Patient-specific management of severe TBI depending on age and cerebrovascular autoregulation status

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Background

Identification of patient-specific therapy targets is crucial for traumatic brain injury (TBI) patients. The objectives were to compare the effectiveness of optimal cerebral perfusion pressure (CPP_{opt}) targeted therapy in younger (< 45 years) and elderly (≥ 45 years) TBI patients as well as to explore the influence of various factors (cerebrovascular autoregulation (CA), cerebral perfusion pressure (CPP) declination from optimal CPP value (ΔCPP_{opt}), age, glucose concentration in blood, etc.) on TBI patients' outcome.

Materials and methods

Multimodal ABP, ICP, CPP and CA monitoring of 81 TBI patients has been performed in Republican Vilnius University Hospital (Lithuania). ICM+ software (Cambridge, UK) was used for continuous CA status assessment by calculating Pressure Reactivity Index (PRx) and for identification of patient-specific CPP_{opt}. The post-hoc analysis of associations between the patients' outcome and complex influence monitored parameters was performed by determining the most important factors affecting outcome.

Results

The multifactorial logistic regression model showed that the most significant factors affecting TBI patient's outcome are age, glucose level in blood serum samples (determined within 24 h after admission), Helsinki CT (HCT) score, ΔCPP_{opt} and duration of longest CA impairment when PRx(t)>0.5 within 24 hours after admission. The modelled accuracies for unfavorable outcome prediction were 83% and 88% respectively.

The age>45 years (P=0.018, $\chi^2=15.50$) was found statistically significantly associated with unfavorable outcome. OptCPP-targeted management was found statistically significantly associated with better outcome for younger patients (age<45 years). The critical values of averaged ΔCPP_{opt} < -5 mmHg, averaged value of PRx>0.36 and duration of LCAI >100 min (P=0.043, $\chi^2=18.00$) were found associated with mortality for younger patients group (<45 years) (Fig. 1). The critical values of averaged PRx>0.26 (P=0.005, $\chi^2=7.80$) and duration of LCAI >61 min (P=0.019, $\chi^2=5.44$) were founded associated with mortality for elderly patients group (>45 years). However, no statistical differences were found between survivals and not survivals comparing ΔCPP_{opt} for elderly patients group (Fig. 1c).

Conclusions

The main influential factors affecting severe TBI treatment outcomes are patient age, HCT, blood glucose level, and the CA status during the first day after patient admission. CPP_{opt}-targeted patient-specific treatment is useful for stabilizing CA in severe TBI patients, as well as especially beneficial for improving outcome for younger patients less than 45-years-old. CA monitoring in first 24 hours seems to be important because especially in older patients because impaired CA is less long tolerated. However, additional research is needed to prove the applicability of CPP_{opt}-targeted therapy for elderly patients greater than 45-years-old.

Fig. 1. Mean PRx, Duration of LCAI events, and mean ΔCPP_{opt} associations with the outcome of younger (age < 45 years) and elderly (age > 45 years) TBI patients. Mean PRx above 0.36 and 0.26 and LCAI (PRx > 0.5) longer than 100 min and 61 min are associated with fatal outcome for younger and elderly TBI patients, respectively (a,b). Mean ΔCPP_{opt} below - 5 mmHg is associated with fatal outcome for younger TBI patients. Statistically significant differences of ΔCPP_{opt} between fatal and non-fatal patients were found only for the younger patients (c).