Estimating Combined Effect of Multiple Treatments

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CMF Clearinghouse Webinar
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Presented by
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Outline

- Problem at Hand
- Practical Guidance
- Example Application
- Future Research
PROBLEM AT HAND
How to estimate combined effect?

- 3000+ CMFs in CMF Clearinghouse
  - Most related to single treatment

A crash modification factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site. The Crash Modification Factors Clearinghouse houses a Web-based database of CMFs along with supporting documentation to help transportation engineers identify the most appropriate countermeasure for their safety needs. Using this site, you can search to find CMFs or submit your own CMFs to be included in the clearinghouse.
How to estimate combined effect?

- Develop CMFs for combinations of treatments
  - Expensive and not feasible for all combinations
How to estimate combined effect?

- Develop guidance for applying multiple CMFs
  - Current research is limited or in-progress
PRACTICAL “INTERIM” GUIDANCE
Be Mindful of Issues

- Added Benefit versus Additive Effects
- Assumption of Independence
- Applicability of CMFs
Be Mindful of Issues

- Added Benefit versus Additive Effects
  - Additional treatment may have added benefit, but effects of treatments are not additive

\[ 20\% + 20\% \neq 40\% \]
Be Mindful of Issues

- Assumption of Independence
  - Safety effects of treatments may overlap

- CMF (rumble strips) = 0.85

- CMF (shoulder width) = 0.86
# Be Mindful of Issues

- **Applicability of CMFs**
  - CMFs may apply to different scenarios
    - Roadway conditions
    - Crash types
    - Crash severities

<table>
<thead>
<tr>
<th>CMF</th>
<th>Crash Type</th>
<th>Crash Severity</th>
<th>Area Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.85</td>
<td>All</td>
<td>All</td>
<td>Rural</td>
</tr>
<tr>
<td>0.83</td>
<td>All</td>
<td>All</td>
<td>Urban</td>
</tr>
<tr>
<td>1.15</td>
<td>All</td>
<td>Property damage only (PDO)</td>
<td>All</td>
</tr>
<tr>
<td>0.62</td>
<td>Angle</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>0.62</td>
<td>All</td>
<td>Fatal</td>
<td>All</td>
</tr>
<tr>
<td>1.48</td>
<td>Rear end</td>
<td>All</td>
<td>All</td>
</tr>
</tbody>
</table>

Install Traffic Signal at Unsignalized Intersection
Opportunities to Overcome Challenges

Added Benefit versus Additive Effects

- Use multiplicative form when necessary
  - \( CMF_{\text{Combined}} = CMF_1 \times CMF_2 \)

\[
20\% + 20\% \neq 40\% \]

\[
0.8 \times 0.8 = 0.64 \text{ (36\% reduction)}
\]
Opportunities to Overcome Challenges

Assumption of Independence

- Is assumption of independence valid?
  - Use engineering judgment

<table>
<thead>
<tr>
<th>Treatment #1</th>
<th>Treatment #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head On</td>
<td>Head On</td>
</tr>
<tr>
<td>Rear End</td>
<td>Rear End</td>
</tr>
<tr>
<td>Right Angle</td>
<td>Right Angle</td>
</tr>
<tr>
<td>Left Turn</td>
<td>Left Turn</td>
</tr>
<tr>
<td>Right Turn</td>
<td>Right Turn</td>
</tr>
<tr>
<td>Run Off Road</td>
<td>Run Off Road</td>
</tr>
<tr>
<td>Pedestrian</td>
<td>Pedestrian</td>
</tr>
<tr>
<td>Bicycle</td>
<td>Bicycle</td>
</tr>
</tbody>
</table>
Opportunities to Overcome Challenges

Assumption of Independence

- Temper effects of additional treatment(s) if necessary

\[
\text{CMF}_{\text{Combined}} = \text{CMF}_1 \times \text{CMF}_{2,\text{Reduced}}
\]

\[
\text{CMF}_{2,\text{Reduced}} = \text{CMF}_2 + \frac{1-\text{CMF}_2}{2}
\]

Be consistent!

Assumes both CMFs apply to the same crash type and severity
Opportunities to Overcome Challenges

Applicability of CMFs

- Only multiply CMFs if they apply to the same crash type and severity
- Estimate impacts independently and then combine results
EXAMPLE APPLICATION
What is the impact?

■ Site Characteristics
  • 2-lane, urban minor arterial
  • Two-way stop-control
  • Pedestrian crossing
  • Bus stops

■ Safety Issues
  • Pedestrian exposure
  • Vehicle speed
  • Driver awareness
  • Driver behavior
## What is the impact?

<table>
<thead>
<tr>
<th>Strategies</th>
<th>CMF</th>
<th>Target Crashes</th>
<th>Total Crashes (5 years)</th>
<th>Expected Crashes WITHOUT</th>
<th>Expected Crashes WITH</th>
<th>Crashes Reduced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhance awareness of pedestrians by installing a pedestrian refuge island.</td>
<td>0.54</td>
<td>Pedestrian</td>
<td>1</td>
<td>0.20</td>
<td>0.11</td>
<td>0.09</td>
</tr>
<tr>
<td>Install raised median island to discourage drivers from using painted median and reduce speeds through the intersection (i.e., traffic calming).</td>
<td>0.68</td>
<td>All crashes</td>
<td>11 (includes pedestrian crash)</td>
<td>2.2</td>
<td>1.50</td>
<td>0.7</td>
</tr>
<tr>
<td>Install raised median island to discourage drivers from using painted median and reduce speeds through the intersection (i.e., traffic calming).</td>
<td>0.68</td>
<td>All crashes</td>
<td>10 (Excludes pedestrian crash)</td>
<td>2.0</td>
<td>1.36</td>
<td>0.64</td>
</tr>
</tbody>
</table>
# What is the impact?

<table>
<thead>
<tr>
<th>Strategies</th>
<th>Crashes Reduced</th>
<th>Average Crash Cost</th>
<th>Annual Benefit</th>
<th>Service Life</th>
<th>Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhance awareness of pedestrians by installing a pedestrian refuge island.</td>
<td>0.09</td>
<td>$158,866 (pedestrian)</td>
<td>$14,298</td>
<td>10</td>
<td>$110,405</td>
</tr>
<tr>
<td>Install raised median island to discourage drivers from using painted median and reduce speeds through the intersection (i.e., traffic calming).</td>
<td>0.7</td>
<td>$32,236 (total)</td>
<td>$20,631</td>
<td>10</td>
<td>$159,307</td>
</tr>
</tbody>
</table>

$269,712
FUTURE RESEARCH
Research Needs

- Guidance on “adjustment” for overlapping effects
- Guidance on estimating standard error for combined effect

NCHRP 17-63 [Active]
Guidance for the Development and Application of Crash Modification Factors

<table>
<thead>
<tr>
<th>Staff Responsibility:</th>
<th>Mark S. Bush</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Agency:</td>
<td>University of North Carolina</td>
</tr>
<tr>
<td>Principal Investigator:</td>
<td>Daniel L. Carter</td>
</tr>
<tr>
<td>Effective Date:</td>
<td>8/1/2013</td>
</tr>
<tr>
<td>Completion Date:</td>
<td>2/1/2016</td>
</tr>
</tbody>
</table>
Thank You!

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Questions?