Inappropriate antithrombotic use in geriatric patients with complicated traumatic brain injury

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BACKGROUND: Preinjury antithrombotic (AT) use is associated with worse outcomes for geriatric (65 years or older) patients with traumatic brain injury (TBI). Previous studies have found that use of AT outside established guidelines is widespread in TBI patients.

METHODS: In this single-center retrospective cross-sectional study, we examined inappropriate AT use among geriatric patients presenting with traumatic intracranial hemorrhage. We reviewed records of patients 65 years or older with preinjury AT use who presented to a Level 1 trauma center with traumatic intracranial hemorrhage between 2016 and 2023. Patient demographics and AT indications/types were extracted. Appropriateness of AT use was determined using established guidelines.

RESULTS: The cohort comprised 207 patients (56.5% male; median age, 77 years). Fall was the most common mechanism of injury (87.9%). At initial presentation, 87.0% of patients had mild TBI (Glasgow Coma Scale scores 13–15). The two most common indications for AT use were atrial fibrillation (41.5%) and venous thromboembolism (14.5%). Anticoagulation therapy was used by 51.7% of patients, antiplatelet therapy by 40.1%, and both by 8.2%. Prescribed AT agents included warfarin (23.2%), direct oral anticoagulants (36.2%), aspirin (32.4%), and clopidogrel (15.0%). Per clinical guidelines, 31 patients (15.0%) were determined to be inappropriately on AT therapy. On multivariable analysis, venous thromboembolism (odds ratio [OR], 5.32; 95% confidence interval [CI], 1.80–15.71; $p = 0.002$) and arterial stent (OR, 4.69; 95% CI, 1.53–14.37; $p = 0.007$) were associated with inappropriate AT use; aspirin was the most common inappropriately prescribed AT (OR, 3.59; 95% CI, 1.45–8.91; $p = 0.006$).

CONCLUSION: Overall, 15% of geriatric TBI patients with preinjury AT use were prescribed this therapy outside of current guidelines. Trauma providers should remain vigilant in identifying such patients and collaborate across multidisciplinary teams to implement interventions that minimize inappropriate AT use. (*J Trauma Acute Care Surg.* 2025;00: 00–00.

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KEY WORDS: Traumatic brain injury; antithrombotic use; elderly; traumatic intracranial hemorrhage; medication reconciliation.

Traumatic brain injury (TBI) is a major cause of mortality and morbidity worldwide.[1] In the United States alone, more than 200,000 individuals are hospitalized annually after sustaining a TBI.[2] The prevalence of TBI is disproportionally high in the geriatric population (65 years or older) because of greater fall risk and age-related changes in the brain that increase susceptibility to injury.[3,4] It has been previously demonstrated that greater patient age, comorbidities, and use of antithrombotic (AT) therapy significantly worsen clinical outcomes in patients after a TBI.[5–7] Older adults are therefore at particularly elevated risk, given their likelihood for presenting with multiple comorbidities in addition to AT therapy.[8–10]

Prior studies have suggested that the prevalence of AT use outside of established guidelines is common.[11–15] A recent study by Blitz et al.[15] showed that 1 in 10 patients who presented to their institution following TBI were inappropriately on AT therapy, with age as a significant predictive factor for inappropriate AT use. Importantly, Blitz et al.[15] excluded patients who were receiving only aspirin, citing that use of aspirin alone is not significantly associated with increased rates of complication for patients with TBI. Recent randomized clinical trials, however, have suggested that low-dose aspirin alone increases the risk for intracerebral bleeding in healthy older adults.[16,17] Accordingly, the American Heart Association (AHA) and United States Preventive Services Task Force (USPSTF) have updated their guidelines regarding aspirin use.[17,18] Considering the findings from Blitz et al.[15] and the updated guidelines regarding aspirin use, we examined the prevalence of inappropriate AT therapy among geriatric patients with TBI.

PATIENTS AND METHODS

We performed a retrospective review of the electronic medical records (EMRs) of patients with TBI presenting with traumatic intracranial hemorrhages at a Level 1 trauma center

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between January 2016 and December 2023. Institutional review board approval for the database was provided without the requirement of patient consent. Inclusion criteria consisted of patients 65 years or older with findings of acute intracranial hemorrhage and preinjury AT use. Demographics, comorbidities, mechanism of injury, presenting Glasgow Coma Scale (GCS) score, frailty index as measured by the revised Risk Analysis Index,[19,20] AT use (including anticoagulation or antiplatelet), AT indications and type, and pattern of AT resumption were extracted from the medical record. Revised-RAI is a weighted metric with 11 variables, with score ranging from 0 to 81.[20] It was developed with rigorous methodology to predict postoperative mortality for up to 1 year and has been found to have excellent internal and external validity among surgical specialties, including neurosurgery.[19–21]

Our algorithm to determine the appropriateness of AT use was adapted from Blitz et al. and current guidelines from AHA and USPSTF.[15–17] The complete algorithm is illustrated in Figure 1. The evidence for assessing AT use in atrial fibrillation (AF) was based on the American College of Cardiology's guideline for the management of patients with AF,[22] using the CHA_2DS_2-VASc clinical risk factor calculator[23] as in Blitz et al.[15] The criteria for determining the appropriateness of antiplatelet therapy after cardiac stent placement were based on the AHA guidelines and dual antiplatelet therapy (DAPT) risk score.[24,25] Similarly, the pathway to assess the appropriateness of AT use in patients with venous thromboembolism (VTE) was developed referencing the guidelines of the American College of Cardiology.[26] The appropriateness of antiplatelet therapy for indications of primary and secondary prevention of coronary artery disease (CAD) and stroke or after heart surgery (coronary artery bypass graft, heart valve replacements) was guided by the AHA and USPSTF.[16,17,24,25] The use of aspirin for analgesic purposes was evaluated based on chronicity of use and provider recommendation. For patients on AT for a prothrombotic disorder, the appropriateness of use was based on the recommendation from their primary hematologists.

The primary outcome of our study was the prevalence of inappropriate use of AT therapy in the patient population. In addition, we evaluated indications and agents that were associated with inappropriate use between patients who were appropriately and inappropriately on AT.

Statistical analyses were performed using SPSS version 29.0 (IBM Corp., Armonk, NY). Univariable and multivariable analyses were conducted. The χ^2 test was used for categorical variables, and the independent-samples *t* test was used for continuous variables. The Shapiro-Wilk test for normality was performed, and median and interquartile ranges (IQRs) were used to describe continuous variables that were not normally distributed. Multivariable logistic regression model was used where appropriate to generate relevant odds ratios (ORs) and 95% confidence intervals (CIs). The Hosmer-Lemeshow goodness-of-fit test was used to evaluate the general model fitting of logistic regression. A p value of <0.05 was considered statistically significant.

The Equator Network's STrengthening the Reporting of OBservational studies in Epidemiology Reporting Guidelines were used to ensure proper reporting of methods, results, and discussion (Supplemental Digital Content, Supplementary Data 1, http://links.lww.com/TA/E185).

RESULTS

Among the 1425 trauma patients with acute intracranial hemorrhage treated at an institution between 2016 and 2023, 557 were 65 years or older, and 220 geriatric patients were on AT. Of these, 13 patients had missing variables on AT indication or incomplete records to determine appropriateness of treatment. The other 207 patients on AT medications were included in our analysis. Patient inclusion flowchart is presented in Figure 2.

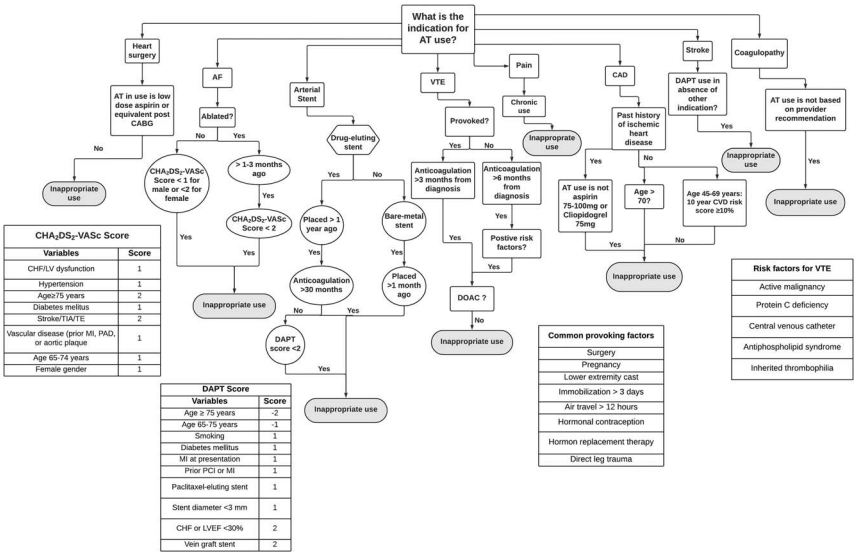

Figure 1. Schematic illustrating the algorithm used to determine inappropriate use of AT. The algorithm was developed with reference to AHA, ACC, and USPSTF guidelines for the respective indications. ACC, American College of Cardiology; CABG, coronary artery bypass graft; CHF, congestive heart failure; CVD, cardiovascular disease; DOAC, direct oral anticoagulants; LV, left ventricular; LVEF, left ventricular ejection fraction; MI, myocardial infarction; PCI, percutaneous coronary intervention; TE, thromboembolism; TIA, transient ischemic attack.

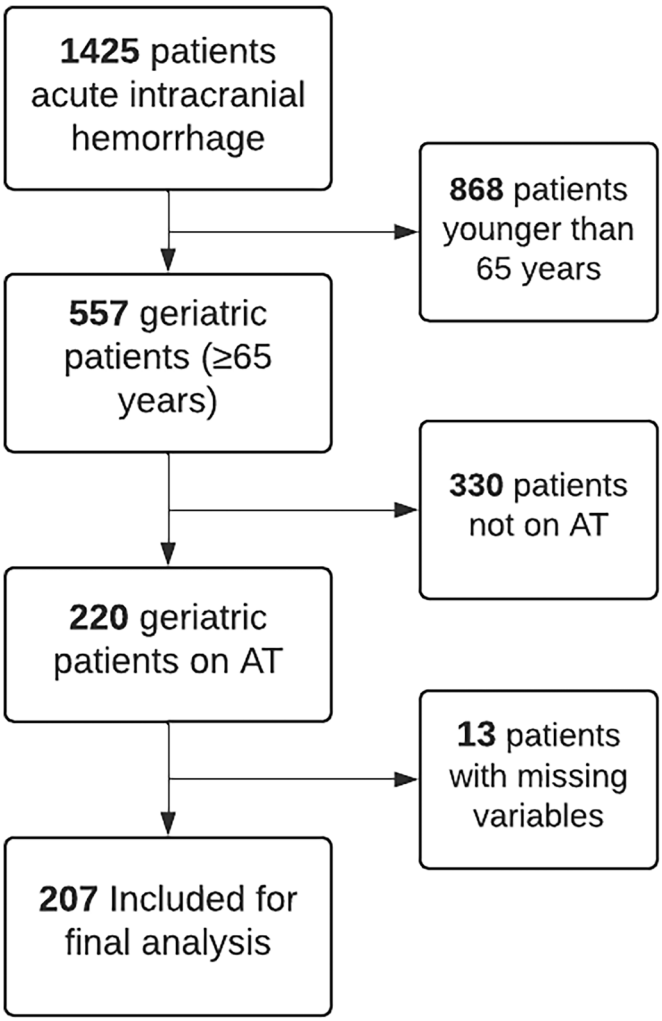

Figure 2. Patient inclusion flow diagram.

Patient demographics and injury characteristics are summarized in Table 1. More patients in the cohort were male (117, 56.5%), and the overall median age was 77 years (IQR, 72–84 years). The majority of patients were classified as having mild TBI (GCS scores 13–15) at presentation (87.0%). The median Injury Severity Score was 14 (IQR, 10–25). The median frailty index of the patients included in our cohort was 32 (IQR, 27–38). The most common mechanism of injury was fall (87.9%), followed by road accident (7.7%). In this cohort, 107 patients (51.7%) were taking anticoagulation monotherapy, 83 (40.1%) were on antiplatelet monotherapy, and 17 (8.2%) were on both antiplatelet and anticoagulant therapy at the time of presentation. Antithrombotic agents included direct oral anticoagulants (36.2%), aspirin (32.4%), warfarin (23.2%), clopidogrel (15.0%), DAPT (1%), and low-molecular-weight heparin (0.5%). The most common indications for AT therapy were AF (41.5%), followed by VTE (14.5%), CAD (14.0%), stroke (9.7%), cardiac stent (9.2%), and cardiac surgery (6.3%).

After referencing clinical guidelines, we assessed the use of AT as inappropriate in 31 patients (15%). Demographics, AT indications, and AT agents are summarized in Table 1. The median age (77 [IQR, 72–87] vs. 77 [72–83] years, $p = 0.992$) and sex distribution (56.8% vs. 54.8% males, $p = 0.838$) were not significantly different between the patients appropriately and inappropriately on AT. In patients inappropriately on AT therapy, the most common indications were VTE (8 patients, 25.8%), followed by CAD (7, 22.6%), cardiac stent (7, 22.6%), and stroke (4, 12.9%). No patients with an indication of AF were deemed to be inappropriately taking AT therapy in our analysis. Aspirin was the most commonly inappropriately used medication (16 patients, 51.6%) in the patient population, followed by warfarin (9, 29.9%) and clopidogrel (6, 19.4%). A total of 21 (11.7%) of patients were readmitted to the hospital for worsening or secondary development of subdural hematoma within 1 year of index TBI. There was no significant difference between the appropriate and inappropriate groups (12.8% vs. 6.7%, $p = 0.345$).

Multivariable analysis controlling for sex, age, and patient frailty showed that the indications of cardiac stent (OR, 4.68; 95% CI 1.53–14.32; $p = 0.007$) and VTE (OR, 5.46; 95% CI, 1.85–16.19; $p = 0.002$) and the AT agent aspirin (OR, 3.65; 95% CI, 1.47–9.10; $p = 0.005$) were significantly associated with inappropriate AT use (Table 2).

The reasons for noncompliance with the recommended clinical guidelines were categorized into two groups: improper medication selection and continued AT use beyond the recommended duration, as summarized in Table 3. In 58.1% of cases with inappropriate AT use, the issue was improper medication selection, whereas prolonged AT use beyond the recommended time frame was the issue in the remaining 41.9% of cases.

The recommendation of AT resumption at discharge was also evaluated (Table 4). Overall, 27.7% of patients were advised not to resume AT, with slightly higher proportion in the inappropriate AT group (33.3%) compared with the appropriate AT group (26.6%). A total of 37.6% of patients were advised to resume their preinjury AT regimen at discharge. In addition, 8.1% of patients were advised to resume a lower dose, 12.1% were instructed to resume the same or modified dose within 2 weeks, and 11.6% were advised to resume the same or modified dose 4 weeks after discharge. Only 2.9% were recommended to follow up with their outpatient provider to determine AT resumption. The resumption patterns did not significantly differ between patients who were appropriately or inappropriately on AT ($p = 0.422$).

Subgroup analysis of patients presenting with mild TBI (GCS scores 13–15) was performed, and results are summarized in Supplemental Digital Content (Supplementary Table 1, http://links.lww.com/TA/E186). In this subgroup, the rate of inappropriate AT use was 16.7%. The median age (78 vs. 78 years, $p = 0.738$), sex distribution (55.3% vs. 53.3% males, $p = 0.841$), median Injury Severity Score (14 vs. 17, $p = 0.423$), median frailty index (33 vs. 30.5, $p = 0.689$), and mechanism of injury ($p = 0.051$) were similar between patients appropriately and inappropriately on AT therapy, respectively. A significantly higher percentage of patients inappropriately on AT therapy were on antiplatelet therapy alone (63.3%, $p = 0.011$). The most common indications in the inappropriate group remained cardiac stent (23.3%), VTE (23.3%), and CAD (23.3%). As in the larger analysis, aspirin monotherapy

TABLE 1. Demographics and Clinical Parameters on Admission for 207 Patients with Appropriate and Inappropriate at Use

Category (n)	Full Cohort (n = 207)	Appropriate AT (n = 176, 85.0%)	Inappropriate AT (n = 31, 15.0%)	*p*
Age, median (IQR)	77 (72,84)	77 (72,85)	77 (72,83)	0.992
Sex				0.838
Female	90 (43.5%)	76 (43.2%)	14 (45.2%)	
Male	117 (56.5%)	100 (56.8%)	17 (54.8%)	
Injury severity				0.678
GCS 3–8	20 (9.7%)	19 (10.8%)	1 (3.2%)	
GCS 9–12	7 (3.3%)	7 (4.0%)	0 (0%)	
GCS 13–15	180 (87.0%)	150 (85.2%)	30 (96.8%)	
ISS, median (IQR)	14 (10,25)	14 (10,25)	17 (10,21)	0.675
Frailty index, median (IQR)	32 (27,38)	32 (28,38)	29 (23,39)	0.763
Mechanism of injury				0.249
Fall	182 (87.9%)	157 (89.2%)	25 (80.6%)	
Road accident	16 (7.7%)	11 (6.3%)	5 (16.1%)	
Sport	5 (2.4%)	5 (2.8%)	0 (0)	
Assault	3 (1.4%)	2 (1.1%)	1 (3.2%)	
Other	1 (0.5%)	1 (0.6%)	0 (0)	
AT agents*				0.403
DOACs	75 (36.2%)	72 (40.9%)	3 (9.7%)	
Aspirin	67 (32.4%)	51 (29.0%)	16 (51.6%)	
Warfarin	48 (23.3%)	39 (22.2%)	9 (29.0%)	
Clopidogrel	31 (15.0%)	25 (14.2%)	6 (19.4%)	
DAPT	2 (1.0%)	2 (1.1%)	0(0)	
LMWH	1 (0.5%)	1 (0.6%)	0 (0)	
Indication				**<0.001**
AF	86 (41.5%)	86 (48.9%)	0 (0)	
VTE	30 (14.5%)	22 (12.5%)	8 (25.8%)	
CAD	29 (14.0%)	22 (12.5%)	7 (22.6%)	
Stroke	20 (9.7%)	16 (9.1%)	4 (12.9%)	
Cardiac stent	19 (9.2%)	12 (6.8%)	7 (22.6%)	
Coagulopathy	2 (1.0%)	2 (1.1%)	0 (0)	
Heart surgery	13 (6.3%)	12 (6.8%)	1 (3.2%)	
Pain	2 (1.0%)	1 (0.6%)	1 (3.2%)	
Other	6 (2.9%)	3 (1.7%)	3 (9.7%)	
Readmission for worsening or secondary development of SDH within one year of index TBI**	21 (11.7%)	19 (12.8%)	2 (6.7%)	0.345

*Some patients were taking more than one AT agent.
**Data only available for 179 patients.
Values are reported as number (%) or median (IQR).
Boldface font indicates statistical significance at $p < 0.05$.
AC, anticoagulation; AP, antiplatelet; DOAC, direct oral anticoagulants; ISS, Injury Severity Score; LMWH, low-molecular-weight heparin; RAI-REV, revised Risk Analysis Index; SDH, subdural hematoma.

comprised more than half (53.3%) of all AT agents inappropriately prescribed.

DISCUSSION

Our results showed that 15% of geriatric patients with TBI who were on AT medications before their injury are prescribed AT therapy outside of current guidelines. Patients with indications consisting of VTE and cardiac stent were significantly more likely to be inappropriately taking AT therapy. Aspirin was the AT agent most commonly identified as inappropriately used.

These findings align with those reported in Blitz et al.,[15] who found that 10% of all patients with TBI with preinjury AT use were inappropriately on AT therapy. In our study cohort, the rate of inappropriate AT use was slightly higher at 15%, likely because our patient population was specific to older adults, whereas Blitz et al.[15] included all adults. This difference may be attributable to the higher prevalence of multimorbidity and lower health literacy among older patients.[27,28] The presence of multiple comorbidities results in polypharmacy, multiple prescribing providers, and more frequent transitions of care. This leaves older patients in a vulnerable position: prone to medication error, inaccurate medication reconciliation, and

TABLE 2. Multivariable Analysis Predicting the OR of Being Inappropriately on AT

Variables	OR	95% CI	*p*
Female sex	0.88	0.38, 2.02	0.654
Age	1.00	0.95, 1.06	0.892
Frailty index (median, RAI-REV)	0.99	0.93, 1.04	0.571
Indications			
Cardiac stent	4.68	1.53, 14.32	**0.007**
VTE	5.46	1.85, 16.19	**0.002**
AT agent			
Aspirin	3.65	1.47, 9.10	**0.005**

Boldface font indicates statistical significance at $p < 0.05$.
RAI-REV, revised Risk Analysis Index.

deprescribing hesitancy.[29–31] The literature consistently shows that AT therapy significantly increases risk for adverse outcomes after TBI.[6,7,32] This effect is further amplified in geriatric patients who are at a greater risk for falls and poor outcomes after TBI.[6,33] As the American population continues to age, the use of AT therapy is expected to rise, thereby increasing the inappropriate use of AT therapy by extension.[4,15]

Our analysis revealed that patients with an indication consisting of either VTE or cardiac stent were significantly more likely to be inappropriately using AT medications. Venous thromboembolism, which includes deep vein thrombosis or pulmonary embolism (PE), is a common and potentially fatal medical problem among older adults.[34] Given the transient nature of VTE, a short-term course of AT may not be appropriately discontinued when a patient's risk decreases. This is further amplified in older patients who have more barriers to consistent clinical follow-up and additional transitions of care posthospitalization.[35] Another factor contributing to the inappropriate use of AT in patients with VTE is the lack of clear consensus on the necessary duration of AT after a VTE episode.[36,37] We assessed the appropriateness of AT for VTE/PE indication based on 2019 American College of Cardiology guidelines on duration of AT after PE, which recommends a 3-month AT course for patients with provoked PE.[26] For patients with unprovoked PE, the guideline suggests considering both risk of recurrent PE and increased risk for bleeding with prolonged AT use. Although the American College of Cardiology guidelines provide a framework, clinicians often struggle with duration management because of the delicate balance between bleeding risk and recurrence of VTE.[26]

Cardiac stent placement was another indication significantly associated with inappropriate AT use. The algorithm to determine the appropriateness of antiplatelet therapy after cardiac stent placement was based on AHA guidelines, which uses DAPT score to predict the risk of bleeding in patients with cardiac stent.[25] Prior studies have indicated that DAPT usage for more than 30 months after placement of a drug-eluting stent is inappropriate.[25] For patients with a DAPT risk score below 2, the duration of DAPT should be further reduced to 12 months.[25] In older patients with inconsistent follow-up[35] and inaccurate medication reconciliation,[30] halting DAPT therapy at the recommended time after stent placement may be overlooked. In 41.9% of patients with inappropriate AT use, noncompliance was due to failure to discontinue the medication at the recommended time. This finding reinforces that proper medication reconciliation and timely cessation of AT are essential to reduce inappropriate use.

We observed that aspirin accounted for 51.9% of cases in which patients were inappropriately on AT. Aspirin is widely used with and without physician guidance with the goal of preventing primary and secondary CAD and stroke.[38] In our cohort, 16 patients were inappropriately taking aspirin. Among them, five were using aspirin for a cardiac stent beyond the recommended duration, and another five were taking it for primary prevention of CAD. Notably, four of these patients were older than 70 years, while the fifth, aged 68 years, had a 10-year atherosclerotic cardiovascular disease risk score that was less than 10%. The remaining cases of inappropriate use included VTE/PE (1), primary stroke prevention (1), chronic pain (1), and other unspecified indication (3). Previously, it was believed that the benefit of aspirin in preventing cardiovascular events and stroke outweighed the risk of bleeding, leading to its liberal use.[38] As a result, previous studies evaluating inappropriate AT use have excluded patients taking aspirin.[15] However, recent studies, particularly the Aspirin in Reducing Events in the Elderly (ASPREE) trial, have shown that daily low-dose aspirin significantly increases the risk for intracranial bleeding without significantly reducing ischemic stroke incidence.[16,39–41] Considering recent findings, the USPSTF and AHA have updated their guidelines to recommend against initiating low-dose aspirin use for primary prevention of cardiovascular disease for individuals over 70 years.[17,18] Similarly, the Beers Criteria from the American Geriatric Society now only recommends to "avoid initiating and consider deprescribing [aspirin for primary prevention] in older adults."[42] Our algorithm for determining inappropriate use incorporated these updated recommendations. The high percentage of inappropriate aspirin use may indicate a delay in adopting these new recommendations into clinical practice. Furthermore, this high usage could also be attributed to the broad range of indications for aspirin and prevalence of self-prescription. Given the updated findings regarding aspirin and bleeding risk, the widespread use of aspirin without evidence-based indication and without physician guidance should be avoided.

The decision and timing of resuming AT after TBI are widely argued in the literature.[43,44] A broad range of time frames, from 3 days to 8 weeks after TBI, have been suggested as safe for resuming AT.[43,45,46] The proportion of patients who resume AT after TBI also varies across studies. Puckett et al.[46] reported that 62.3% of patients in their cohort resumed oral anticoagulation after TBI, whereas Albrecht et al.[43] observed that 55% of patients received warfarin for at least one 30-day period within the first year after TBI. The decision to resume AT involves balancing the risks of hemorrhage and thrombosis and is best made on a case-by-case basis, often with input from a

TABLE 3. Reasons for Noncompliance in Patients With Inappropriate AT Use

Reason for Noncompliance With the Guideline	No. Cases (%)
Medication selection	18 (58.1%)
Continued AT use beyond recommended time frame	13 (41.9%)

TABLE 4. The Pattern of AT Resumption at Discharge of Patients Who Were Appropriately and Inappropriately on AT

Category (n)	Full Cohort (n = 173)*	Appropriate AT (n = 143)	Inappropriate AT (n = 30)	*p*
Pattern of resumption				0.422
Advised not to resume	48 (27.7%)	38 (26.6%)	10 (33.3%)	
Resume same dose at discharge	65 (37.6%)	52 (36.4%)	13 (43.3%)	
Resume reduced dose at discharge	14 (8.1%)	14 (8.1%)	0	
Resume equivocal or modified dose within 2 wk of discharge	21 (12.1%)	18 (12.6%)	3 (10.0%)	
Resume same or modified dose 4 wk after discharge	20 (11.6%)	16 (11.2%)	4 (13.3%)	
Advised to follow up with a provider in outpatient setting regarding resumption	5 (2.9%)	5 (3.5%)	0	

*Only 173 patients were included because of data unavailability or patient death prior to hospital discharge.

multidisciplinary team. At our institution, we frequently consult with cardiology or hematology specialists to guide the decision on AT resumption. In our cohort, 27.7% of patients were advised not to resume AT at discharge. Among the remaining 72.3%, patients either resumed the same dose (37.9%) or a reduced dose (9.8%) at discharge, resumed AT 2 weeks (12.1%) or 4 weeks (11.6) postdischarge, or were referred to an outpatient provider (2.9%). Although 15% of patients were inappropriately on AT, recommendations for AT resumption did not differ between patients appropriately or inappropriately on AT. Previous studies have demonstrated that elderly patients on AT are at higher risk for readmission with recurrent subdural hematoma after TBI.[47,48] In our cohort, 11.7% of patients required readmission for hematoma recurrence within 1 year of initial TBI, but the readmission rate did not differ between those appropriately or inappropriately on AT. The readmission rate in our cohort was lower than has previously been reported in similar patient cohorts. This may reflect our approach of avoiding unnecessary AT resumption.[47,49] However, further research is needed to explore whether readmission rates and hematoma recurrence differ based on specific patterns of AT resumption.

Ultimately, our current study highlights an opportunity for improvement in the workflow to better screen and identify patients with inappropriate AT use and recommend discontinuation prior to discharge. Neurosurgeons and trauma teams may play a critical role in identifying these patients and collaborating with hematology or cardiology specialist to guide decisions regarding AT resumption.

Limitations

Limitations to this study include the retrospective nature of the study design, which introduces selection bias that may affect the results. The determination of AT was based on data in the patients' EMR and their documented comorbidities, meaning that the accuracy of the data collected is incumbent on the completeness and accuracy of the information in the EMR. Patients' EMR may not be fully updated, especially if they receive care from multiple health systems. Our sample consists of patients treated at a Level 1 trauma center with a large catchment area. Many patients in our cohort are transferred from the surrounding area, resulting in limited information in their EMR regarding specific details of their comorbidities and medication. We also acknowledge that certain patients with VTE may need to use warfarin because they cannot take direct oral anticoagulants because of contraindications. Our analysis and chart review cannot differentiate whether VTE patients are using warfarin specifically because of contraindications to direct oral anticoagulants. Conducting patient-level case studies may be necessary to obtain this granular data.

In addition, our algorithm to determine appropriateness was developed based on the most recent guidelines. Some guidelines have been updated recently, but our patient cohort includes patients who presented as far back as 2016. Therefore, some patients who were appropriately using AT in 2016 may be considered inappropriate users by 2024 standards.

CONCLUSION

Our study showed that 15% of geriatric patients with TBI with preinjury AT use were inappropriately on AT therapy. The most common indication for AT use was a history of VTE and cardiac stent placement. Aspirin was the most common medication used inappropriately. To address the high prevalence of inappropriate AT use in this vulnerable patient population, neurosurgeons and trauma providers should be vigilant in identifying such patients and fostering multidisciplinary collaboration to assess and implement interventions that minimize inappropriate AT use.

AUTHORSHIP

R.G. contributed in the conception and study design. D.G., D.B., C.A.B., and R.G. contributed in the literature review. D.G., D.B., J.A., M.T.B., S.L., J.C., M.M., T.E., M.P., S.T.M., and R.G. contributed in the data acquisition. D.G., D.B., and R.G. contributed in the data analysis and interpretation. D.G. contributed in the drafting of the manuscript. D.G., D.B., J.A., M.T.B., S.L., J.C., M.M., T.E., M.P., C.A.B., S.T.M., and R.G. contributed in the critical revision.

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DISCLOSURE

Conflicts of Interest: Author Disclosure forms have been supplied and are provided as Supplemental Digital Content (http://links.lww.com/TA/E187).

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