Calculating Crash Risk

Importance of Crash Risk Calculation

- Extensive research identifying driver behaviors that impact driving performance (safety surrogate measures)
  - Secondary task engagement increases lane deviations, missed red lights, late braking behavior, etc.
- Does a decrease in driving performance = increased crash risk?

Crash Risk Literature Review

- Reidelmeier & Tibshirani (1997)
  - Driving with cell phone increased risk by 4 times
- Violanti (1998)
  - Driving with a cell phone increases crash risk by 2 times.
- McEvoy, Stevenson, McCartt, Woodward, Haworth, Palamara, & Cercarelli (2005)
  - Driving with a cell phone increases crash risk by 4 times that of an alert driver.

Epidemiological Analyses vs. Empirical Analyses

- Epidemiological Research
  - Analyses include thousands of actual crashes and/or police-reported/injury crashes
  - Data is limited in that PARs are not accurate
    - Victims may not be able to report or willing to report their actions
  - Timing is difficult to assess
- Empirical Research
  - Precise data collection on safety surrogates (i.e. lane deviations, speed deviations, etc.)
  - Little to no data on actual crashes
- Naturalistic Research
  - Analyses include hundreds of crashes and near-crashes
  - Driver behavior is captured in the seconds leading up to crash/near-crash

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Crash Risk…defined

- The ratio of the odds is a commonly employed measure of association between the presence of cases (crash and near-crash events) and the controls (baseline driving epochs).
- Odds ratios are used as an approximation of relative crash risk in case control designs.
  - This approximation is valid for evaluations of rare events.
    - (Greenberg, Daniels, Flanders, Eley, & Boring, 2001).

Odds Ratio Calculation

- Odds = P(Event will occur)/P(Event will not occur)
- P(crash with inattention occurs)/P(crash occurs without inattention)
- OR= AD/BC

	Event	Baseline
Inattention	A	B
No Inattention	C	D

Identification of Events Using 100 Car Data

- Trained data reductionists recorded driver behaviors under the following circumstances:
  - Driver engaged in behavior within 5 seconds of onset of conflict or through the conflict
- Included both crashes and near-crashes
  - To increase power
  - Kinematic analysis indicated similarities between these two events and differences from incidents.

Crash/Near-Crash Risks Due to Secondary Task Engagement

- Complex secondary tasks increased risk by 3.1 (CI:1.7, 5.5) times that of an alert driver.
- Moderate secondary tasks increased risk by 2.1 (CI: 1.6, 2.7) that of an alert driver.
- Simple secondary task did not increase risk. OR = 1.2 (CI: 0.9, 1.6)

Crash/Near-Crash Risk for Total Time Eyes-Off Forward Roadway

- Eye glances less than 2s did not significantly increase risk
- Eye glances ≥ 2.0s increased risk by 2.3 times (CI: 1.8, 2.9) that of an alert driver

Risky Driving Behavior Analysis

- How do various risky driving behaviors, in isolation and combination, impact crash/near crash risk?
  - Calculated adjusted odds ratios (logistic regression) for risky driving behaviors since many are highly correlated with each other.
  - First comparison of adjusted ORs and crude ORs.

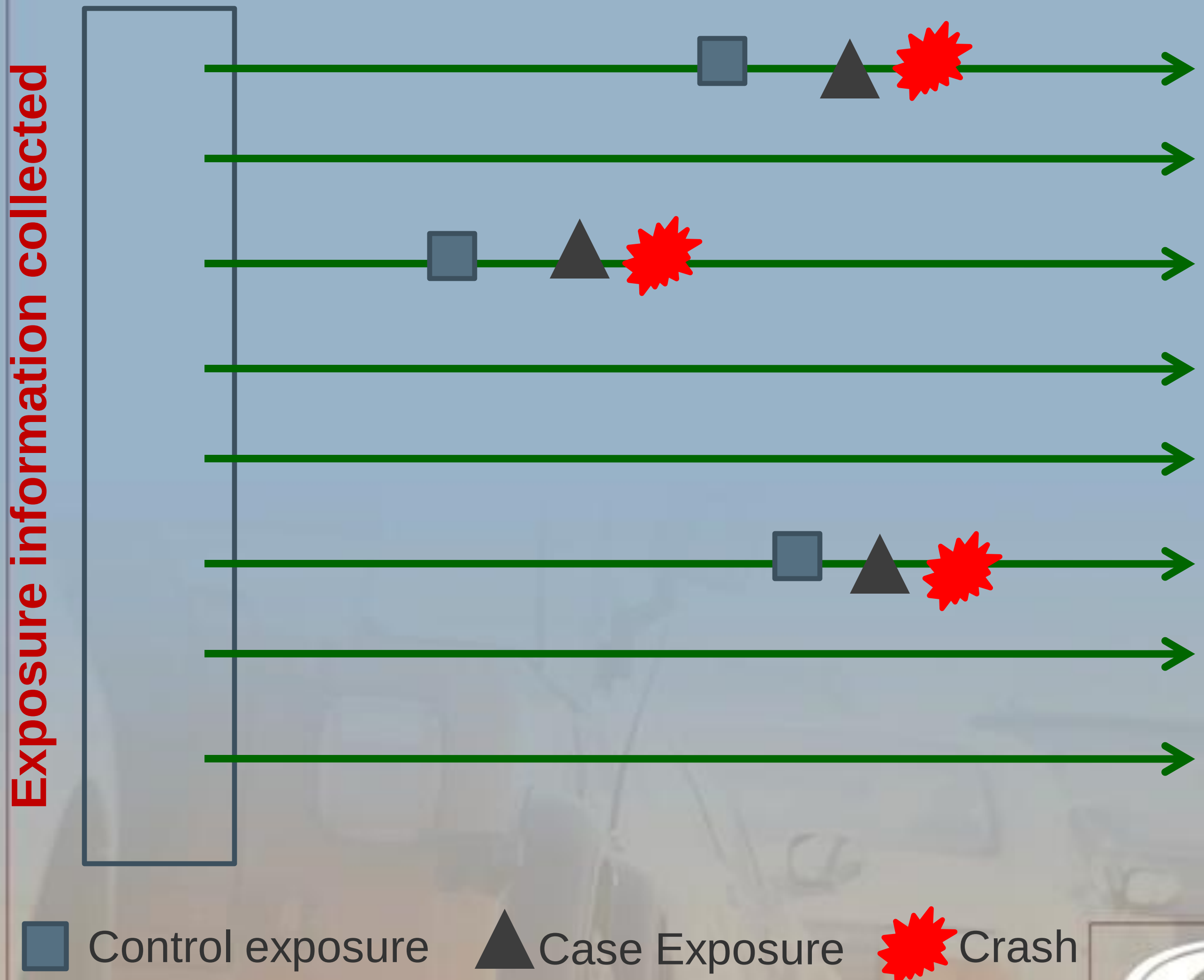
Comparison of Crude and Adjusted Odds Ratios

Driver State or Driving Behavior	Crude Odds Ratio	Adjusted Odds Ratio
Drowsiness	3.17	2.90
Inappropriate Speed	3.52	2.90
Total Time EOR > 2 s	1.97	1.90
Close Proximity to Other Vehicle	0.56	0.40

GEE Logistic Regression Odds Ratio Estimation Results for Roadway Infrastructure

Factors	Odds Ratio	Lower CI	Upper CI
Weather: Cloudy versus clear	3.75	2.74	5.13
Alignment: Curve, level versus straight, level	1.46	1.17	1.83
Density: Forced/unstable versus free flow	3.28	2.08	5.2
Density: Unstable temporary flow versus free flow	6.82	4.86	9.57
Density: Stable flow versus free flow	4.01	3.21	5.02

Case-Crossover



Sample exposure immediate before crashes

Sample exposure for time interval some period before crash

Control Factors

- Driver ID
- GPS location (± 100 meters)
- Time of Day (± 2 hours)
- Day of week (weekday vs. weekend)

- Relation to junction

Future Analyses: Case-Crossover Baseline

- Compare the crash/near-crash risk calculations from the case-control analysis to the case-crossover analysis.
  - Assess the differences and compare to previous literature
  - More power in the case-crossover and anticipate tighter confidence intervals which may make some of the previously calculated OR significantly different from 1.0.

Conclusions

- Naturalistic driving data are ideal for calculating crash/near-crash risks for driver behavior.
- While data are ideal, selecting baseline sample and type of baseline sample are complex issues.
  - Operationally defining event/baseline is tricky.
  - Larger scale studies may not have these issues.
- Different approaches have their pros/cons.
  - The research questions regarding risk need to drive decisions.

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Questions…