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Measuring the Accuracy of Predictions from Patient-Specific Models of Intracranial Pressure Dynamics



Intracranial Pressure Dynamics

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Objective

Determine the prediction capability of a computer model of ICP dynamics

Background

- Outcomes for elevated ICP following traumatic brain injury (TBI) remain mixed
- TBI remains leading cause of death and disability in children
- Sophisticated computer models calibrated to fit patient-specific clinical data
- No studies have reported the prediction capability of these models

Discussion/Conclusion

- Despite small error in model fit to data, model prediction error is too large to be clinically useful
- Caution warranted: prediction is hard!!
→ A good fit between model and historical data may not yield good predictions!



Figure 1: Model ICP (blue) vs. Actual ICP (green), w/HOB (red) and Respiration Rate (dotted black)

Methods

- Clinically annotated prospective data collected: mild physiologic challenge protocol
 - Head of bed: 0 to 30 degrees
 - Respiration Rate: mild hyper- to hypo-ventilation
 - 9 TBI patients, 24 sessions
- Data from early in single long session or from prior sessions used to estimate patient-specific parameter values for computer model of ICP dynamics
 - Curve-fitting optimization minimized squared error, modeled ICP vs. data
- Resulting patient-specific models used to predict patient's ICP response to interventions
 - Later in the same session
 - In subsequent sessions

Results

- Avg. mean absolute error (MAE) for fitness of model to the data: 1.9 mmHg
→ for segments with avg. mean absolute deviation of 3.1 mmHg
- Avg. MAE for predictions:
4.0 mmHg w/in same session;
6.7 mmHg across sessions