Using Causal Models in Psychomotor Performance Assessment

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University of Minnesota
Medical School
Driven to Discover℠
<table>
<thead>
<tr>
<th>Potential Funding Sources</th>
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<td>2 Intramural grant</td>
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<td>3 Clinical Departmental funds</td>
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<td>6 Hospital QI/PI Process</td>
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<td>7 Philanthropy</td>
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<td>11 DoD</td>
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Background

• How are psychomotor skills typically evaluated?
• The impact of competency based medical education on administrative workloads\(^1\)
• Procedural expert evaluator scarcity\(^2,3\)
• What are causal models?
Causal Models

- Allow us to draw qualitative assumptions about cause-effect relationships between various experiments and data
- Why are they useful?
  - Analyze the same variables within different groups
  - Draw useful assumptions when we cannot influence populations or data sets

We propose using a causal model in psychomotor performance assessment to
- Identify outliers in our learner group
- Reduce the need for expert faculty involvement

We hypothesized that a clinically novice (C_N) group will show greater variance in the actions taken to deliver a RSII than a clinically proficient (C_P) group
Established an ideal practice sequence to create the model
- Number of ETI attempts, limiting apnea duration, and preO₂ ≥ 3min

- Clinically Proficient (Cₚ) Group
  - Clinical setting, N=45, CRNAs and Anesthesiologists
  - Live recorder timestamping event sequences

- Clinically Novice (C₉) Group
  - Simulation setting, N=15, CA-1 anesthesia residents
  - AV recording for simulation
The Model’s Assumption
- \( \{\mu, \sigma\} : C_N \rightarrow C_P \)

Our causal model allows us to estimate the total effect of \( C_N \) and \( I \) on the probability distribution of \( C_P \)

The fit of \( C_N \) to \( C_P \)

Normalization with increased experience
Results: ETI Attempts

ETI Attempts

Clinically Proficient
Clinical Novice

Clinically Proficient
Prior Posterior
Results: Duration of Apnea

- $C_N$ outperform $C_P$
- The role of outliers
  - Clinical case difficulty
Results: Preoxygenation Duration

Preoxygenation Duration by Groups

Θ = 0.40

Clinical Novice

Θ = 0.64

Clinically Proficient
Conclusions: ETI Attempts

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<tr>
<th></th>
<th>Prior</th>
<th>Posterior</th>
<th>Diff</th>
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<tbody>
<tr>
<td>( \mu )</td>
<td>1.04</td>
<td>1.00</td>
<td>0.04</td>
</tr>
<tr>
<td>( \sigma )</td>
<td>0.20</td>
<td>0.48</td>
<td>0.28</td>
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- Model’s normalizing effect on small sample data
- SD change and the role of changing providers
  - Range of attempts and attempts per provider
- ETI prep and setup differences
Conclusions: Duration of Apnea

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<th>Posterior</th>
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<tr>
<td>μ</td>
<td>167.56</td>
<td>110.00</td>
<td>57.56</td>
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<tr>
<td>σ</td>
<td>99.71</td>
<td>110.00</td>
<td>10.29</td>
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- The $C_N$ group outperformed the $C_p$ in terms of mean apnea time experienced by their patients.

- The role of large SD
  - Simulated patient had no complications
  - Fitting known low difficulty populations to mixed difficulty
Conclusions: Preoxygenation Duration

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<th>Diff</th>
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</thead>
<tbody>
<tr>
<td>θ</td>
<td>0.64</td>
<td>0.62</td>
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- $C_P$ appears to outperform $C_N$ reasonably well prior to modeling
  - Model does not show contribution of data structure

- The $C_N$ group is at least able to approximate the performance of $C_P$ in this area without much additional effort
  - Model improvement is needed
Limitations

• Very little data and single institution
  - Outliers and class imbalance

• Lack of simulation patient diversity
  - Specifically for the number of ETI attempts and apnea duration

• Preoxygenation ≥ 3min, interpreted as hit/miss
  - Unexplored points and $C_N/C_P$ curve relation
Summary

• Reduced faculty investment

• Residents scheduled their simulation time

• Audiovisual recordings allowed offsite review

• Availability of quick reference logs
References

• Aylward M, Nixon J, Gladding S. An Entrustable Professional Activity (EPA) for Handoffs as a Model for EPA Assessment Development. Acad Med. 2014 Oct;89(10):1335-40
Thank you for listening!

Questions and Suggestions?