SHORT COMMUNICATION

Development of a risk score to guide brain imaging in older patients admitted with falls and confusion

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Objectives: CT scanning of the brain is commonly performed in older people admitted to hospital with a fall, but the yield of positive findings is low. We used audit data to develop a risk-stratification score to guide more efficient use of CT scanning.

Methods: 12 potential predictors of positive CT findings were derived from a literature review. Case notes of consecutive patients presenting with falls and confusion who had undergone brain imaging were reviewed as part of an ongoing audit. Correlation of each factor with positive CT findings was undertaken and a final risk score was developed. Receiver-operating characteristic analysis was undertaken, an optimum cut-off identified, and positive and negative predictive values were calculated.

Results: 66 patients with a mean age of 74.8 years were included. 13 of the 66 (20%) brain imaging studies revealed a new pathology. Previous history of falls, atrial fibrillation, head or face trauma, focal neurological signs, warfarin use and a Glasgow coma score of <14 were significant univariate positive predictors. Antecedent dementia was included as a negative predictor. The final weighted score (range –1 to 8 points) gave an area under the curve of 0.83 (95% confidence interval 0.70 to 0.96, $p < 0.001$). When using a cut-off of 3 points, sensitivity for significant new pathology on brain imaging was 83%, specificity was 89%, positive predictive value was 63% and negative predictive value was 96%.

Conclusion: A simple weighted risk score may be able to guide the need for brain imaging in older people presenting to hospital with falls. The score requires validation in a larger, prospectively collected cohort.

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Patients who fall and present to medical admissions units with confusion pose a diagnostic problem because of their inability to give a coherent history. A pre-existing diagnosis of dementia often further hampers the clinical assessment; because of these reasons, older people with falls and confusion often undergo CT of the head. The diagnostic yield of these investigations is often low. A study of 294 patients with acute confusion found a diagnostic yield of only 14% if clinical suspicion was the sole reason for referral [1]. A large number of these investigations could therefore, in theory, be avoided, enabling better use of resources, reducing healthcare costs and minimising patient exposure to unnecessary radiation. To better target the use of brain imaging in this patient group, a risk scoring system is required. Such scoring systems have been developed for use in general [2] and paediatric patients [3] presenting with head trauma, but old age is usually included as part of the indication for scanning. As such, existing risk scoring systems may lack discrimination when used in older patients. Pre-existing falls risk scoring systems that are widely used, such as the Tinetti score [4], are mainly designed to calculate risk of falls rather than to help

preselect patients that might have significant intracranial pathology as a cause (or result) of their fall.

We therefore developed a risk scoring system specifically for use in older patients admitted to hospital with a fall who are also confused.

Methods and materials

A literature search was carried out using MEDLINE and EMBASE using the search terms “risk AND (brain OR head) AND (trauma OR fall) AND older”, with additional references retrieved via hand searching. Previous reports were screened to extract factors that have been associated with the occurrence of significant findings on CT brain scanning in patients with a history of suspected head trauma [5–8]. A total of 12 potential factors were identified: falls prior to the index fall; atrial fibrillation; signs of head, face or scalp trauma; new focal neurological signs; taking warfarin; international normalised ratio (INR) above therapeutic range, antecedent dementia, Glasgow coma score (GCS) <14, history of alcohol abuse, vomiting, headache and previous stroke.

Consecutive adult patients admitted to a large medical admissions unit were then assessed as part of an audit of indications for CT scanning. Patients were included if they were admitted with a fall, were felt to be confused by the admitting team and received CT imaging of the brain

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within 1 week of admission. To reflect the uncertainty and lack of available information typical at the time of acute admission in most admission units, "confusion" was denoted as present if the admitting team or the referring primary care physician had noted confusion. We did not rely on any objective measure and the state of confusion could be of any duration. No lower age cut-off was applied.

Unenhanced CT of the brain was performed according to standard clinical protocols using a General Electric 64-slice helical scanner (GE Healthcare, Buckinghamshire, UK), acquiring 0.625 mm slices. Investigations were reported by consultant radiology staff and supervised trainee radiology staff according to usual practice and results were obtained from the hospital electronic report recording system. Investigations were classed as positive if they were reported as showing any intracranial blood, a new ischaemic lesion or any space-occupying lesion. Other information was collected from the medical notes by a member of the acute medical team on an audit proforma that included the 12 risk factors mentioned above as well as basic demographic information. The data were collected anonymously on the audit proforma. Ethical approval was not sought as all data used were collected as part of routine medical care and audit by the acute medical team caring for the patients. Staff outside the attending clinical team did not have access to the data.

Each of the 12 factors was tested for univariate association with a positive CT scan using the χ^2 test. Factors where the p -value was <0.2 were used to construct a risk score, weighted according to the strength of association. Receiver-operating characteristic curves were constructed and an optimal cut-off was selected. Sensitivity, specificity, and positive and negative predictive values were then calculated by comparing risk score categorisation with the CT categorisation.

Results

66 patients were included, with a mean age of 74.8 years (standard deviation 12.0; range 42 to 97 years). 54/66 (82%) were aged over 65 years and 59% were male. 64% of patients lived in their own home and the remainder were admitted from either residential or nursing homes. 13/66 (20%) imaging investigations revealed significant new pathology (7 intracranial haemorrhages, 4 acute cerebral infarcts and 2 space occupying lesions). Univariate analysis indicated atrial fibrillation, history of falls, face/scalp trauma, new focal neurological signs, warfarin, dementia and a GCS <14 were positively associated with new CT findings ($p<0.2$). Antecedent dementia was negatively associated with new CT findings. All were assigned a value of +1 point except for new focal signs (+3 points) and antecedent dementia (−1 point, as this was inversely associated with a positive CT scan).

Using the above score, the area under the receiver-operating characteristic curve was 0.83 (95% CI 0.70 to 0.96). A cut-off score of three or above was selected as the

optimum point to balance sensitivity and specificity. Using this cut-off, the results were classified as shown in Table 1. We used these figures to derive a sensitivity of 83%, specificity 89%, positive predictive value of 63% and negative predictive value of 96%.

Discussion

The score that we have derived has a high negative predictive value in this population, who were predominantly aged over 65 years. A score below three therefore potentially allows CT scanning to be safely omitted, as the yield of positive findings is very low. Assessment of older patients admitted with falls and confusion is often initially difficult because of a lack of information. A period of observation and obtaining a collateral history will usually clarify whether confusion is owing to dementia or delirium, and may allow delirium to settle with supportive care, orientation and correction of underlying illnesses. However, the high-throughput environment of emergency departments and medical assessment units often leads to pressure for rapid investigation rather than the more time-consuming approach of information gathering and observation. It is within this high throughput environment that we propose that this risk score may be able to allow better targeting of CT scanning of the brain in this patient group.

Any test or risk score requires validation in a large population separate from the population in which it was first developed [9]. Until this is done, our risk score should not be adopted into practice. Such testing should be relatively easy to perform and may also allow further refinement to the score to improve the ability of the score to rule out the need for CT of the brain in some older patients admitted with falls and confusion.

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Table 1. Test scores vs CT results

	Negative CT	Positive CT	Total
Score 0–2	48	2	50
Score 3+	6	10	16
Total	54	12	66