Falls are common in the elderly, but the appropriate criteria for a head computed tomography (CT) is still largely undefined [1]. The risk for radiation-induced malignancy is a consideration in younger patients [2] but is less important in elderly patients with a shorter expected lifespan. However, obtaining a CT scan and waiting interpretation adds to the length of stay in the emergency department (ED), contributing to overcrowding and increasing costs [3]. ED crowding has negative consequences including poorer patient outcomes and the inability of staff to adhere to guideline-recommended treatment [4].

Experts recommend either universal CT head scanning in elderly patients or limiting testing to patients with loss of consciousness or decreased consciousness on admission after a traumatic brain injury, or treatment with an oral anticoagulant [5-13]. Commonly, emergency departments continue to use the 2008 recommendations of the American College of Emergency Physicians [10-13] to scan anyone 65 years of age or older after a head trauma, without distinction. However, there are studies that have adopted commonly used criteria for a CT head scan but have excluded age as single criteria for testing [8]. Furthermore, 50% of the 71 trauma centers in Europe do not order a CT scan in patients aged 60 years or older without other risk factors [9].

We studied the risk of an intracranial bleed in elderly patients with head trauma after a fall, and attempted to predict those with an intracranial hemorrhage (ICH) with and without surgical intervention.

PATIENTS AND METHODS
We included all hospitalizations in 2017 in an internal medicine emergency department patients aged 65 years or more, and reviewed all cases where a head CT scan was conducted. There were 9364 patients and 412 head CT scans performed (4.4%) [Table 1]. All elderly patients after head trauma are hospitalized for at least 24 hours.

We selected those with low velocity head trauma after a fall (N=206). Falls were a defined as a sudden involuntary change...
from a vertical position, from a standing position. Patients slipping off a bed or a chair receiving a head CT scan were also
loss of consciousness after falling, facial fractures (nose or si-
help, but able to walk unassisted), facial/scalp sutures, and neu-
rological signs on admission. Minimal brain trauma was defined
as no loss of consciousness after the fall, retrograde amnesia,
oral anticoagulation treatment, or neurological findings on ad-
mission, including an acute decrease in mental status. The out-
come variables were an ICH and the need for neurosurgery.

STATISTICAL ANALYSIS
We calculated proportions and relative risks with 95% confi-
dence intervals. Furthermore, we determined the sensitivity of
various criteria to identify an ICH and the proportion of CT
scans that would not be ordered in the absence of the individual
criteria. Logistic regression analysis was not done because of
small numbers.

The study was approved by the local ethics committee (0032-
18 LND), which is reviewed by the Ministry of Health. Patient
informed consent was waived.

RESULTS
There were 412 CT head scans performed in the emergency
department for patients aged 65 years or older [Table 1]. Of
those patients, head trauma was the cause for referral in 50.0%
(N=206). There were 14 ICHs (6.8%, 3.8–11.1%) and three
(1.5%, 0.3–4.2%) with a neurosurgical procedure. One patient
presenting with a coma (0.5, 0.0–2.7) died 2 hours after arriving
[Table 2]. Intracranial bleeds were more common in males, in
patients with a headache, in those presenting with neurological
signs or loss of consciousness after the fall, and in those with
facial fractures [Table 3] but the confidence limits of the relative
risks were wide because of small numbers. Age ≥ 80 years, need
for head sutures, oral anticoagulation, and Rankin grade 3 were
not associated with an intracranial bleed.

All of the patients who died or required neurosurgery had
neurological signs on admission (N=4) [Table 4], which were
not found in 97.1% (200/206) (93.8–98.9%) of the patients.
Seven of the 14 patients with an ICH had only a minimal brain
injury, but adding a facial fracture identified 12 of the 14 pa-
tients (85.7%), not found in 83.5% (95% confidence interval
[95%CI] 77.7–88.3) of the cohort. Adding Rankin scale 3 or
greater identified all patients with an ICH, and was not found in
108 of the 206 patients (52.4%, 95%CI 45.4–59.4).

DISCUSSION
The major finding of this study was that no elderly patient pre-
senting with head trauma without neurological findings on ad-
mission had a serious ICH that lead to death or the need for a
neurosurgical procedure. If patients without neurological signs
did not have a head CT ordered, there would be a 97.1% reduc-
tion in tests performed in patients referred for head trauma.

However, it is unclear if prediction models should attempt
to detect all patients with ICH or only those with clinically im-
portant lesions and whether early diagnosis of a traumatic ICH
will improve the clinical outcome. We found that CT scans in
patients presenting with neurological signs, post-trauma loss
of consciousness, treatment with oral anticoagulants, or facial
fractures detected 85.7% of those with an ICH and if used as
the criteria for ordering a CT head scan would reduce testing
by 83.5%. This finding is consistent with a study that found that
CT-detected skull fractures were the strongest clinical predic-
tors for an ICH in the elderly [6]. However, in our study, al-
though the CT scan identified the facial fracture, all of whom
complained of a headache, it is unclear if sensitivity to palpation
could detect all those with a nose or sinus fracture, and with
what proportion of false positives. There is one study reporting
that the physical examination had approximately 90% sensitivi-
ty and specificity in identifying a nasal fracture [14]. We did not
find that the need for head sutures was more common in those
with an ICH; thus, facial fractures might be a more specific indi-
cator than any evidence of trauma above the clavicle.

One study of elderly patients without mental status chang-
es reported that those without signs of head trauma including
contusions, abrasions, lacerations, avulsions, or ecchymosis had

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Table 1. Reasons for head CT scan in 412 patients

<table>
<thead>
<tr>
<th>Reasons for CT scan</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head trauma</td>
<td>206 (50.0)</td>
</tr>
<tr>
<td>Acute stroke</td>
<td>48 (11.7)</td>
</tr>
<tr>
<td>Transient ischemic attack</td>
<td>16 (3.9)</td>
</tr>
<tr>
<td>Deterioration/weakness</td>
<td>44 (10.7)</td>
</tr>
<tr>
<td>Decreased mental status</td>
<td>29 (4.0)</td>
</tr>
<tr>
<td>Headaches</td>
<td>13 (3.2)</td>
</tr>
<tr>
<td>Seizures</td>
<td>14 (3.4)</td>
</tr>
<tr>
<td>Vertigo</td>
<td>13 (3.2)</td>
</tr>
<tr>
<td>Loss of consciousness</td>
<td>12 (2.9)</td>
</tr>
<tr>
<td>Coma</td>
<td>5 (1.2)</td>
</tr>
<tr>
<td>Before lumbar puncture</td>
<td>4 (1.0)</td>
</tr>
<tr>
<td>Other conditions*</td>
<td>8 (1.9)</td>
</tr>
</tbody>
</table>

*dysarthria-1, hemianopsia-1, arrhythmia-2, shoulder injury-1, suspected cerebral vascular accident-3
CT = computed tomography
a rate of 2.6% of ICH compared to 7.3% of those with signs of head trauma [15]. However, the specificity was only 37.8%. None had neurosurgery. Another study identified all elderly patients with an ICH if they had a headache or evidence of trauma above the clavicle but the specificity was only 16.2% [16].

Our results are consistent with the results of six previous studies of elderly patients. Bennett and colleagues [16] studied 296 patients aged 65 years or older with a simple fall excluding those with multi-trauma. They found nine (3%) with ICH, but no patient required neurosurgery. In a second study, Davey and co-authors [17] reported that only 1.4% (2/137) of elderly patients > 65 years with minimal head injury had an ICH without need for neurosurgery. In a third study, 723 elderly patients selected for no change in mental status and not referred to the trauma bay, none had neurological procedures, and 52 (7.3%) had ICH [15]. In a fourth study, Riccardi et al. [18] excluded patients with any symptoms except in the area of trauma, on oral anticoagulant therapy, loss of consciousness after the event, a fall from over 1 meter height, neurological signs, previous neurosurgical intervention, neurological disorder, alcohol or illicit drugs assumption, and patients with abnormal conscious state.

Table 2. Fourteen patients with intracranial bleeding after low velocity head trauma

<table>
<thead>
<tr>
<th>Age/sex</th>
<th>Rankin scale*</th>
<th>Facial Fracture</th>
<th>LOC</th>
<th>Neurological signs</th>
<th>Diagnosis and other relevant clinical considerations</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>92/Female</td>
<td>3</td>
<td>–</td>
<td>+</td>
<td>Coma</td>
<td>Acute and chronic SDH- midline deviation</td>
<td>Died 2 hours after admission</td>
</tr>
<tr>
<td>86/Male</td>
<td>3</td>
<td>–</td>
<td>–</td>
<td>Confusion, and unsteady gait</td>
<td>Chronic and re-bleed SDH +mass effect</td>
<td>Craniotomy</td>
</tr>
<tr>
<td>65/Male</td>
<td>0–2</td>
<td>–</td>
<td>–</td>
<td>Dysarthria</td>
<td>SDH+ parenchymal edema, brain herniation</td>
<td>Craniotomy</td>
</tr>
<tr>
<td>84/Male</td>
<td>0–2</td>
<td>Maxillary sinuses</td>
<td>+</td>
<td>Post-trauma amnesia</td>
<td>Parenchymal bleed</td>
<td>Shunt</td>
</tr>
<tr>
<td>66/Male</td>
<td>0–2</td>
<td>–</td>
<td>+</td>
<td>None</td>
<td>SDH</td>
<td>No treatment</td>
</tr>
<tr>
<td>79/Female</td>
<td>3</td>
<td>Nose</td>
<td>–</td>
<td>None</td>
<td>SDH, anticoagulants for atrial fibrillation.</td>
<td>Stop anticoagulants, neurosurgery consult</td>
</tr>
</tbody>
</table>

Table 3. Low velocity head trauma in 206 elderly patients comparing those with and without intracranial bleeding

<table>
<thead>
<tr>
<th>Predictor</th>
<th>No bleeding (N=192), n (%)</th>
<th>Bleeding (N=14), n (%)</th>
<th>Relative risk (95% confidence interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>75 (39.1)</td>
<td>11 (78.6)</td>
<td>2.0 (1.5–2.8)</td>
</tr>
<tr>
<td>Age, in years ≥ 80</td>
<td>116 (60.4)</td>
<td>7 (50.0)</td>
<td>0.8 (0.5–1.4)</td>
</tr>
<tr>
<td>Oral anticoagulants</td>
<td>7 (3.6)</td>
<td>1 (7.1)</td>
<td>0.7 (0.3–14.8)</td>
</tr>
<tr>
<td>Rankin ≥ 3</td>
<td>72 (29.0)</td>
<td>5 (35.7)</td>
<td>1.0 (0.7–1.3)</td>
</tr>
<tr>
<td>Head sutures</td>
<td>21 (10.9)</td>
<td>1 (7.1)</td>
<td>0.7 (0.1–4.5)</td>
</tr>
<tr>
<td>Headache</td>
<td>150 (78.1)</td>
<td>14 (100)</td>
<td>1.3 (1.2–1.4)</td>
</tr>
<tr>
<td>Facial fractures</td>
<td>16 (8.3)</td>
<td>7 (50.0)</td>
<td>6.0 (3.0–12.1)</td>
</tr>
<tr>
<td>Neurological signs*</td>
<td>2 (1.0)</td>
<td>4 (28.6)</td>
<td>27.4 (5.5–137.0)</td>
</tr>
<tr>
<td>Loss of consciousness**</td>
<td>2 (1.0)</td>
<td>4 (28.6)</td>
<td>27.4 (5.5–137.0)</td>
</tr>
</tbody>
</table>

*neurological signs: dysphagia, stupor, confusion with unsteady gait, coma, post-trauma amnesia, and confusion at admission (n=2)  
**after the trauma
for dementia or psychosis. They reported a 1.6% rate of ICH (35/2149) requiring surgery in three patients (0.14%). ICHs were higher in those taking anti-platelet medications, and in those over age 80 years old but they did not report the clinical presentation of the three patients requiring surgery. Pages and colleagues [12] reported 7.6% ICHs in 500 elderly patients who fell (mean age 85 years) but only three (0.6%) required surgical intervention. Risk factors for an ICH included male sex, decreased consciousness, focal neurological findings and a past history of a post-traumatic brain injury. They did not report the details of those requiring emergency surgery, but none required surgery on follow-up. Finally, Gangavati et al [19] reported a 1.7% (7/404, 95%CI 0.7–3.5) rate of surgical interventions in elderly patients who fell and presented without focal neurological deficits, a 1.7% (7/404, 95%CI 0.7–3.5) rate, but details of post-trauma loss of consciousness or mental status on admission were not reported in those patients.

None of our patients deteriorated during hospitalization suggesting that the hospitalization was unnecessary. This finding is consistent with other reports. Campiglio et al. [20] reported that even in patients on anticoagulants a delayed traumatic ICH in patients with mild brain injury was 1.4% (4/284) and did not occur in any patient with Glasgow Coma Scale/Score (GCS) of 15 and an unremarkable neurological examination. An Israeli study of elderly patients with an ICH, a mild TBI and a high GCS score were non-operatively treated, discharged home in a relatively short time and did not experience any major drop in their functional status [21]. Marincowitz et al. [1] reported that patients with a small ICH, an initial GCS of 15, and a normal neurological examination did not die or require neurosurgery over a 30-day follow-up period. We had one patient with an ICH on oral anticoagulation therapy that was discontinued.

**LIMITATIONS**

Our study has a number of limitations. First, there were only 14 patients with an ICH; therefore, attempts to establish criteria to identify those patients are problematic and multivariate analysis is invalid. This finding, however, is inherent for any condition with an uncommon outcome measure and in itself demonstrates the low clinical utility of the procedure. Second, there is referral bias. Our hospital is regional, but all cases suspected as needing a neurosurgeon, are referred to larger hospitals in other areas. This method is unlikely to include patients with minimal brain trauma, but it is unclear how physicians determine which patient to refer. Finally, recommendations on the use of head CT scanning might be setting specific, and physicians might order a head CT in elderly patients without indications to reassure the patient, because of patient expectations, or the worry of legal liability [17].

**CONCLUSIONS**

Our patients without neurological findings did not require neurosurgery, and careful palpation of the facial bones to identify facial fractures might aid in the decision whether to perform a head CT scan. There is a need for multicenter studies to determine if this retrospective observation is an important predictor of an intracranial hemorrhage and more importantly indicative of the need for surgical intervention in elderly patients with a minimal brain injury.

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**References**


**Table 4. Options for head CT scanning in the elderly with low velocity falls**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>N, n (%), 95%CI</th>
<th>Intracranial bleeds, n (%), 95%CI</th>
<th>Surgery/death, n (%), 95%CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>All patients</td>
<td>206</td>
<td>14 (6.8, 3.8–11.1)</td>
<td>4 (1.9, 0.5–4.9)</td>
</tr>
<tr>
<td>No neurological findings</td>
<td>200 (97.1, 93.8–98.9)</td>
<td>10 (5.0, 2.4–9.0)</td>
<td>0 (0.0, 0.0–1.8)**</td>
</tr>
<tr>
<td>Minimal injury*</td>
<td>195 (94.7, 90.6–97.3)</td>
<td>7 (3.6,1.5–7.3)</td>
<td>0 (0.0, 0.0–1.9)**</td>
</tr>
<tr>
<td>+No facial fracture</td>
<td>172 (83.5,77.7–88.3)</td>
<td>2 (1.2, 0.1–4.1)</td>
<td>0 (0.0, 0.0–2.1)**</td>
</tr>
<tr>
<td>+No Rankin-3</td>
<td>108 (52.4,45.4–59.4)</td>
<td>0 (0.0, 0.0–3.4)**</td>
<td>0 (0.0, 0.0–3.4)**</td>
</tr>
</tbody>
</table>

*no post-trauma loss of consciousness, neurological findings, or anticoagulation therapy  
**97.5% one sided  
95%CI = 95% confidence interval, CT = computed tomography


What is the opposite of two? A lonely me, a lonely you.
Richard Wilbur (1921–2017), American poet and translator

It’s surprising how much memory is built around things unnoticed at the time.
Barbara Kingsolver (born 1955), novelist, essayist, and poet

Heavy hearts, like heavy clouds in the sky,
are best relieved by the letting of a little water.
Christopher Morley (1890–1957), writer

Capsule

Final report of a trial of intensive versus standard blood-pressure control

The SPRINT Research Group randomly assigned 9361 participants who were at increased risk for cardiovascular disease but did not have diabetes or previous stroke to adhere to an intensive treatment target (systolic blood pressure < 120 mmHg) or a standard treatment target (systolic blood pressure < 140 mmHg). At a median of 3.33 years of follow-up, the rate of the primary outcome and all-cause mortality during the trial were significantly lower in the intensive-treatment group than in the standard-treatment group (rate of primary outcome 1.77% per year vs. 2.40% per year, hazard ratio 0.73, 95% confidence interval [95%CI] 0.63–0.86, all-cause mortality 1.06% per year vs. 1.41% per year, hazard ratio 0.75, 95%CI 0.61–0.92). Serious adverse events of hypotension, electrolyte abnormalities, acute kidney injury or failure, and syncope were significantly more frequent in the intensive-treatment group. When trial and post-trial follow-up data were combined (3.88 years in total), similar patterns were found for treatment benefit and adverse events; however, rates of heart failure no longer differed between the groups.

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