




Delayed intracranial hemorrhage after head injury among elderly patients on anticoagulation seen in the emergency department

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Abstract

Introduction Elderly patients on oral anticoagulation are commonly seen in emergency departments (EDs). Oral anticoagulation, particularly warfarin, is associated with an increased risk of intracranial hemorrhage after head trauma. Data on delayed bleeds in anticoagulated patients are limited. The objective of this study was to examine risk of delayed intracranial hemorrhage in patients presenting to the ED with a head injury anticoagulated with warfarin or a direct oral anticoagulant, compared to patients not anticoagulated.

Methods Cohort study using administrative data from Ontario of patients ≥ 65 years presenting to the ED with a complaint of head injury between 2016 and 2018. The primary outcome was delayed intracranial hemorrhage, defined as a new ICD-10 code for intracranial hemorrhage within 90 days of the initial ED visit for a head injury where no intracranial hemorrhage was diagnosed. The main exposure variable was oral anticoagulation use, which was a three-level variable (warfarin, direct oral anticoagulants, or no oral anticoagulation). We used multivariable logistic regression to determine the odds of delayed intracranial hemorrhage based on anticoagulation status.

Results 69,321 patients were included: 58,233 (84.0%) had not been prescribed oral anticoagulation, 3081 (4.4%) had a warfarin prescription, and 8007 (11.6%) had a direct oral anticoagulant prescription. Overall, 718 (1.0%) patients had a delayed intracranial hemorrhage within 90 days of ED visit for head injury. Among patients not anticoagulated, 586 (1.0%) had a delayed intracranial hemorrhage, 54 (1.8%) patients on warfarin, and 78 (1.0%) patients on a direct oral anticoagulant had a delayed intracranial hemorrhage. There was an increased odds of delayed intracranial hemorrhage with warfarin use compared with no anticoagulation (OR 1.5, 95% CI 1.1–2.1). There was no association between delayed intracranial hemorrhage and direct oral anticoagulant use compared to no anticoagulation (OR 0.9, 95% CI 0.6–1.1).

Conclusions There was an increased odds of delayed intracranial hemorrhage within 90 days in older ED head injured patients prescribed warfarin compared to patients not on anticoagulation. Direct oral anticoagulant use was not associated with increased risk of delayed intracranial hemorrhage.

Keywords Head injury · Delayed intracranial hemorrhage · Anticoagulation · Emergency medicine

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Résumé

Introduction Les patients âgés sous anticoagulation orale sont fréquemment accueillis dans les services d'urgence. L'anticoagulation orale, en particulier la warfarine, est associée à un risque accru d'hémorragie intracrânienne après un traumatisme crânien. Les données sur les saignements retardés chez les patients anticoagulés sont limitées. L'objectif de cette étude était d'examiner le risque d'hémorragie intracrânienne tardive chez les patients se présentant aux urgences avec un traumatisme crânien et anticoagulés avec de la warfarine ou un anticoagulant oral direct, par rapport aux patients non anticoagulés.

Méthodes Étude de cohorte utilisant les données administratives de l'Ontario des patients ≥ 65 ans se présentant aux urgences avec une plainte de traumatisme crânien entre 2016 et 2018. L'issue primaire était l'hémorragie intracrânienne tardive, définie comme un nouveau code CIM-10 pour une hémorragie intracrânienne dans les 90 jours suivant la visite initiale aux urgences où aucune hémorragie intracrânienne n'a été diagnostiquée. La principale variable d'exposition était le recours à l'anticoagulation orale, qui était une variable à trois niveaux (warfarine, anticoagulants oraux directs ou pas d'anticoagulation orale). Nous avons utilisé une régression logistique multivariée pour déterminer les chances d'hémorragie intracrânienne tardive en fonction du statut d'anticoagulation.

Résultats 69 321 patients ont été inclus : 58 233 (84,0 %) n'avaient pas reçu de prescription d'anticoagulant oral, 3 081 (4,4 %) avaient une prescription de warfarine et 8 007 (11,6 %) avaient une prescription directe d'anticoagulant oral. Dans l'ensemble, 718 (1,0 %) patients ont présenté une hémorragie intracrânienne tardive dans les 90 jours suivant leur visite aux urgences pour un traumatisme crânien. Parmi les patients non anticoagulés, 586 (1,0 %) ont eu une hémorragie intracrânienne retardée, 54 (1,8 %) patients sous warfarine et 78 (1,0 %) patients sous anticoagulant oral direct ont eu une hémorragie intracrânienne retardée. Le risque d'hémorragie intracrânienne tardive était plus élevé avec l'utilisation de la warfarine qu'en l'absence d'anticoagulation (OR : 1,5, IC 95 % : 1,1-2,1). Il n'y avait pas d'association entre l'hémorragie intracrânienne tardive et l'utilisation d'anticoagulants oraux directs par rapport à l'absence d'anticoagulation (OR : 0,9, IC 95 % : 0,6-1,1).

Conclusions Il y avait une probabilité accrue d'hémorragie intracrânienne retardée dans les 90 jours chez les patients plus âgés victimes d'un traumatisme crânien aux urgences à qui l'on avait prescrit de la warfarine que chez les patients qui n'étaient pas sous anticoagulation. L'utilisation d'anticoagulants oraux directs n'était pas associée à un risque accru d'hémorragie intracrânienne tardive.

Mots clés Traumatisme crânien · Hémorragie intracrânienne retardée · Anticoagulation · Médecine d'urgence

Clinician's capsule

What is known about this topic?

Oral anticoagulation, particularly warfarin, is associated with increased risk of intracranial hemorrhage after head trauma in older adults.

What did this study ask?

What is the risk of delayed intracranial hemorrhage after head injury in patients anticoagulated with warfarin or direct oral anticoagulants versus no anticoagulation?

What did this study find?

Overall risk of delayed intracranial hemorrhage is low, but increased in patients prescribed warfarin compared to patients not on oral anticoagulation.

Why does this study matter to clinicians?

Clinicians should be aware of the risk of delayed intracranial hemorrhage, particularly in those on warfarin, following head injury.

Introduction

Head trauma following a fall is a common among older patients seen in the emergency department (ED) [1, 2]. Anticoagulation, particularly with warfarin, is thought to increase the risk of traumatic intracranial hemorrhage after a head injury, therefore, many head injured anticoagulated patients presenting to the ED receive diagnostic imaging to rule out intracranial hemorrhage [3–7]. Data on the incidence of intracranial hemorrhage after initial presentation with a head injury (i.e., a delayed intracranial hemorrhage) are limited, especially in patients taking anticoagulants [8]. The reported incidence of delayed intracranial hemorrhage among anticoagulated patients after an initial normal computed tomography (CT) scan varies considerably. A recent meta-analysis found that studies of patients on direct oral anticoagulants had a reported incidence of delayed intracranial hemorrhage between 0 and 13.6%, and patients on warfarin had an incidence of delayed intracranial hemorrhage between 0 and 10.2% [9]. In this meta-analysis, the definition of delayed intracranial hemorrhage varied between studies from 6 h to 30 days.

Several guidelines suggest a period of in-hospital observation and possible repeat imaging for patients on anticoagulation [10, 11]. Clinical practice guidelines from Australia suggest clinical judgement in the management of elderly patients on anticoagulation with no intracranial hemorrhage at initial presentation, stating there is limited evidence on how to manage the risk of delayed intracranial hemorrhage [12]. In contrast, UK guidelines do not recommend observation for patients on anticoagulation with minor head trauma in the absence of other indications including abnormal CT head findings, a Glasgow Coma Score (GCS) < 15, or other concerning features such as persistent vomiting [13]. Other guidelines state there are insufficient studies to address how to manage subpopulations who may be at higher risk of delayed complications following ED discharge [14].

The purpose of this study was to examine delayed intracranial hemorrhage (diagnosed within 90 days of the index ED visit) in patients seen in the ED with a head injury who were anticoagulated with warfarin or a direct oral anticoagulant compared with patients who were not anticoagulated.

Methods

Study design and setting

This was a planned subgroup analysis of a larger study that compared the risk of intracranial hemorrhage in elderly anticoagulated patients 65 years and older seen in the ED with a head injury [15]. We conducted a cohort study using population-based administrative data from 2016 to 2018 from Ontario, Canada that were held at Ontario Health. The study received ethics approval by the Research Ethics Board at Sinai Health and was compliant with privacy procedures at Ontario Health.

Data sources

Data regarding ED visits were obtained from the Canadian Institutes of Health Information National Ambulatory Care Reporting System (CIHI-NACRS) and the electronic Canadian Triage and Acuity Scale (eCTAS) database. NACRS contains data on all ED visits in the province. eCTAS is an electronic triage system that was introduced in 2016 and is now used in more than 90% of EDs across the province. Data regarding acute care hospitalizations were obtained from the Discharge Abstract Database. The Ontario Health Insurance Plan (OHIP) database contains physician billings for medically necessary care. The Registered Persons Database contains mortality information for all Ontario residents, including out-of-hospital deaths. The Ontario Drug Benefit database, which contains prescription drug information for Ontarians covered by the province, was used to identify

anticoagulant status at the time of the ED visit. See supplemental material for further details on databases used.

Study population

We identified patients 65 years and older with a valid OHIP number who were seen in an Ontario ED with a presenting triage complaint of ‘head injury’ in NACRS or eCTAS, or “head injury” or “head trauma” identified by electronic searching of free-form text and manual review of the eCTAS triage note and comment fields, in patients triaged via eCTAS between January 2016 and December 2018. Only the first ED visit for a head injury during the study period was included. We excluded visits at EDs that were not open 24 h per day and visits to urgent care centers (as these are typically centers that see lower acuity patient populations, usually without CT imaging). ED visits where patients left without being seen or left against medical advice were excluded, as were patients who died en-route to ED. Patients prescribed heparin in the 7 days prior to the index ED visit and patients on dialysis were excluded, because these patients are unlikely to receive direct oral anticoagulants. Patients with an intracranial hemorrhage diagnosis in NACRS on the index ED visit for the head injury were excluded because they would not have the primary outcome of a ‘delayed bleed’. Patients who died within 90 days of the index ED visit and did not have a diagnosed intracranial hemorrhage prior to death were excluded because it was unknown if they had an undiagnosed delayed intracranial hemorrhage that caused death.

Exposure

The main exposure variable was anticoagulant use, which was treated as a three-level categorical variable: no anticoagulation, warfarin, or a direct oral anticoagulant (apixaban, dabigatran, or rivaroxaban). There were no patients on edoxaban. To be classified as on an anticoagulant, the patient must have had a filled a prescription for an anticoagulant that covered at least the 2 days prior to the index ED visit for the head injury. See the supplemental material for codes to identify anticoagulants in the Ontario Drug Benefit database.

Outcomes

The primary outcome was a delayed intracranial hemorrhage, defined as an intracranial hemorrhage diagnosis in the inpatient or outpatient setting within 90 days of the index ED visit for head injury where there was no diagnosed intracranial hemorrhage on that ED visit. A 90-day period was chosen to explore longer term outcomes compared to the previous literature. We used the main discharge diagnosis in NACRS and the Discharge Abstract Database, which uses

the *International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10)* to identify intracranial hemorrhage. See supplemental material for codes used to identify intracranial hemorrhage. We did not have information on the date of the bleed, only that it had occurred within 90 days of the index ED visit.

Covariables

Covariates that were included in the statistical model were chosen a priori based on potential predictors or confounders of intracranial hemorrhage or the risk of head injury and included the following: demographics (age, sex), comorbidities (Charlson Comorbidity Score, atrial fibrillation, cancer, coronary artery disease, chronic obstructive pulmonary disease, congestive heart failure, dementia, diabetes, hypertension, liver failure, multiple sclerosis, Parkinson's disease, renal failure, seizure disorder, ischemic stroke or transient ischemic attack, hemorrhagic stroke, venous thromboembolism), clopidogrel prescription in last 7 days, and hospital type (small, community, or academic). See supplemental material for covariate descriptions.

Statistical analysis

Descriptive statistics were used to compare variables of interest between the three different exposure levels. Patient characteristics were reported using frequencies and proportions. Multivariable logistic regression with a generalized estimating equation (GEE), to account for clustering by hospital, was used to examine whether anticoagulant use with warfarin or a direct oral anticoagulant increased the odds of delayed intracranial hemorrhage compared to no anticoagulant use. Unadjusted and adjusted odds ratios (OR) with 95% confidence intervals (CI) were calculated. We conducted two sensitivity analyses. First, we excluded patients who did not receive a CT scan on the index ED visit to remove any potential missed intracranial hemorrhages on the index ED visit that were ultimately recorded as delayed intracranial hemorrhage. Second, we created a composite outcome examining death within 90 days or a delayed bleed to assess the worst-case scenario that all patients who died within 90 days had a delayed bleed. Analyses were conducted using SAS 9.3 (SAS, North Carolina).

Results

There were 77,834 ED visits by patients 65 years and older for a head injury. We excluded 4620 patients who had an intracranial hemorrhage diagnosed on the index ED visit and 3893 patients who died during the 90-day follow-up period without a diagnosed delayed intracranial hemorrhage

(Fig. 1), leaving 69,321 patients in the analysis. Of included patients, 58,233 (84.0%) were not on anticoagulation, 8007 (11.6%) were on a direct oral anticoagulant, and 3081 (4.4%) were on warfarin. Overall, delayed intracranial hemorrhage occurred in 718 (1.0%) patients: 586 (1.0%) patients not on anticoagulation had a delayed intracranial hemorrhage, whereas 54 (1.8%) patients on warfarin, and 78 (1.0%) patients on a direct oral anticoagulant had a delayed intracranial hemorrhage. See Table 1 for baseline characteristics of patients included in the study.

In the multivariable model, there was an increased odds of delayed intracranial hemorrhage among patients on warfarin compared to those not on oral anticoagulation (OR 1.5, 95% CI 1.1–2.1). There was no significant difference in delayed intracranial hemorrhage between patients on a direct oral anticoagulant compared to no oral anticoagulation (OR 0.9, 95% CI 0.6–1.1). Male sex (OR: 1.9, 95% CI 1.6–2.2), history of hemorrhagic stroke (OR 1.6, 95% CI 1.1–2.5), dementia (OR 1.4, 95% CI 1.2–1.7), age > 80 years (OR 1.3, 95% CI 1.2–1.5), and hypertension (OR 1.2, 95% CI 1.0–1.4) were all associated with increased odds of delayed intracranial hemorrhage (Table 2).

In the sensitivity analysis where we excluded patients who did not have a CT scan on the index ED visit, the incidence of delayed intracranial hemorrhage was 1.1% in patients not on anticoagulation, 1.7% in patients on warfarin, and 1.0% in patients on direct oral anticoagulants. While patients on warfarin had an increased odds of delayed intracranial hemorrhage, it was no longer statistically significant (OR 1.4, 95% CI 0.9–2.0). Direct oral anticoagulant use was not significantly associated with delayed intracranial hemorrhage compared with no anticoagulation. In the sensitivity analysis assessing the composite outcome, death or delayed intracranial hemorrhage within 90 days occurred in 5.7% of patients not on anticoagulation, 11% of patients on warfarin, and 8.5% of patients on direct oral anticoagulants. Results were similar to primary analysis: warfarin was significantly associated with an increased odds of delayed intracranial hemorrhage compared to no anticoagulation (OR 1.2, 95% CI 1.0–1.4), while direct oral anticoagulant use was not associated with a significant difference in delayed intracranial hemorrhage compared to no anticoagulation (OR 0.9, 95% CI 0.8–1.1). See supplemental material (Supplemental Table e4 and e5) for sensitivity analyses.

Discussion

Interpretation of findings

In this population-based study of 69,321 older patients seen in the ED for a head injury with no intracranial hemorrhage diagnosed on the index ED visit, we found intracranial

Table 1 Baseline characteristics of patients 65 and older seen in the emergency department with a head injury

Variable, %	TOTAL N=69,321	Anticoagulation		
		No oral anticoagulation (n=58,233)	Warfarin (n=3,081)	DOAC (n=8,007)
Demographics				
Age > 80	49.7	46.3	68.2	67.0
Mean age (years \pm SD)	80.1 \pm 8.8	79.5 \pm 8.9	83.6 \pm 7.8	83.3 \pm 7.5
Male	38.0	37.2	41.8	41.7
Missing = 2				
Comorbidities				
Atrial fibrillation	25.7	15.1	77.8	82.7
Cancer	6.6	6.4	6.9	8.0
Coronary artery disease	26.7	23.4	46.3	43.6
COPD	12.5	11.4	17.4	18.4
CHF	14.9	10.1	43.7	38.5
Dementia	26.2	25.1	29.4	32.7
Diabetes	31.5	30.8	36.4	34.5
Hypertension	63.1	61.0	73.4	75.0
Liver failure	1.1	1.1	1.1	1.0
Multiple Sclerosis	0.4	0.5	0.2	0.3
Parkinson	4.3	4.3	3.5	4.3
Renal Failure	9.9	8.9	21.9	12.7
Seizure	3.1	3.0	3.7	3.1
Stroke/TIA (ischemic)	14.5	12.9	21.7	23.7
Stroke (hemorrhagic)	1.8	1.7	2.9	2.2
Venous thromboembolism	4.7	3.0	2.0	2.2
Charlson comorbidity > 3	18.2	15.9	33.3	29.9
Medications				
Clopidogrel	6.8	7.8	2.0	1.8
ED variables				
Hospital type				
Missing = 771				
Community	72.4	73.3	70.6	73.4
Small	5.8	6.0	6.3	4.6
Academic	20.7	20.7	23.1	22.1
Outcome				
CT on index ED visit	73.5	70.4	89.6	90.0
Delayed intracranial hemorrhage within 90 days	1.0	1.0	1.8	1.0

COPD chronic obstructive pulmonary disease, *CHF* congestive heart failure, *DOAC* direct oral anticoagulant, *ED* emergency department, *ICH* Intracranial hemorrhage, *SD* standard deviation, *TIA* transient ischemic attack

hemorrhage occurred in 1% of patients up to 90 days later. Among patients on warfarin, 1.8% had a delayed intracranial hemorrhage within 90 days of the index ED visit, while 1.0% of patients on direct oral anticoagulants and 1.0% of patients not on anticoagulation had an intracranial hemorrhage. Patients on warfarin had a higher odds of delayed intracranial hemorrhage compared to patients not on anticoagulation; however, there was no difference in the risk of

delayed intracranial hemorrhage in patients on direct oral anticoagulants compared to those not anticoagulated.

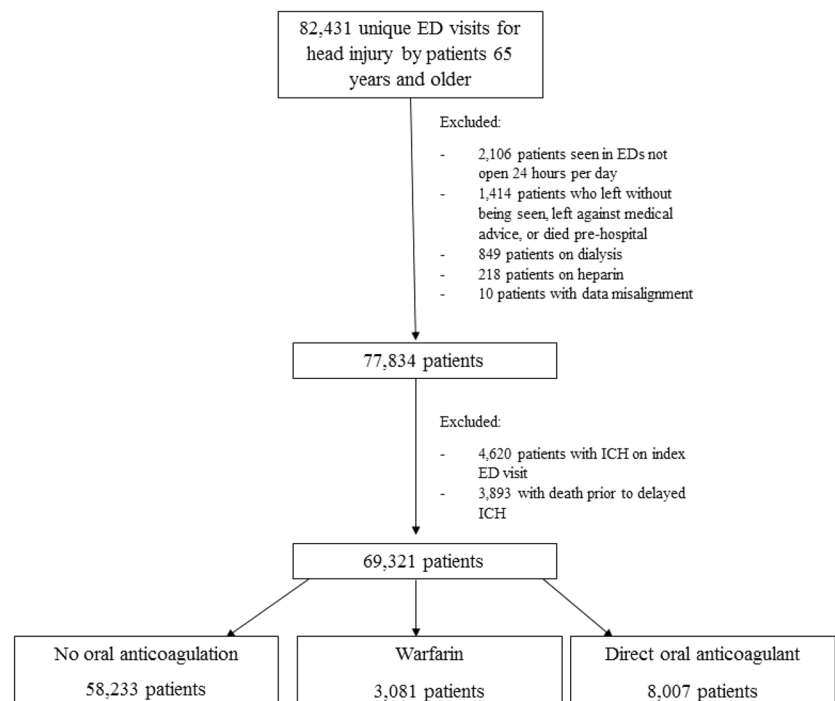
Comparison to previous studies

Overall, we found a low risk of delayed intracranial hemorrhage in older patients seen in the ED with a head injury, including those on anticoagulation. These findings are consistent with previous studies, which have reported a wide

Table 2 Unadjusted and adjusted odds of delayed intracranial hemorrhage within 90 days of index emergency department visit for head injury

Variable	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Anticoagulation		
No oral anticoagulation. (ref)	Ref.	Ref.
Warfarin	1.8 (1.3–2.4)	1.5 (1.1–2.1)
DOAC	1.0 (0.8–1.2)	0.9 (0.6–1.1)
Age > 80	1.4 (1.2–1.6)	1.3 (1.2–1.5)
Male	1.8 (1.6–2.1)	1.9 (1.6–2.2)
Atrial fibrillation	1.2 (1.0–1.3)	0.9 (0.8–1.1)
Cancer	1.1 (0.9–1.5)	1.1 (0.8–1.4)
Coronary artery disease	1.1 (0.9–1.3)	0.9 (0.8–1.1)
COPD	1.0 (0.8–1.2)	0.9 (0.7–1.1)
CHF	1.3 (1.1–1.6)	1.2 (0.9–1.4)
Dementia	1.6 (1.3–1.9)	1.4 (1.2–1.7)
Diabetes	1.1 (1.0–1.3)	1.1 (0.9–1.3)
Hypertension	1.3 (1.1–1.5)	1.2 (1.0–1.4)
Liver failure	1.2 (0.6–2.2)	1.0 (0.5–2.0)
Multiple Sclerosis	1.0 (0.2–4.0)	1.2 (0.3–4.9)
Parkinson	1.2 (0.8–1.7)	1.0 (0.7–1.3)
Renal failure	1.5 (1.2–1.8)	1.2 (0.9–1.6)
Seizure	1.4 (1.0–2.1)	1.1 (0.8–1.7)
Stroke/TIA (ischemic)	1.4 (1.1–1.7)	1.2 (1.0–1.4)
Stroke (hemorrhagic)	2.2 (1.4–3.4)	1.6 (1.1–2.5)
Venous thromboembolism	1.2 (0.9–1.6)	1.0 (0.8–1.4)
Clopidogrel	1.0 (0.7–1.3)	0.8 (0.6–1.1)
Charlson comorbidity > 3	1.3 (1.1–1.6)	1.0 (0.8–1.2)
Small Hospital compared to Community Hospital	0.9 (0.6–1.4)	1.0 (0.7–1.5)
Academic Hospital compared to Community Hospital	1.2 (0.9–1.6)	1.2 (0.9–1.6)

COPD chronic obstructive pulmonary disease, *CHF* congestive heart failure, *CI* confidence interval, *DOAC* direct oral anticoagulant, *TIA* transient ischemic attack, *OR* odds ratio

Fig. 1 Study flow diagram

ranging incidence of delayed intracranial hemorrhage. For instance, in a prospective observational study of 859 older patients with blunt head trauma, overall 0.3% of patients had a delayed intracranial hemorrhage within 14 days (1.3% of patients on warfarin and 0.4% patients not on anticoagulation) [16]. The higher incidence of delayed intracranial hemorrhage in our study may be a result of a combination of factors, including a subsequent injury in the 90-day follow-up period causing intracranial hemorrhage, or a spontaneous intracranial hemorrhage not associated with the initial head injury.

A recent meta-analysis of 12 studies and 5289 patients examined the risk of delayed intracranial hemorrhage in adult patients on anticoagulation, found 69 (1.3%) patients had a delayed intracranial hemorrhage after an initial normal head CT, and the pooled weighted proportion of delayed intracranial hemorrhage in patients on warfarin was 2.3% (95% CI 1.26–3.66) compared to 2.4% (95% CI 1.31–3.88) for patients on a direct oral anticoagulant [9]. In contrast, our study found a higher incidence of delayed intracranial hemorrhage in warfarin users compared to direct oral anticoagulant users. Differences between patients in the meta-analysis and those in our study, as well as the smaller sample size in the meta-analysis may account for these differences, however, our study was consistent in finding that the overall incidence of delayed intracranial hemorrhage in this patient population is low. Further large prospective studies would be required for a more accurate estimate of delayed intracranial hemorrhage.

Limitations

There are several limitations to our study. We defined delayed intracranial hemorrhage as an intracranial hemorrhage within 90 days from the index ED visit for a head injury where there was no diagnosis of an intracranial hemorrhage. We did not have the date of the intracranial hemorrhage in this 90-day period, which limited our ability to comment on timing of delayed intracranial hemorrhage. Furthermore, we cannot comment on whether the intracranial hemorrhage was a complication of the initial head injury, if there was a second head injury causing intracranial hemorrhage, or if the intracranial hemorrhage occurred spontaneously, therefore the rate of true delayed intracranial hemorrhage may be lower than reported. For patients who died within 90 days of the index visit without a diagnosed delayed intracranial hemorrhage, it was unknown if this was due to intracranial hemorrhage or another reason, therefore, these patients were excluded from the primary analysis which may have led us to underestimate the true rate. However, there is no reason to expect that over or under detection of delayed intracranial hemorrhage would have occurred differentially between groups. Although we cannot comment on whether

the delayed intracranial hemorrhages that occurred in non-anticoagulated patients were clinically significant, intracranial hemorrhage diagnosis among anticoagulated patients is important to guide anticoagulation therapy, even when there is no clinical effect. If patients died outside of Ontario after the initial ED visit for head injury, we may not have follow-up information on these patients.

We determined anticoagulation status based on filling of government covered prescriptions. It is possible there was misclassification of patients not using anticoagulants, if their medication was covered by private insurance. We were unable to report aspirin use, because aspirin is usually purchased over-the-counter in Ontario. Our study defined anticoagulant use based on the index ED visit for head injury. Therefore, we do not know whether anticoagulation was continued, changed or stopped in patients after the initial head injury and within the follow-up period, which may also affect the risk of bleeding. We used ED presenting complaint obtained at triage to identify patients with a head injury, which may not capture all head traumas if they had a different presenting complaint recorded or presented as a major trauma. This study used administrative data, therefore there is the possibility of coding errors in for the variables used, including the main diagnosis. However, many previous studies have used the databases we used and found good validity of mandatory variables.

Clinical and research implications

We found warfarin use was associated with a significantly increased odds of delayed intracranial hemorrhage within 90 days of an initial head injury compared to not using anticoagulants, while direct oral anticoagulant use was not associated with delayed intracranial hemorrhage. In our previous study, [15] we found warfarin was associated with an increased risk of intracranial hemorrhage on the index ED visit after a head injury compared to both no anticoagulation and direct oral anticoagulant use. We did not find a difference in the risk of intracranial hemorrhage in patients using a direct oral anticoagulant compared to no anticoagulation. Several guidelines suggest in-hospital observation and possible repeat imaging for elderly patients with a head injury who are anticoagulated because of risk of delayed intracranial hemorrhage [10, 11]. Patients, particularly those on warfarin, should be aware of the risk of delayed intracranial hemorrhage following head injury and be aware of signs and symptoms that should be prompt return ED visits. Future trials are needed to evaluate the benefit of a warfarin-specific head injury follow up protocol. Our study adds further evidence showing that direct oral anticoagulants are safer than warfarin in the adult population, even when examining delayed bleeding.

Other factors associated with increased risk of delayed intracranial hemorrhage in our model included: age > 80 years, male sex, dementia, hypertension and history of hemorrhagic stroke. This is consistent with a previous observational study of delayed intracranial hemorrhage which found older age and hypertension were independent risk factors, although anticoagulant use was not assessed in this analysis [17].

Conclusions

In this population-based study of older ED patients with a head injury, we found the overall risk of delayed intracranial hemorrhage after head injury in elderly patients seen in the ED is low, with no difference in the risk of delayed intracranial hemorrhage between patients on direct oral anticoagulants compared to no anticoagulation. In comparison, we found an increased risk of in patients on warfarin compared to patients not on anticoagulation.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s43678-022-00392-z>.

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