BET 1: COAGULOPATHY AS A RISK FACTOR IN WARFARINISED HEAD INJURY PATIENTS

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ABSTRACT
A short-cut review was carried out to determine whether the International Normalised Ratio (INR) value was a predictor of the risk of intracranial haemorrhage in patients taking warfarin after head injury. 796 papers were found using the reported search, of which eighteen were directly relevant. The author, date and country of publication, patient group studied, study type, relevant outcomes, results and study weaknesses are shown in the accompanying table. It is concluded that level of the INR correlates poorly with the risk of haemorrhage and that the risk of haemorrhage remains significant even in patients with a sub-therapeutic INR.

CLINICAL SCENARIO
A 72-year-old woman presents with a minor head injury (MHI). Her INR was 2, and she has no amnesia or loss of consciousness, therefore not strictly fulfilling the National Institute for Health and Care Excellence (NICE) criteria for a scan. The radiologist on call does not want to scan the patient unless her INR had been >2.5, and so the request is denied.

You wonder why the radiologist had chosen an INR of 2.5 and want to find out more about relevance of the INR in the WHI patient, and specifically to question the reassurance that a therapeutic or even subtherapeutic INR could bring for the otherwise asymptomatic MHI.

THREE-PART QUESTION
In (elderly warfarinised head injury (WHI) patients) does the (International Normalised Ratio (INR)) influence the likelihood of (intracranial haemorrhage (ICH))?

SEARCH STRATEGY
MEDLINE 1946 to August Week 4 2013 using the OVID interface [(exp Craniocerebral trauma/ OR head injur$.mp) AND (exp Warfarin/ OR warfarin.mp OR exp Coumarins/ OR exp Anticoagulants/ OR anticoagula$.mp OR phenprocoumon.mp OR acenocoumarol.mp OR dicumarol.mp OR 4-hydroxycoumarins.mp OR sintrom.mp OR synthrome.mp OR coumadins.mp)] LIMIT to humans AND english language.

SEARCH OUTCOME
In total, 796 papers were found, of which 778 were irrelevant. The remaining 18 were directly relevant to the three-part question and are summarised in the table 1. The references of these papers were also searched but yielded no additional relevant papers.

Relevant papers were those looking at warfarinised head injuries, together with assessment of the presenting INR and a CT scan for assessment of ICH to give an indicator for bleeding.

COMMENTS
There were no randomised controlled trials, but a mixture of case-controlled studies and cohort studies to give grade B recommendations for our emergency department population. There is good evidence here to demonstrate the deleterious effects of a supra-therapeutic INR (Menditto et al, 2012; Major and Reed, 2009; Pieracci et al, 2007; Cohen et al, 2006; Franko et al, 2006), but you would also expect this to accompany clinical signs, a reduced Glasgow Coma Score (GCS) and an increased mortality. It is of more use, though, to examine the impact.
No intracranial injury found in any of the 39 patients who had a CT. Telephone follow-up of the remaining 26 patients revealed no evidence of complications related to their head injuries.

Use of FFP and cryoprecipitate to reverse coagulopathy did not impact on mortality. Nearly half of patients studied underwent craniotomy with 67% 30-day mortality. Overall mortality rate in WHI patients was 50% (816) compared with 20% (51/256) in those without coagulopathy (p=0.011). In subgroup of patients with INR >3.5, the mortality rate approached 75%

10 patients found to have such injuries (7%, 95% CI 3% to 11%). No significant demographic or case-characteristic differences between groups with and without CT-identified injuries. Median (IQR) INR 2.1 (1.8–3.0) CT abnormal vs 2.1 (1.6–2.7) CT normal (p=0.6)

WHI group: no significant differences between those with and those without ICH in terms of age, gender, INR (3.2±1.9 with ICH vs 3.2±2.5 without, p=0.914), or MOI. ISS significantly higher (21.3±8.2 vs 3.4±7.1, p<0.001) and GCS significantly lower (12.0±4.2 vs 14.7±1.6, p<0.001) for patients with ICH. Control group: WHI not significantly different from WHI group but significantly higher ISS than WHI group

Group 2b: All had evidence of ICH on CTB. All had FFP±vitamin K. 3 had craniotomy with decompression (2 died; 1 discharged to nursing/rehab facility) and the 4th declined intervention and subsequently died

Their computer system may not have identified all eligible patients leading to a selection bias. Retrospective. In the 38 patients in whom PT was checked, none was >30 s and almost 1/3 were <14 s, indicating that even though these patients were on warfarin, few were actually AC

Really no data displayed to appreciate. Inadequate sample size for those with INR >3 (n approx. 8) from which to draw meaningful conclusions. Retrospective design using different time periods from 2 centres for an unexplained reason. Selection bias from including only those who had CTB and no follow-up data to ensure no DICH

Well designed but no mention of impact of level of anticoagulation with regards to mortality. Apparently, most patients were therapeutic though

Retrospective chart review from 2 centres, May 1996–May 2000 from 1 and Jan–Dec 1998 from another. 144 WHI patients identified that had CTB. Excluded those with high-risk and moderate-risk findings. Median (IQR) age 83 (77–87)

Mina et al, 2003, USA

Prospective evaluation of all WHI patients seen in ED of level 1 trauma centre between Jan 2001 and Feb 2002 via a ‘Coumadin protocol’ and compared with a group of age-matched patients over the same time period admitted with head injury but not on warfarin. 94 WHIs, mean age 77±11. Control group mean age 75±12 with normal INR values (mean 1.1±0.1)

Reynolds et al, 2003, USA

32 WHI patients over 7-year period identified from trauma registry database at level 2 trauma centre. Group 1–24 patients (mean age 82.5). All GCS 15. 8 had INR checked (mean 2.45, range 1.6–3.6). Group 2a—4 patients. All GCS 15. Mean INR 2 (range 1.5–2.6). Group 2b—4 patients. All GCS 15 but all became comatose within 6 h. Mean INR 2.5 (range 2.3–3.1)

Cohort study

Clinically significant intracranial injury

Cohort study

Clinically important CT injury that results in change in disposition

Case–control study

Demographics

WHI group: no significant differences between those with and those without ICH in terms of age, gender, INR (3.2±1.9 with ICH vs 3.2±2.5 without, p=0.914), or MOI. ISS significantly higher (21.3±8.2 vs 3.4±7.1, p<0.001) and GCS significantly lower (12.0±4.2 vs 14.7±1.6, p<0.001) for patients with ICH. Control group: WHI not significantly different from WHI group but significantly higher ISS than WHI group

ICH

25/94 (27%) WHI group. 47/70 (67%) control group. No significant differences in age, gender, ISS, GCS or MOI

Mortality

Significantly higher WHI group 12/25 (48%) vs 5/47 (10%) control group, p<0.001. WHI group: INR similar (3.3±1.6 dead vs 3.0±2.1 survivors, p=0.585). ISS significantly lower and GCS significantly higher in survivors. Control group: ISS not significantly different but GCS significantly higher in survivors

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<td><strong>Gittleman et al, 2005, USA</strong></td>
<td>89 patients being treated with heparin or coumadin who had a head injury and underwent a CTB at a level 1 trauma centre identified over a 4-year period (April 1997–Jan 2002) using hospital information database and neuroradiology case log. 77 taking coumadin, 8 taking heparin and 4 taking both</td>
<td><strong>Cohort study</strong></td>
<td>ICH</td>
<td>7 patients with ICH and all had GCS &lt;15. Included 3 cerebellar haemorrhages that were more suggestive of hypertensive rather than traumatic aetiology. No significant difference found between those with ICH and those without with respect to coagulation profile (INR 2.2 ± 1.1 with ICH vs 2.5 ± 1.2 without ICH)</td>
<td>Relatively small numbers and failed to meet sample size required by pretest power calculation. Selection bias from only including those who had CTB. Retrospective. No breakdown of ICH patients to say who was on coumadin or heparin and presumably this could skew the mean INR values of the groups. No mortality data or follow-up data either regarding the possibility of DICH</td>
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<td><strong>Ivascu et al, 2005, USA</strong></td>
<td>82 WHI patients identified prospectively between Feb 2003 and April 2007, of which 19 (23%) had evidence of ICH on CTB. Compared with 2 control groups: a group identified during this protocol and a group of historic controls treated before implementation of this protocol to fast-track anticoagulation reversal</td>
<td><strong>Cohort study</strong></td>
<td>Age, sex, MOI, presenting GCS</td>
<td>Not statistically significant between groups with ICH and those without</td>
<td>The validity of comparing the median INR is questionable, as opposed to the comparison of mean INR. There are minimal details given of the level of coagulopathies, such as range, from which more informed conclusions could be drawn</td>
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<td><strong>Cohen et al, 2006, USA</strong></td>
<td>77 patients from 2 trauma databases over 3-year period on warfarin with minor head injury (GCS 13–15). Average age 68. INR obtained in 57% with average 4.4 and values &gt;3 in 47%, range 1.8–9.5. (There was another group of 49 patients who had GCS &lt;8, average age 65. Average INR 6.5, 50% &gt;5. Mortality 87.8%)</td>
<td><strong>Cohort study</strong></td>
<td>Mortality</td>
<td>20 evaluated and sent home from ED. Of these, 35% had CT and all were normal. 18 returned and subsequently diagnosed with significant ICH. 2 patients died at home, 1 with autopsy-confirmed acute SDH. Overall mortality in these 20 patients was 88.8%. 45 patients admitted for observation for head injury± treatment of other injuries. CT obtained before admission in 70%, with only 4 showing any ICH. Within 8–18 h of injury (mean 12 h), 80% deteriorated to GCS &lt;10 with ICH. Mortality in this group 84%. 12 patients presented within h or days of injury with ICH. All underwent emergent craniotomy with a resultant mortality of 83.3%</td>
<td>No matched control group. Majority of patients supra-therapeutically AC, and of those undergoing CT on initial presentation, only slightly more than 30% had any evidence of ICH. Retrospective</td>
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<td><strong>Franko et al, 2006, USA</strong></td>
<td>Retrospective analysis of consecutive series of 1493 adult blunt head injury patients between Jan 2001 and May 2005. 159 warfarinised patients identified and were significantly older, with average age 78±10 and average INR 2.4±1.06</td>
<td><strong>Case–control study</strong></td>
<td>ISS, LOS</td>
<td>Significantly greater 14.5±8.4 WHI vs 12.4±9.4 control, p&lt;0.01</td>
<td>They cite a selection bias through education of AC patients, encouraging the seeking of early medical attention, even after seemingly minimal trauma, and so more of these patients present for evaluation. It is suggested that non-therapeutic users and non-users (NU) had similar results, but they were not compared directly. Retrospective</td>
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<td>Pieracci et al, 2007, USA</td>
<td>Retrospective study (2004–2006) of all trauma patients aged &gt;65 (n=275) evaluated by a trauma service at a level 1 trauma centre who had a CTB following a head injury, including 40 WHI. 3 cohorts compared: (1) WHI with INR ≥2 (therapeutic group (TG)), n=22, 11 of whom had INR &gt;3. Mean INR 3.33, range 2.12–7.28. (2) WHI with INR &lt;2 (non-therapeutic group (NT)), n=18. Mean INR 1.51, range 1.00–1.96. (3) Warfarin NU, n=235. Mean INR 1.11, range 0.87–4.01</td>
<td>Case–control study</td>
<td>Admission GCS</td>
<td>TG 9 patients (40.9%), p=0.001; NT 2 patients (11.1%); NU 22 patients (11.9%). OR=3.13, 95% CI 1.97 to 13.39.</td>
<td>Relatively small sample size, therefore, unable to fully compare warfarin users with INR ≥2–3 with those with INR ≥2–3. Results suggest threshold rather than a linear relationship between level of anticoagulation and risk of ICH, which is consistent with exponential scale of INR. However, both a small number of therapeutic users and a relatively narrow range of INRs among them preclude more detailed analysis. Retrospective</td>
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<td>ICH</td>
<td>TG 17 patients (77.2%), p=0.10; NT 9 patients (50.0%); NU 105 (56.8%). OR=2.59, 95% CI 0.92 to 7.32, p=0.07 comparing TG to NU group. Subgroup analysis revealed no difference in likelihood of ICH between those with INR 2–3 (9/11, 81.8%) and INR &gt;3 (8/11, 72.7%)</td>
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<td>Overall mortality</td>
<td>TG 7 patients (31.8%), p=0.009; NT 2 patients (11.8%); NU 17 patients (9.4%). OR=4.48, 95% CI 1.60 to 12.50, p=0.004 comparing TG to NU group</td>
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<td>Mortality after ICH</td>
<td>TG 6 patients (35.3%), p=0.01; NT 1 patient (12.5%); NU 14 patients (13.7%). OR=3.42, 95% CI 1.09 to 10.76, p=0.03 comparing TG to NU group</td>
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<td>Grandhi et al, 2008, USA</td>
<td>Retrospective review of all patients evaluated at level 1 trauma centre between Jan 2000 and Dec 2006, to include patients ≥65 coded with a closed head injury. 52/491 (11%) were documented as taking warfarin (AC) and subsequently compared with those not AC (NAC) by 1:3 propensity matching. Mean admission INR in AC group 2.4±1.2</td>
<td>Case–control study</td>
<td>Ventilator LOS (days)</td>
<td>2.8±7.9 AC vs 1.5±5.8 NAC, p=0.08</td>
<td>Numbers too small to determine if there was a certain level of anticoagulation for which outcomes significantly worsened type 2 error. Analysis of association between degree of anticoagulation and various measures of morbidity and mortality with larger sample populations may be able to determine a ‘cut-off’ INR value for which the benefits of anticoagulation are outweighed by its potential complications. Retrospective</td>
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<td>ICU LOS (days)</td>
<td>6.4±11.8 AC vs 4.4±7.3 NAC, p=0.19</td>
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<td>Hospital LOS (days)</td>
<td>10.5±13.6 AC vs 9.1±12.1 NAC, p=0.97</td>
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<td>Mortality</td>
<td>19/49 (38.8%) AC vs 34/147 (23.1%) NAC, p=0.04</td>
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<td>Major and Reed, 2009, UK</td>
<td>399 patients presenting to University Hospital ED with head injury and coexistent anticoagulant (warfarin) or antiplatelet (aspirin, clopidogrel or dipyridamole) therapy who were admitted to the hospital over a 3-year period (Jan 2005–Dec 2007), identified through search of electronic patient records</td>
<td>Cohort study</td>
<td>ICH</td>
<td>110 patients (28% had CTB, of which 24 showed ICH. 4 died and 2 had neurosurgical intervention, but none of these were warfarinised. Of 89 patients on warfarin (including 5 also on aspirin), 37 (33%) underwent CTB, with 4 of these (15%) having ICH. There were 63 patients on warfarin who had an INR &lt;3 (2/17 +ve scans) and 26 who had an INR &gt;3 (2/10 +ve scans). The RR of a patient having a +ve CT with an INR &gt;3 compared with an INR &lt;3 was 1.7 (95% CI 0.3 to 10.3)</td>
<td>Patients discharged from ED excluded leading to a selection bias. Retrospective. Only 44/110 patients scanned had the indication recorded. No information as to whether those with +ve scans were the ones with indications for scanning. May suggest that a significant proportion of this cohort was low risk</td>
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<td>Brewer et al, 2011, USA</td>
<td>Retrospective review of trauma registry at level 2 trauma centre. All trauma registry patients with MHI registered between 2004 and 2006 who were taking clopidogrel or warfarin. GCS 15 and had CTB included. Trauma registry includes all patients admitted to or consulted by the trauma service. 141 patients (mean age 79, range 36–101)</td>
<td>Case–control study</td>
<td>ICH</td>
<td>41 patients (29%) diagnosed with ICH, 23/84 (27%) on warfarin. Mean presenting INR with ICH 1.97±0.92 compared with 2.3±1.2 without ICH (p=0.0987). 15/36 (41%) on clopidogrel, 3/21 (14%) on combination therapy. 39 (95%) of patients with ICH underwent reversal discontinuation of clopidogrel: warfarin. 5 patients required surgical evacuation of ICH. 4 patients died. LOC (Wald=7.468, β=1.179, p=0.008) predicted a +ve CT. Type of medication (warfarin, clopidogrel or aspirin) did not reach statistical significance as a predictor of a +ve CT</td>
<td>Patient population only includes those from trauma registry and may explain a selection bias. Relatively small numbers and retrospective design</td>
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<td><strong>Claudia et al, 2011, Italy</strong></td>
<td>Medical records of 1554 adult patients with MHI evaluated by a University Hospital ED between Jan 2007 and Feb 2008 analysed retrospectively. 1410 patients (mean age 57) had at least 1 risk factor and so underwent CTB. 75 patients (5.2%) on warfarin</td>
<td>Case–control study</td>
<td>ICH</td>
<td>89 patients in total (12 warfarinised) Anticoagulation (OR=2.69, 95% CI 1.36 to 5.3, p&lt;0.005) multiple linear regression: coefficient β 0.078, t=2.841, p=0.005 Mean INR for warfarinised patient 2.37±1.04 and was significantly associated with ICH after head injury (r=0.37, p&lt;0.005). INR values analysed using ROC curve, AUC 0.76 (95% CI 0.62 to 0.91), p&lt;0.05. Showed that most effective INR cut off value was 2.43, with sensitivity of 92%, specificity of 66%, and PPV and NPV of 33% and 97%, respectively</td>
<td>Small sample size—12/75 with ICH. Retrospective</td>
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<td><strong>Menditto et al, 2012, Italy</strong></td>
<td>97 prospectively enrolled consecutive warfarinised (for at least 1/52) patients ≥14 years old in Level 2 trauma centre without ICH on 1st CT after minor head injury (any head trauma, other than superficial injury to face, presenting with GCS 14 or 15), regardless of presence of absence of LOC, within 48 h of injury, with ISS &lt;15 between Jan 2007–Mar 2010. Structured clinical pathway implemented, comprising 24-h period of observation and 2nd CT prior to discharge</td>
<td>Case series</td>
<td>Immediate TICH</td>
<td>19/97 (16%) +ve initial CT scan No deaths reported 5/97 (6%) (95% CI 1% to 11%). Only 1 showed signs of neurological deterioration during observation period, 2/5 were discharged anyway as ICH regarded as minimal. 2 discharged after completing study protocol with –ve CT admitted 2/7 and 8/7 later with symptomatic SDH; neither required surgery. 2/5 with DICH at 24 h had initial INR &gt;3 as did both beyond 24 h (RR DICH with INR &gt;3 was 14 (95% CI 4 to 49)). 10 refused 2nd CT and were well during 30/7 follow-up 3 hospitalised 1 craniotomy</td>
<td>None had GCS 14 or received concomitant antithrombotic therapy. Only 5 developed ICH by 2nd CT—therefore lacking statistical power to analyse multivariate predictors of such haemorrhage. Not designed to investigate optimal period of observation before repeat CT</td>
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<td><strong>Nishijima et al, 2012, USA</strong></td>
<td>Prospective observational study at 2 trauma centres and 4 community hospitals’ EDs in California of patients ≥18 with blunt head trauma (most commonly ground level fall (83.3%), regardless of LOC/amnesia and preinjury warfarin or clopidogrel use (but not both) within previous 7/7 between Aug 2009–Jan 2011. Followed for 2/52 by review of in-patient electronic medical record or by telephone survey if already discharged. 1064 patients enrolled (768 warfarin (72.2%) and 296 clopidogrel (27.8%)). 364 (34.2%) from level 1 or 2 trauma centres and 700 (65.8%) community hospitals. 1000 received head CT in ED. Both warfarin and clopidogrel groups had similar demographics and clinical characteristics, although concomitant aspirin use more prevalent among clopidogrel group. Enrolled after screening by treating physician (16.7% missed by screening failure, but these had similar characteristics and outcomes). Repeat CT was at clinicians’ discretion. Excluded patients with known injury transferred in as their injuries would falsely inflate prevalence of TICH. 78.5% had INR checked, median 2.5; IQR 2.0–3.3</td>
<td>Cohort study</td>
<td>Immediate TICH</td>
<td>37/724 (5.1%) (95% CI 3.6% to 7.0%). Follow-up of 63/64 not undergoing initial CT showed no subsequent diagnosis of TICH. Majority of patients (62.2%) had GCS 15, and 4/37 (10.8%) had no LOC, GCS 15 and no evidence of trauma above clavicles 8/37 (21.6%) (95% CI 9.8% to 38.2%)</td>
<td>Observational—not everyone scanned initially for ethical reasons, or routinely before discharge. Clinical follow-up though to elicit clinically important outcomes. Warfarin users more aware of risks and so more likely to present with less severe mechanisms of injury</td>
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<td>Nishijima et al, 2013, USA</td>
<td>Secondary aims from previously published study data (see below). Those without initial CT however excluded, leaving 982 patients on warfarin (72.7%) or clopidogrel. Mean age 75 with almost equal sex distribution, 83.6% were ground level falls and 89.5% were GCS 15</td>
<td>Cohort study</td>
<td>Immediate TICH</td>
<td>60 patients (6.1%; 95% CI 4.7% to 7.8%). None of 65 without initial CT were later diagnosed with TICH although 2 were lost to follow-up. 31/60 warfarinised. RR of warfarin 0.40 (95% CI 0.25 to 0.65) 10/60 (16.7%; 95% CI 8.3% to 28.5%)</td>
<td>In addition to comments for the previous paper, there were relatively few patients meeting primary outcome of immediate TICH, however, including more patients with TICH would not resolve the fact that many patients with immediate TICH appeared to have no risk factors for TICH beyond age and anticoagulant use. Also limited ability to conduct subgroup analyses by medication type (warfarin or clopidogrel) or by INR level</td>
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<td>Rendell and Batchelor, 2013, UK</td>
<td>82 WHI patients identified from 3238 CT scans requested by the ED over 2-year period (Jan 2008–Dec 2009) 72/82 (88%) patients had their INR checked</td>
<td>Cohort study</td>
<td>Immediate TICH</td>
<td>12/82 (15%). RR of ICH for INR subgroups calculated: INR &lt;2 (RR 1.88; 95% CI 0.65 to 5.55); INR 2–3 (RR 0.84; 95% CI 0.27 to 2.64); and INR &gt;3 (RR 0.53; 95% CI 0.13 to 2.29). The greatest proportion of those with ICH (42%) had a sub-therapeutic INR. 2/12 (17%) found to have ICH despite not meeting criteria for a CT scan according to NICE. Results of INR subgroup analysis suggest that a sub-therapeutic INR may not be protective against ICH following a minor head injury</td>
<td>Retrospective review so never easy to capture all patients. However, a random trawl of notes over a 2-month period coded as head injury revealed no further patients. Small, but comparatively equivalent sample size, did not allow statistically significant conclusions, but did, however, yield interesting conclusions</td>
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aOR, adjusted OR; AUC, area under the curve; CTB, CT brain; DICH, delayed intracranial haemorrhage; ED, emergency department; FFP, fresh frozen plasma; GCS, Glasgow Coma Score; ICU, intensive care unit; INR, International Normalised Ratio; ISS, injury severity score; LOC, loss of consciousness; LOS, length of stay; MHI, minor head injury; MOI, mechanism of injury; NICE, National Institute for Health and Care Excellence; NPV, negative predictive value; PPV, positive predictive value; PT, prothrombin time; ROC, receiver operator curve; RR, relative risk; SDH, subdural haematoma; TICH, traumatic intracranial haemorrhage; WHI, warfarinised head injury.
of the INR in the low risk patient: one who is asymptomatic with GCS 15. Cohen et al (2006) highlight significant inconsistencies in the management of this group of patients even in a single centre, particularly with respect to measuring the INR, obtaining a CT scan and indeed the timing of this scan. They suggest routine measurement of the INR in all those warfarinised and consideration of routine CT scanning. There is much to suggest, though, that there is not a great causal signficance in the level of coagulopathy in the low-risk WHI patient (Rendell and Batchelor, 2013; Nishijima et al, 2012). Nishijima et al (2013), Nishijima et al (2012), Gittleman et al (2005) and Li et al (2001) demonstrate the high incidence of ICH in anticoagulated patients following seemingly trivial injury without high-risk features. Furthermore, Rendell and Batchelor (2013), Brewer et al (2011) and Reynolds et al (2003) found no statistical difference in INR between those with positive compared with negative scans, Mina et al (2003) between those that died compared with survivors and Reynolds et al (2003) between those with ICH who remained stable compared with those who subsequently deteriorated. Rendell and Batchelor (2013) and Ivascu et al (2005) conclude that neither the GCS nor the level of anticoagulation can reliably predict the presence of ICH, even that a sub-therapeutic INR appears to offer no protection, and that urgent scanning combined with prompt reversal can reduce ICH progression and improve mortality. Therefore, both the clinical picture and the INR have not shown to be effective at ruling out ICH in the asymptomatic WHI patient. It is, nevertheless, an important investigation in this setting, as an early check has been shown to allow rapid time to reversal of the INR with ICH. Importantly, Nishijima et al (2013) and Rendell and Batchelor (2013) found that there was no ‘low-risk group’ of warfarinised head injury patients safely managed without CT despite their apparent well-being. In the presence of a normal CT scan, it would appear to be prudent to admit a patient with a supra-therapeutic INR for at least a period of observation, and perhaps consideration given to short-term reversal of anticoagulation, as advocated by Cohen et al (2006).


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