Acute MRI enhances prognostication in traumatic brain injury

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Traumatic brain injury (TBI) is the highest cause of death under 40 years of age.[1] Improvements in road safety, intensive and neurosurgical care enhance survival but may increase unfavourable outcomes (e.g. DECRA)[2]. Therefore early prognostic tools are essential to allow informed decisions about continued treatment. Current TBI outcome databases, e.g. IMPACT, predict outcome from initial clinical, lab and CT data with no adjustment for injury progression during intensive care.[3] Recent advances in magnetic resonance imaging (MRI) provides an exciting opportunity to refine and individualise TBI prognostication. Here we hypothesised that a quantitative acute MRI was superior to IMPACT at differentiating between favourable *vs*. unfavourable outcome and survival *vs*. death at 6 months from injury.

Moderate and severe TBI patients requiring neuro-critical care and able to undertake a research MRI within 7 days of injury were recruited. Traumatic lesion volumes (core contusion and oedema in the hemispheres, basal ganglia and brain stem and subdural blood) were quantified by manually drawing regions of interest on FLAIR and gradient echo MRI. Clinical variables required for the IMPACT model were collected. Multiple analysis of variance (MANOVA) was performed to determine if MRI added statistical explanation of variance (i.e. partial η^2) in patient outcome. These data generated multivariate linear models of prediction which were tested against the IMPACT model for superiority.

One-hundred-and-twenty-five patients were recruited between 2006-2014 (Median age 33y, range 16-72y; 94M:29F). MANOVA revealed that MRI approximately doubled the partial η^2 from 18.2% to 30.0% for unfavourable outcome and from 22.1% 44.9% for death compared to IMPACT model variables in this population. Core hemispheric contusion (P=0.002) and oedema (P=0.014) were associated with unfavourable outcome whereas brainstem (P=0.019) and basal ganglia oedema (P=0.001) were associated with death. A linear prediction model with MRI derived lesion volumes and clinical data significantly increased the area under the ROC curve compared against IMPACT for the risk of unfavourable outcome (Fig 1), but not for death.

Incorporation of acute MRI lesion volumes increased statistical explanation of variation in outcome and generates a linear prediction model superior to IMPACT, a current gold standard. Development of automated lesion detection software[4] will allow straightforward quantification of brain injury enabling prospective validation and translation of the model into the clinical environment.

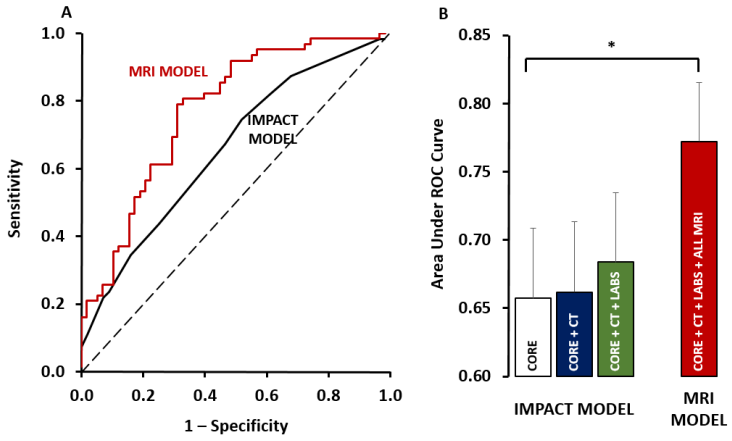

Fig 1A: ROC curves for favourable vs. unfavourable outcome constructed from the published IMPACT core model and MRI model in this cohort. 1B: Mean±SEM area under ROC curves, *P<0.05 vs. IMPACT.

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