgroups. Life expectancy less than 6 months was an exclusion criterion and probably excluded patients with pancreatic cancer and metastatic cancers already diagnosed at the randomization stage. Therefore, it is also possible that those patients who were included in the NAVIGATE ESUS trial had a less severe cancer or they were disease-free. This bias could be an additional explanation of the similar outcome between cancer and non-cancer patients. The diagnosis and the type of cancer were based on participant self-report and was not confirmed, and no information about cancer staging or anti-cancer treatment were collected. Further, diagnostic testing may affect outcome analysis as patients in higher income countries may have undergone more extensive pre-enrollment investigations than those in middle or lower income countries. We did not have data on specific biological markers, since additional blood samples were only rarely collected. Patients with venous thrombosis at baseline were also excluded due to the clear indication for anticoagulation.

This subgroup analysis of the NAVIGATE ESUS trial shows that the efficacy and safety profile of rivaroxaban compared with aspirin in ESUS patients with cancer was similar to the overall population of the trial. However, due to the limited number of endpoints in cancer patients leading to underpowered subgroup analyses, these results should be interpreted with caution. Results of this analysis could still be helpful for the design of future trials of thromboprophylaxis in patients with cancer, which is a population with simultaneously high thrombotic and high bleeding risk.

REFERENCES

1. Hart RG, Diener HC, Coutts SB, et al. Embolic strokes of undetermined source: the case for a new clinical construct. Lancet Neurol 2014;13:429-438.

2. Hart RG, Sharma M, Mundl H, et al. Rivaroxaban for secondary stroke prevention in patients with embolic strokes of undetermined source: Design of the NAVIGATE ESUS randomized trial. European Stroke Journal 2016;1:146-154.

3. Kasner SE, Lavados P, Sharma M, et al. Characterization of Patients with Embolic Strokes of Undetermined Source in the NAVIGATE ESUS Randomized Trial. J Stroke Cerebrovasc Dis 2018;27:1673-1682.

4. Hart RG, Sharma M, Mundl H, et al. Rivaroxaban for Stroke Prevention after Embolic Stroke of Undetermined Source. N Engl J Med 2018;378:2191-2201.

5. Schwarzbach CJ, Schaefer A, Ebert A, et al. Stroke and cancer: the importance of cancer-associated hypercoagulation as a possible stroke etiology. Stroke 2012;43:3029-3034.

6. Lip GY, Chin BS, Blann AD. Cancer and the prothrombotic state. Lancet Oncol 2002;3:27-34.

7. Selvik HA, Thomassen L, Logallo N, Naess H. Prior cancer in patients with ischemic stroke: the Bergen NORSTROKE study. J Stroke Cerebrovasc Dis 2014;23:919-925.

8. Sanossian N, Djabiras C, Mack WJ, Ovbiagele B. Trends in Cancer Diagnoses among Inpatients Hospitalized with Stroke. Journal of stroke and cerebrovascular diseases : the official journal of National Stroke Association 2013;22:1146-1150.

9. Navi BB, Singer S, Merkler AE, et al. Recurrent thromboembolic events after ischemic stroke in patients with cancer. Neurology 2014;83:26-33.

10. Navi BB, Reiner AS, Kamel H, et al. Association between incident cancer and subsequent stroke. Ann Neurol 2015;77:291-300.

11. Nam KW, Kim CK, Kim TJ, et al. Predictors of 30-day mortality and the risk of recurrent systemic thromboembolism in cancer patients suffering acute ischemic stroke. PLoS One 2017;12:e0172793.

12. Putaala J, Curtze S, Hiltunen S, Tolppanen H, Kaste M, Tatlisumak T. Causes of death and predictors of 5-year mortality in young adults after first-ever ischemic stroke: the Helsinki Young Stroke Registry. Stroke 2009;40:2698-2703.

13. Navi BB, Reiner AS, Kamel H, et al. Risk of Arterial Thromboembolism in Patients With Cancer. J Am Coll Cardiol 2017;70:926-938.

14. Cestari DM, Weine DM, Panageas KS, Segal AZ, DeAngelis LM. Stroke in patients with cancer: incidence and etiology. Neurology 2004;62:2025-2030.

15. Navi BB, Singer S, Merkler AE, et al. Cryptogenic subtype predicts reduced survival among cancer patients with ischemic stroke. Stroke 2014;45:2292-2297.

16. Velander AJ, DeAngelis LM, Navi BB. Intracranial hemorrhage in patients with cancer. Curr Atheroscler Rep 2012;14:373-381.

17. Seok JM, Kim SG, Kim JW, et al. Coagulopathy and embolic signal in cancer patients with ischemic stroke. Ann Neurol 2010;68:213-219.

18. Kim SG, Hong JM, Kim HY, et al. Ischemic stroke in cancer patients with and without conventional mechanisms: a multicenter study in Korea. Stroke 2010;41:798-801.

19. Hart RG, Veltkamp RC, Sheridan P, et al. Predictors of Recurrent Ischemic Stroke in Patients with Embolic Strokes of Undetermined Source and Effects of Rivaroxaban Versus Aspirin According to Risk Status: The NAVIGATE ESUS Trial. J Stroke Cerebrovasc Dis 2019;28:2273-2279.

20. Navi BB, Marshall RS, Bobrow D, et al. Enoxaparin vs Aspirin in Patients With Cancer and Ischemic Stroke: The TEACH Pilot Randomized Clinical Trial. JAMA Neurol 2018;75:379-381.

21. Nam KW, Kim CK, Kim TJ, et al. Treatment of Cryptogenic Stroke with Active Cancer with a New Oral Anticoagulant. J Stroke Cerebrovasc Dis 2017;26:2976-2980.

22. Jang H, Lee JJ, Lee MJ, et al. Comparison of Enoxaparin and Warfarin for Secondary Prevention of Cancer-Associated Stroke. J Oncol 2015;2015:502089.

Acknowledgments: We thank Ms. Anu Eräkanto for technical support.

Disclosures: All authors except Yan Yun Liu (statistician) and Heikki Joensuu (oncologist) were investigators for the NAVIGATE ESUS trial. GN, HM, ET, SEK, RGH, and TT were on the steering committee of the NAVIGATE ESUS trial.

Potential conflict of interest: Dr. Ntaios reports grants, personal fees and non-financial support from Bayer, during the conduct of the study; grants, personal fees and non-financial support from BMS/Pfizer, personal fees and non-financial support from Boehringer Ingelheim, outside the submitted work; Dr. Saarinen reports personal fees from Bayer, outside the submitted work; Dr.Martí-Fàbregas reports other from Bayer, during the conduct of the study; Dr.Berkowitz reports personal fees from Bayer U.S. LLC, during the conduct of the study/outside the submitted work; Dr.Mundl reports personal fees from BAYER AG Germany, during the conduct of the study and outside the submitted work; Dr.Kasner reports grants from Bayer, during the conduct of the study; personal fees from Bristol Myers Squibb, personal fees from Boehringer Ingelheim, grants and personal fees from Medtronic, outside the submitted work; Dr.Hart reports personal fees from Bayer AG, during the conduct of the study; Dr.Tatlisumak reports grants and personal fees from Bayer, during the conduct of the study; grants and personal fees from Boehringer Ingelheim, personal fees from Lumosa Pharm, grants and personal fees from Bayer, personal fees from BMS, personal fees from Portola Pharm, outside the submitted work.

Sources of funding: NAVIGATE ESUS trial was sponsored by Bayer AG and Janssen Research and Development. The analyses for this manuscript and the writing work did not receive any specific funding from any source.

Authors' contributions: Study concept and design: All authors. Data collection: All authors. Statistical analyses: YYL. Manuscript drafting: NMM, GN, YYL, RGH, TT. Manuscript reviewing for intellectual input: All authors. All authors agreed on submitting this version of the manuscript to the journal. TT takes full responsibility of correctness of all data, analyses, and presentation of the results as well as the whole manuscript.

Sponsor's role: The sponsor of the NAVIGATE ESUS trial had no role in the analyses, writing, content of the manuscript, or decision to submit this manuscript.

TABLES

Table 1. Baseline features and outcomes of participants with vs without cancer.

Characteristic	Cancer (+) (N=543)	Cancer (-) (N=6670)	*P* value
Age, years	72.1 (8.2)	66.5 (9.8)	<.0001
Age<60 years	37 (7)	1679 (25)	<.0001
Male sex	318 (59)	4118 (62)	0.1436
Cancer diagnosed < 1year	48 (9)	Not applicable	Not applicable
Race:			
White only	384 (71)	4832 (72)	0.3875
Black only	8 (1)	103 (2)	0.8973
East Asian only	106 (20)	1308 (20)	0.9599
Others (includes not reported/multiracial)	45 (8)	427 (6)	0.0875
BMI, kg/m^2	26.5 (4.8)	27.3 (5.0)	0.0002
<25 kg/m^2	218 (40)	2282 (34)	0.0053
≥25 - <30 kg/m^2	222 (41)	2753 (41)	0.8489
≥30 kg/m^2	101 (19)	1606 (24)	0.0038
Weight, kg	73.6 (15.9)	76.4 (16.5)	0.0002
Medical history:			
Hypertension	397 (73)	5188 (78)	0.0123
Diabetes mellitus	141 (26)	1665 (25)	0.6034
Current tobacco use	70 (13)	1414 (21)	<.0001
Coronary artery disease	30 (6)	442 (7)	0.3181
Heart failure	16 (3)	222 (3)	0.6320
Prior stroke or TIA	98 (18)	1165 (17)	0.7317
Global region			
U.S.A. and Canada	91 (17)	827 (12)	0.0034

Characteristic	Cancer (+) (N=543)	Cancer (-) (N=6670)	*P* value
Latin America	32 (6)	714 (11)	0.0004
Western Europe	274 (50)	2807 (42)	0.0001
Eastern Europe	44 (8)	1074 (16)	<.0001
East Asia	102 (19)	1248 (19)	0.9661
Qualifying stroke:			
Arterial territory of qualifying stroke			
Anterior circulation	384 (71)	4803 (72)	0.5199
Posterior circulation	176 (32)	2093 (31)	0.6181
Cerebral hemisphere with cortical involvement	327 (60)	3708 (56)	0.0367
Cerebral hemisphere, subcortical only	71 (13)	1447 (22)	<.0001
Brainstem only	16 (3)	315 (5)	0.0572
Cerebellum only	55 (10)	506 (8)	0.0334
Multiple Locations	74 (14)	689 (10)	0.0163
NIHSS score at randomization	0.0 (0.0 - 2.0)	1.0 (0.0 - 2.0)	<.0001
NIHSS score ≤5	523 (96)	6403 (96)	0.7623
Modified Rankin Scale (mRS) at randomization			
mRS 0 or 1	365 (67)	4305 (65)	0.2110
mRS 2	111 (20)	1561 (23)	0.1154
mRS ≥3	67 (12)	803 (12)	0.8375
EQ-5D Score at randomization	73.8 (7.2)	74 (6.1)	0.8934
Time from qualifying stroke to randomization, days	42.0 (16.0 - 92.0)	36.0 (14.0 - 88.0)	0.1647
First ischemic stroke n (100-Person Years)	32 (6.5)	283 (4.6)	
First Major bleed n (100-Person Years)	10 (2.0)	75 (1.2)	
All-cause mortality n (100-Person Years)	18 (3.5)	99 (1.5)	

Data expressed as n (%), mean (standard deviation), or median (interquartile range)

* Event rates reported in 100-Person Years.

Note: Participants with skin cancer only (n=77) are included in the No cancer group.

Table 2. Baseline features of participants according to site of cancer.

Characteristic	No Cancer (N=6670)	Prostate Cancer (N=107)	Breast Cancer (N=101)	Colon Cancer (N=66)	Lung Cancer (N=30)	Other Cancer (N=239)
Age, years	66.5 (9.8)	73.8 (6.2)	73.4 (7.2)	74.6 (8.1)	71.7 (7.4)	70.0 (9.1)
Age<60 years	1679 (25)	1 (1)	5 (5)	1 (2)	0 (0)	30 (13)
Male sex	4118 (62)	107 (100)	1 (1)	41 (62)	19 (63)	150 (63)
Cancer diagnosed < 1year	0 (0)	14 (13)	7 (7)	5 (8)	6 (20)	16 (7)
Race:						
White only	4832 (72)	78 (73)	80 (79)	45 (68)	17 (57)	164 (69)
Black only	103 (2)	3 (3)	1 (1)	1 (2)	2 (7)	1 (0)
East Asian only	1308 (20)	11 (10)	13 (13)	18 (27)	8 (27)	56 (23)
Others (includes not reported/multiracial)	427 (6)	15 (14)	7 (7)	2 (3)	3 (10)	18 (8)
BMI, kg/m^2	27.3 (5.0)	26.6 (3.5)	27.0 (4.4)	26.2 (4.6)	23.8 (3.6)	26.6 (5.5)
<25 kg/m^2	2282 (34)	35 (33)	40 (40)	27 (41)	19 (63)	97 (41)
≥25 - <30 kg/m^2	2753 (41)	56 (52)	40 (40)	29 (44)	10 (33)	87 (37)
≥30 kg/m^2	1606 (24)	16 (15)	21 (21)	10 (15)	1 (3)	53 (22)
Weight, kg	76.4 (16.5)	79.0 (11.7)	68.9 (13.0)	73.5 (17.6)	66.4 (13.3)	74.1 (17.6)
Medical history:						
Hypertension	5188 (78)	73 (68)	81 (80)	47 (71)	21 (70)	175 (73)
Diabetes mellitus	1665 (25)	31 (29)	20 (20)	19 (29)	6 (20)	65 (27)
Current tobacco use	1414 (21)	9 (8)	6 (6)	8 (12)	5 (17)	42 (18)
Coronary artery disease	442 (7)	9 (8)	5 (5)	4 (6)	3 (10)	9 (4)
Heart failure	222 (3)	1 (1)	4 (4)	2 (3)	4 (13)	5 (2)
Prior stroke or TIA	1165 (17)	10 (9)	23 (23)	16 (24)	9 (30)	40 (17)
Arterial territory of qualifying stroke:						
Anterior circulation	4803 (72)	74 (69)	72 (71)	53 (80)	22 (73)	163 (68)
Posterior circulation	2093 (31)	37 (35)	31 (31)	14 (21)	10 (33)	84 (35)

Characteristic	No Cancer (N=6670)	Prostate Cancer (N=107)	Breast Cancer (N=101)	Colon Cancer (N=66)	Lung Cancer (N=30)	Other Cancer (N=239)
Cerebral hemisphere with cortical involvement	3708 (56)	71 (66)	63 (62)	45 (68)	17 (57)	131 (55)
Cerebral hemisphere, subcortical only	1447 (22)	11 (10)	16 (16)	9 (14)	3 (10)	32 (13)
Brainstem only	315 (5)	4 (4)	3 (3)	0 (0)	0 (0)	9 (4)
Cerebellum only	506 (8)	9 (8)	10 (10)	4 (6)	2 (7)	30 (13)
Multiple Locations	689 (10)	12 (11)	9 (9)	8 (12)	8 (27)	37 (15)
NIHSS score at randomization	1.0 (0.0 - 2.0)	0.0 (0.0 - 2.0)	0.0 (0.0 - 1.0)	1.0 (0.0 - 2.0)	1.0 (0.0 - 2.0)	0.0 (0.0 - 2.0)
NIHSS score ≤5	6403 (96)	105 (98)	96 (95)	64 (97)	28 (93)	230 (96)
Modified Rankin Scale (mRS) at randomization:						
mRS 0 or 1	4305 (65)	70 (65)	64 (63)	43 (65)	17 (57)	171 (72)
mRS 2	1561 (23)	25 (23)	24 (24)	10 (15)	8 (27)	44 (18)
mRS ≥3	803 (12)	12 (11)	13 (13)	13 (20)	5 (17)	24 (10)
Time from qualifying stroke to randomization, days	36.0 (14.0 - 88.0)	48.0 (16.0 - 101.0	44.0 (20.0 - 102.0	42.5 (20.0 - 87.0)	33.0 (11.0 - 58.0)	39.0 (14.0 - 88.0)

Data expressed as n (%), mean (standard deviation), or median (interquartile range)

* Event rates reported in 100-Person Years.

Note: Participants with skin cancer only (n=77) are included in the No cancer group.

Table 3: Rate of major outcomes and response to treatment (ITT)

	Rivaroxaban assigned (N=3609)		**Aspirin assigned (N=3604)**			
	Number of randomized patients	**Number of events (event rate*)**	**Number of randomized patients**	**Number of events (event rate*)**	**Hazard ratio (95% CI)**	***P* value (interaction)****
Recurrent ischemic stroke						
Cancer (+)	254	18 (7.7)	289	14 (5.4)	1.43 (0.71, 2.87)	
Cancer (-)	3355	141 (4.5)	3315	142 (4.6)	0.98 (0.78, 1.24)	0.3137
First ISTH major bleed						
Cancer (+)	254	7 (2.9)	289	3 (1.1)	2.57 (0.67, 9.96)	
Cancer (-)	3355	55 (1.7)	3315	20 (0.6)	2.75 (1.65, 4.59)	0.9539
All -cause death						
Cancer (+)	254	9 (3.7)	289	9 (3.3)	1.10 (0.44, 2.78)	
Cancer (-)	3355	56 (1.7)	3315	43 (1.3)	1.30 (0.87, 1.93)	0.7733

^Follow-up censored after 2 days from stopping assigned study drug

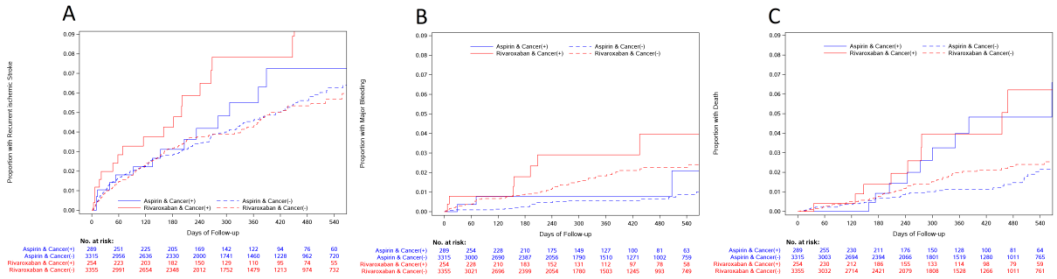
*Event rates reported in 100-Person Years

**Hazard Ratio, 95% CI, and p for interaction not reported if Hazard Ratio is ≥10 or cannot be computed

ISTH=International Society on Thrombosis and Haemostasis; CI=confidence interval

FIGURES

Figure. Kaplan-Meier curves of the cumulative risks in cancer patients treated with rivaroxaban or aspirin for (A) recurrent ischemic stroke, (B) major bleeds, and (C) all-cause death.



ene_14172_f1.tif