Domoic Acid Neurotoxicity in Native American Children

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Background: Domoic Acid

Domoic acid (DA): marine based biotoxin

Shellfish accumulate DA by

• Filtering contaminated plankton or
• Feeding directly on contaminated organisms

Can cause memory impairment and seizures at low levels of exposure and coma or death at high levels
Razor Clams and Pacific Northwestern Native Americans

- Retain DA longer than other shellfish
- Even with “safe levels” of DA, mild memory decline detected in adults who were high consumers of razor clams
Razor Clams and Pacific Northwestern Native Americans

- Are a major source of protein
- Have significant cultural meaning
- Are part of ceremonial harvests
- Are consumed throughout the year

Razor clams
## Domoic Acid and Children

<table>
<thead>
<tr>
<th>Unknown impact of dietary DA consumption on children</th>
<th>Unknown impact of prenatal DA exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Studies on adults suggest there could be an impact</td>
<td>• Animal models</td>
</tr>
<tr>
<td></td>
<td>• Learning, memory problems</td>
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<td>• Social disruptions</td>
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<td>• Changes in brain morphology</td>
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Objectives

Study 1: to determine the impact of five years of dietary exposure to presumably safe levels of DA on memory in 108 Native American children

Study 2: to conduct a pilot study of the developmental and cognitive outcomes of prenatal exposure to DA via maternal razor clam consumption
Study 1

DIETARY CONSUMPTION OF DA IN CHILDREN
Method: Study 1

- 108 Native American children
- Ages 7 to 12 years
- Dietary records collected for 5 years
- Calculated ≥15 clams/month=high consumer
- Cognitive assessments
  - California Verbal Learning Test
  - Wechsler Intelligence Scale for Children IV
  - Children’s Memory Scale
- GEE analysis
Results: Study 1

Razor Clam Consumption

- No clams: 53%
- Low consumers: 43%
- High consumers: 4%
## Child Cognitive Scores: Consumers vs. Non-Consumers

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Task</th>
<th>Mean score, those who ate razor clams [compared to those who did not] (95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVLT-C</td>
<td>Total Recall</td>
<td>-0.2 (-0.7, +0.3)</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td>Short Delay</td>
<td>+0.0 (-0.2, +0.2)</td>
<td>0.93</td>
</tr>
<tr>
<td></td>
<td>Long Delay</td>
<td>+0.0 (-0.2, +0.3)</td>
<td>0.73</td>
</tr>
<tr>
<td>WISC-IV</td>
<td>Digit Coding</td>
<td>+0.2 (-1.9, +2.3)</td>
<td>0.83</td>
</tr>
<tr>
<td>CMS</td>
<td>Learning</td>
<td>+5.6 (-6.3, +17.6)</td>
<td>0.36</td>
</tr>
<tr>
<td></td>
<td>Short Delay</td>
<td>+6.0 (-6.2, +18.2)</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>Long Delay</td>
<td>+6.1 (-5.9, +18.1)</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>+5.8 (-6.1, +17.7)</td>
<td>0.34</td>
</tr>
</tbody>
</table>
Study 2

PRENATAL DA EXPOSURE: A PILOT STUDY
Method: Study 2

• Pilot with a series of case studies
• Parents: measures of dietary consumption of DA via razor clam consumption during pregnancy and nursing
• 13 infants and toddlers
  – Ages 8 to 26 months
  – Mullen Scales of Early Learning AGS Edition
Method: Study 2

• 8 children were located for follow up 7 years later
  – Ages 6 to 9 years
  – Cognitive assessments
    • Wechsler Intelligence Scale for Children IV
    • Lafayette Grooved Pegboard
    • Children’s Memory Scale
    • CNS Vital Signs Neurocognitive Battery
Results: Study 2

Prenatal Exposure to DA via Razor Clams

- Not prenatally exposed: 5 (38.5%)
- Prenatally exposed: 8 (61.5%)
Results: Study 2

Prenatal DA exposure → Lower gross motor skills in infancy
  $t(8)=3.05, p=.02$
Results: Study 2

Prenatal DA exposure

Lower processing speeds in childhood
\[ t(3)=3.81, \, p=.03 \]

Lower executive functioning in childhood
\[ t(3)=3.65, \, p=.04 \]

Marginal association between prenatal DA exposure and lower cognitive flexibility
\[ t(3)=2.77, \, p=.07 \]
Preliminary Conclusions

• Children do not consume a high number of razor clams
  – This may protect them from neurotoxicity

• Prenatal exposure does appear to contribute to some cognitive and motor difficulties into middle childhood
  – Findings are consistent with animal models
Future Directions

• Larger scale studies are needed to replicate prenatal exposure findings
• The possible contribution of nursing exposure needs to be established
• Problems found in middle childhood: Do they extend to adolescence? Adulthood?
Acknowledgements

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