Diagnostic accuracy of individual characteristics following minor head injury in children: A Systematic Review

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Introduction:

Clinical decision rules for minor head injury patients incorporate a number of individual characteristics grouped together to provide a tool for identifying those at risk of intracranial injury. We performed a systematic review of the individual characteristics that contribute to clinical decision making and calculated likelihood ratios of significance for each. These data were then compared with current clinical decision rules.

Methods:

Potentially relevant studies were identified by an electronic search of key databases. Papers in English were included with a cohort of more than 20 patients and over 50% being children having suffered a minor head injury (GCS 13-15). Studies described any characteristic to identify patients at risk of intracranial injury or neurosurgery and had to include a proportion of the cohort undergoing imaging. Titles, abstracts and full-text articles were independently screened for relevance by two sets of paired authors (one clinician and one reviewer in each pair) with any discrepancies about inclusion being discussed and resolved. A QUality Assessment of Diagnostic Accuracy Studies (QUADAS) checklist was compiled and each article scored appropriately.

Results:

In total 29 studies were identified of which two reported on infants only, two on infants and children and one on adolescents only. Cohorts ranged from 39 to 31694 subjects. Prevalence of neurosurgery ranged from 0.6 to 8.5% (median 3.2%, IQR: 0.8 to 6.0%) and prevalence of intracranial injury ranged from 0.58 to 54.6% (median 12.1%, IQR: 4.1 to 21.0%). There was considerable heterogeneity between studies in all aspects of quality assessment so a random effects meta-analysis was only performed on those individual clinical characteristics that were studied in multiple cohorts and were defined consistently across studies.

CHILDREN: Intracranial injury

Clinical characteristic	Number of studies	Heterogeneity test p-value[1]		Pooled estimates					
		Sensitivity	Specificity	Sensitivity	Specificity	NLR	95% HDR	PLR	95% HDR
Intoxication	4	0.689	< 0.001	3.8	98.6	0.976	0.946, 1.072	2.72	0.29, 26.06
Fall – any	5	< 0.001	< 0.001	34.7	54.7	1.206	0.726, 1.683	0.78	0.34, 1.41
Fall from a height	1	N/A	N/A	28.0	87.8	0.820	0.689, 0.977	2.29	1.43, 3.68
Dizziness	3	0.881	0.012	5.2	93.5	1.014	0.910, 1.109	0.79	0.11, 4.30
Coagulopathy	2	0.010	< 0.001	5.8	99.7	0.942	0.520, 1.706	6.56	3.08, 14.00
Assault	2	0.648	0.017	3.4	95.9	1.010	0.565, 1.805	0.79	0.44, 1.42
Visual symptoms	2	< 0.001	0.933	9.1	98.9	0.864	0.549, 1.360	3.51	1.63, 7.57
Sports injury	1	N/A	N/A	1.4	93.8	1.052	1.005, 1.101	0.22	0.01, 3.49
Prior neurosurgery	1	N/A	N/A	0.7	99.9	0.994	0.984, 1.004	5.93	1.42, 24.81
Motor vehicle collision – pedestrian	6	< 0.001	< 0.001	19.4	91.9	0.883	0.754, 1.043	2.32	0.75, 6.56
Motor vehicle collision – in car	5	< 0.001	< 0.001	15.2	90.0	0.947	0.870, 1.065	1.99	0.82, 4.30
Motor vehicle collision with bicycle	1	N/A	N/A	15.3	96.7	0.876	0.833, 0.921	4.63	3.49, 6.15
Any seizure	9	0.602	< 0.001	10.0	96.3	0.935	0.899, 0.987	2.69	1.17, 6.24
Any LOC	16	< 0.001	< 0.001	45.0	79.6	0.693	0.574, 0.831	2.21	1.42, 3.66
Any headache	14	< 0.001	< 0.001	33.9	73.3	0.905	0.784, 1.010	1.26	0.97, 1.61
Undefined vomiting	10	< 0.001	< 0.001	20.2	92.2	0.868	0.794, 0.935	2.58	1.52, 4.49
Undefined or mixed amnesia	8	< 0.001	< 0.001	33.4	81.4	0.821	0.642, 0.998	1.82	1.00, 3.74
Severe or persistent headache	5	< 0.001	< 0.001	13.5	94.9	0.916	0.872, 0.986	4.35	1.07, 12.35
Persistent vomiting	4	0.028	< 0.001	22.1	92.9	0.840	0.635, 0.969	3.14	1.30, 8.05

Results *contiuned*

CHILDREN: Intracranial injury

Clinical characteristic	Number of studies	Heterogeneity test p-value[1]		Pooled estimates					
		Sensitivity	Specificity	Sensitivity	Specificity	NLR	95% HDR	PLR	95% HDR
Anterograde or post-trauma amnesia	1	N/A	N/A	20.9	93.0	0.851	0.401, 1.804	2.97	1.40, 6.29
Post-trauma seizure	5	0.493	0.810	8.7	98.0	0.932	0.849, 1.004	8.49	0.93, 31.66
Scalp laceration	3	0.002	0.051	7.4	89.1	1.040	0.782, 1.107	0.67	0.02, 2.27
Scalp haematoma	5	< 0.001	< 0.001	45.4	73.1	0.745	0.615, 0.918	1.70	1.30, 2.23
GCS < 15	12	< 0.001	< 0.001	45.9	90.0	0.608	0.377, 0.826	4.50	1.70, 10.08
GCS < 14	5	< 0.001	< 0.001	40.1	88.7	0.717	0.448, 1.797	3.33	0.76, 23.64
Focal neurological deficit	10	< 0.001	< 0.001	21.1	99.0	0.798	0.615, 0.915	20.46	7.40, 54.24
Depressed skull fracture	2	0.032	< 0.001	16.0	99.8	0.855	0.756, 0.966	73.82	46.45, 117.32
Basal skull fracture	5	< 0.001	< 0.001	17.8	98.7	0.833	0.703, 0.929	16.90	6.13, 32.44
Radiological skull fracture	7	< 0.001	< 0.001	48.4	89.3	0.585	0.516, 0.708	4.55	1.64, 15.73

GCS, Glasgow Coma Scale; LOC, loss of consciousness; HDR, high density region; NLR, negative likelihood ratio; PLR, positive likelihood ratio
[1] p-value based on Q statistic

The most useful characteristics were depressed or basal skull fracture and focal neurological deficit (PLR>10). Coagulopathy, post-traumatic seizure and previous neurosurgery (albeit in only one study) all markedly increased the likelihood of intracranial injury (PLR 5 to 10). Fall from a height, visual symptoms, bicycle MVA, any seizure, loss of consciousness, vomiting, severe or persistent headache, anterograde or retrograde amnesia, GCS less than 15 and radiological skull fracture all moderately increased the likelihood of intracranial injury (PLR 2 to 5). Only two studies report data for neurosurgical injuries and examined a limited range of characteristics. In infants, a depressed skull fracture or focal neurological deficit indicate a substantially increased risk of intracranial injury, while GCS <15 and any loss of consciousness indicate a moderately increased risk.

Conclusion:

Overall the CHALICE and NEXUS II rules appeared to be most consistent with the findings of our meta-analysis, in terms of including criteria that are diagnostically useful and excluding those that are not. Our meta-analysis supported the use of loss of consciousness, GCS less than 15, skull fracture, vomiting and headache (if severe or persistent), but suggested that scalp laceration/haematoma or an undefined headache were of little diagnostic value.

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