Analysis of Changes in the ICP Signal Prior to Critical Increases

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Overview

- Introduction
- Methodology
  - Spike Detection
  - Signal Characterization
  - Data Analysis
- Results and Discussion
- Conclusion

Introduction

- Why are ICP increases important
- Purpose of this study
  - Show that the ICP signal undergoes detectable changes prior to a rapid increase
  - Identify these changes
  - Predict ICP increases
- Source of the data
  - Doernbecher Children’s Hospital (OHSU)
  - 21 different patients

Spike Detection

- Signal was lowpass filtered ($f_c = 0.125$ Hz)
- Selection Criteria
  - $\text{Min}(\text{ICP}_d) - \text{Max}(\text{ICP}_a) > 10 \text{ mmHg}$
  - $\text{Min}(\text{ICP}_d) > 20 \text{ mmHg}$
- 23 spikes were found in 7 different patients

Signal Characterization

- ICP spikes were divided into six 30-second segments
  - Segments 1-5: Normal levels of ICP
  - Segment 6: Transition from normal ICP to raised ICP

Data Analysis

- Metrics recorded for each ICP segment
  - Raw ICP signal
  - Peak Amplitude
  - Peak-to-Peak distance
  - Peak-to-Valley distance
  - Percussion wave slope
Data Analysis

• Sign test
  – Unknown distribution
  – Samples were assumed independent
• $H_0$: transition ICP = normal ICP
  $H_1$: transition ICP $\neq$ normal ICP
• For every segment, the five metrics were recorded (raw ICP, peak-to-peak distances, peak amplitudes...)

The mean and variance of each metric were calculated in every segment.
• $A +$ was recorded if $\mu_6 > \mu_{1-5}$ or $\mu_6 < \mu_{1-5}$ (similarly, if $\sigma^2_6 > \sigma^2_{1-5}$ or $\sigma^2_6 < \sigma^2_{1-5}$)
• $A -$ was recorded otherwise
• The number of $+$'s were counted for each one of the test statistics
• The $p$-values were calculated

Results

<table>
<thead>
<tr>
<th></th>
<th>Raw ICP</th>
<th>Peak Ampl.</th>
<th>P-P distance</th>
<th>P-V distance</th>
<th>P1 slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu$</td>
<td>14</td>
<td>14</td>
<td>7</td>
<td>13</td>
<td>20</td>
</tr>
<tr>
<td>$\sigma^2$</td>
<td>14</td>
<td>13</td>
<td>12</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td># of +'s</td>
<td>14</td>
<td>13</td>
<td>15</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>$p$ value</td>
<td>0.105</td>
<td>0.060</td>
<td>0.202</td>
<td>0.105</td>
<td>0.055</td>
</tr>
</tbody>
</table>

Conclusion

• Results suggest that detectable changes take place prior to a critical increase in ICP
• I still need to determine which metrics are best for predicting spikes
• The results of this analysis could be used for a real-time ICP spike predictor

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