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

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Measuring the Accuracy of Predictions from Patient-Specific Models of 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

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

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)