Federal Motor Carrier Safety Administration
Office of Analysis, Research and Technology

Evaluating the Safety Benefits of a Low Cost Driver Behavior Management System in Commercial Vehicle Operations

PRELIMINARY RESULTS

FMCSA Webinar

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Acknowledgements

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- Dr. Martin Walker was the COTR
- Olu Ajayi was the TOM
- Trucking fleets and drivers who participated in the pilot test

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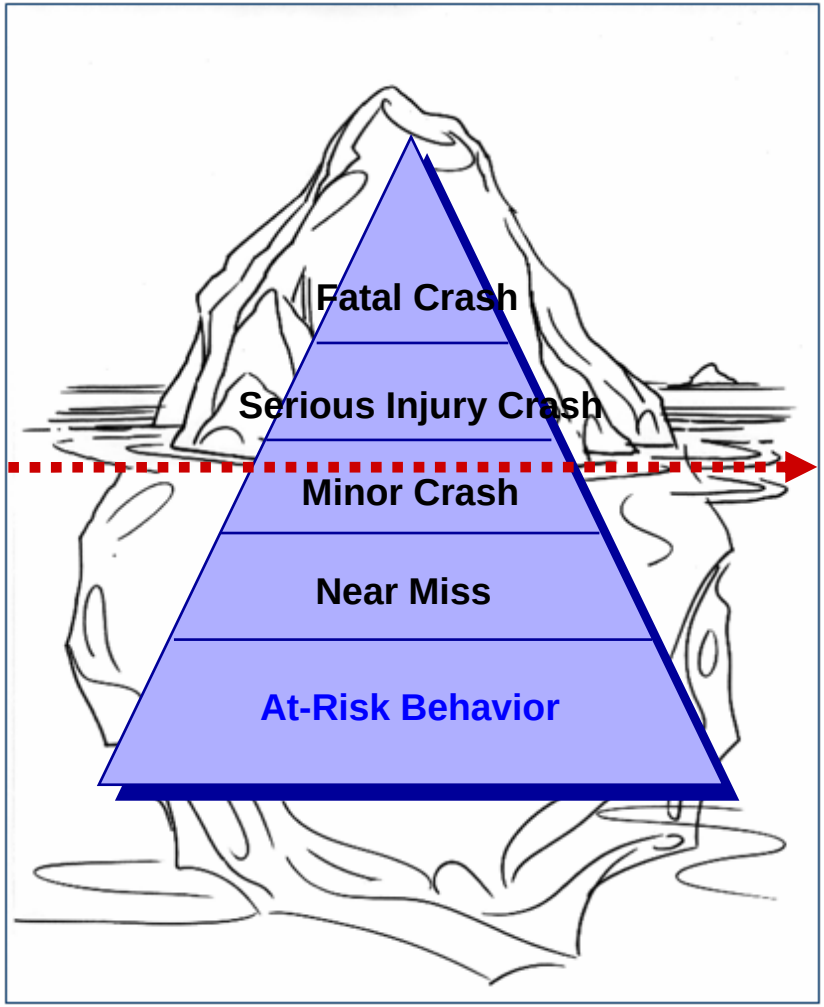
Project Objectives

- Driving Behavior Management Systems (DBMS) more prevalent
- Companies making claims as to the safety benefits of these devices
- FMCSA contracted VTTI to provide an independent evaluation of a commercially available low-cost DBMS
  - In-vehicle video technology
  - Performance management software
  - Driver counseling

Introduction

- Crashes involving large trucks constitute a significant risk
- Studies have shown that driver behaviors are the primary contributing factor in crashes (FMCSA, 2006; Treat et al., 1979)
  - Decision errors (e.g., following too close)
  - Recognition errors (e.g., internal distraction)
  - Performance errors (e.g., poor directional control)
  - Non-performance errors (e.g., asleep)

Leading versus Trailing Indicators



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Behavioral Approaches

- Behavioral approaches to reducing problem behavior have proven track record (Geller, 2001; Gustello, 1993)
- All prior work in settings where employees can be directly observed
  - Difficult with truck drivers
    - Lone workers
    - Limited accountability
    - Accuracy
    - Dangerous
- Missing an objective, reliable way to observe driver behavior

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Driving Behavior Management Systems

- New technologies available that provide objective measures of driver behavior
  - Continuous measures of driver behavior/performance
  - In-vehicle video technology
    - Can be used to provide drivers with feedback
    - Identify risky drivers
- Technology alone insufficient to alter driver behavior
- Combination of DBMS and behavioral safety techniques are a powerful approach in reducing at-risk behaviors and associated crashes

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Sole Source Notice

- Prior to starting study, VTTI posted a Sole Source Notice on website
  - Requested responses from interested technology vendors
  - 3 components of DBMS
    - Video, software, counseling
  - Donate equipment and personnel
  - Low cost and commercially available
  - Have 2 fleets on-board, 50 drivers each, for “pilot test”
    - Long-haul, local/short-haul
- DriveCam® was selected as the technology vendor

DriveCam Event Recorder

- Event recorder placed on truck's windshield
- 2 cameras
  - Driver's face
  - Forward view
- 3 accelerometers
  - Y-, x-, and z-axis
- Recording in constant loop
  - Trigger greater than or equal to $|0.5\ g|$
    - Saved 8 sec before, 4 sec after trigger
- Event status light

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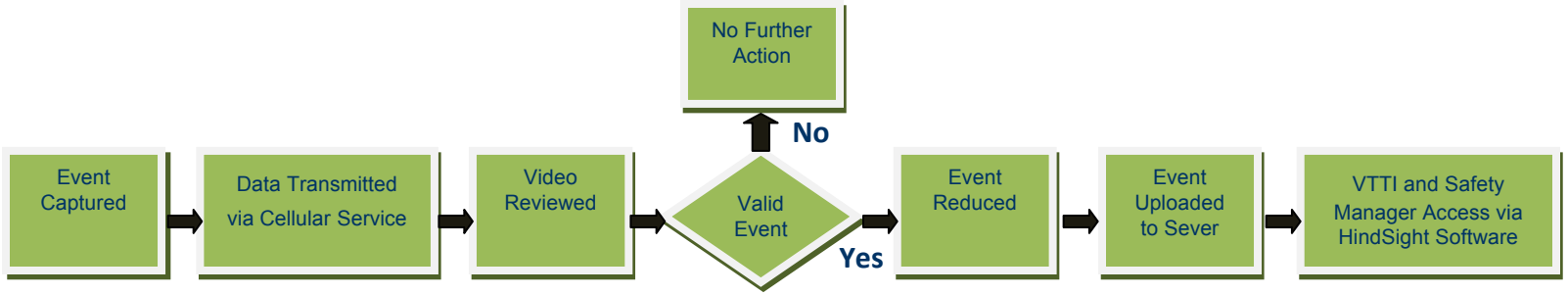
Video Examples

Three video examples of the DBMS were shown during the webinar.

Data Reduction

- Stored events sent to DriveCam via cellular transmission each day
- Trained data analysts reviewed each event
  - Event validity determined
  - If valid, then reduced
    - Trigger, root cause, behaviors, narrative, Event Score, etc.
      - If collision or Event Score ≥5, then manager sent email indicating review of safety-related event



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HindSight Software

https://online.drivecam.com/B2B/EventAnalysis.aspx?drive=ne2up2f9n9BJJSPUVyHv8bsf3tE4HL0ikuhqPfPCQt0=

File Edit View Favorites Links DriveCam Login Cnet-News TSD Mohawk - TeamPlain Web Access Mohawk Wiki MRD Mohawk

Drivecam - Event Analysis - Event #243

DriveCam Demonstration System

DRIVECAM DRIVER RISK MANAGEMENT SYSTEM

Home

Enter Event # GO Help Sign Out

This driver requires Face-To-Face Coaching.

Driver: [redacted]

Vehicle: TestVehicle03451391

Group: Taxi Van

Event Analysis Risk Score: 9

Event Trigger: Hard Cornering
Outcome: No Collision

Root Causes
Distractions: Cell Phone
Demeanor: No Issue

Risky Actions
Seat Belts: Driver Unbelted
Fundamentals: Following Too Close

Comments

DriveCam
WED, SEP 26, 2007 04:57PM PDT
This event was triggered by a hard corner.

The driver is not wearing a seatbelt. This is a violation of company policy.

The driver was maintaining a following distance of 1 second or less. This is not enough time to see a problem and smoothly respond to it. Following too close limits the driver's ability to see ahead, reduces reaction time and may aggravate the driver ahead. Space needs to be increased to your organization's recommendations to reduce potential risk.

Event 243 Sep 26 2007 9:01PM PST

FWD -0.07 LAT 0.00 TIME -9.00

Playing "243041754266123": 544 K bits/second 00:01

Pause

Driver: [redacted]

Course of Action: No Change

Click here to add your comments to this event.

Tools OK Cancel Apply < Prev Next >

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Coaching Process

- Manager reviewed event (and prior events)
- Driver and manager watched event
- Manager explained viewpoint and root cause
  - Kept positive
- Determined follow-up steps
  - Training, discipline, reward, etc.
- Resolved event in HindSight software
  - Indicated coaching occurred and any notes

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Research Design

- A^4B^{13} reversal design (quasi-experiment)
- A^4 was the 4 week Baseline phase
  - Vehicle instrumented with event recorder
  - Drove during normal, revenue-producing deliveries
  - Managers did not have access to recorded data
  - No coaching or feedback light
- B^{13} was the 13 week Intervention phase
  - Identical to Baseline phase; however:
    - Managers had access to recorded data
    - Coaching when necessary
    - Feedback light activated

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Participants and Setting

- Carrier A
  - Long-haul carrier in Southeastern U.S.
  - Delivered dry goods
  - 50 drivers had event recorder installed, 36 drivers completed data collection
    - 46 drivers signed Informed Consent Form (ICF)
- Carrier B
  - Local short-haul carrier in Pacific Northwest U.S.
  - Delivered beverage and paper goods
  - 50 drivers had event recorder installed, 41 drivers completed data collection
    - 30 drivers signed ICF

Procedures (1)

- DriveCam instructed to conduct business as usual
- Prior to installation drivers/managers attended a project briefing
  - Purpose of study
  - Informed consent procedures
  - DriveCam technology
- 50 trucks at each site had a DriveCam event recorder installed
- Start 4 week Baseline phase
  - Event light deactivated, no coaching, no access to events

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Procedures (2)

- Managers participated in training prior to start of Intervention phase
  - How DriveCam technology works
  - How to use HindSight software to view events
  - How to coach drivers
- Start 13-week Intervention phase
  - Event light activated, coaching (if necessary), access to events
  - Drivers completed In-Study Questionnaire
- Post-Study Questionnaire
  - Perceptions and opinions of DriveCam safety program

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Hypothesis 1

There will be a significant reduction in the mean rate of safety-related events from baseline to intervention

- Dependent variable (DV) was the mean rate of safety-related events/10,000 miles
  - Frequency of safety-related events was divided by the number of miles traveled
  - Normalized the data and accounted for missing days, dropouts, and/or exposure
- Paired sample t-test was used to assess if a there was a significant reduction in DV from the Baseline to Intervention phase ($\alpha = 0.05$)

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Carrier A: Results (1)

- 36 drivers included in the data analyses
  - 14 drivers quit, resigned, withdrew, had a malfunctioning event recorder, and/or did not meet the minimum requirements to be included in the data analyses
  - Technical issues precluded 5 drivers from being included in the data analyses and an additional 8 drivers had missing baseline data
  - 58 safety-related events during the Baseline phase (2 collisions and 56 risky driving events)
  - 141 safety-related events during the Intervention phase (2 collisions and 139 risky driving events)

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Carrier A Results (2)

- The 36 drivers drove a total of 291,869 miles during the Baseline phase
  - The mean rate of safety-related events/10,000 miles during the Baseline phase was 1.94
- These same 36 drivers drove a total of 1,170,721 miles during the Intervention phase
  - The mean rate of safety-related events/10,000 miles during the Intervention phase was 1.2
- Paired sample t-test was significant ($t_{(35)} = 1.7$, $p = 0.046$)
  - Significant reduction in the mean rate of safety-related events/10,000 miles from the Baseline to Intervention phase

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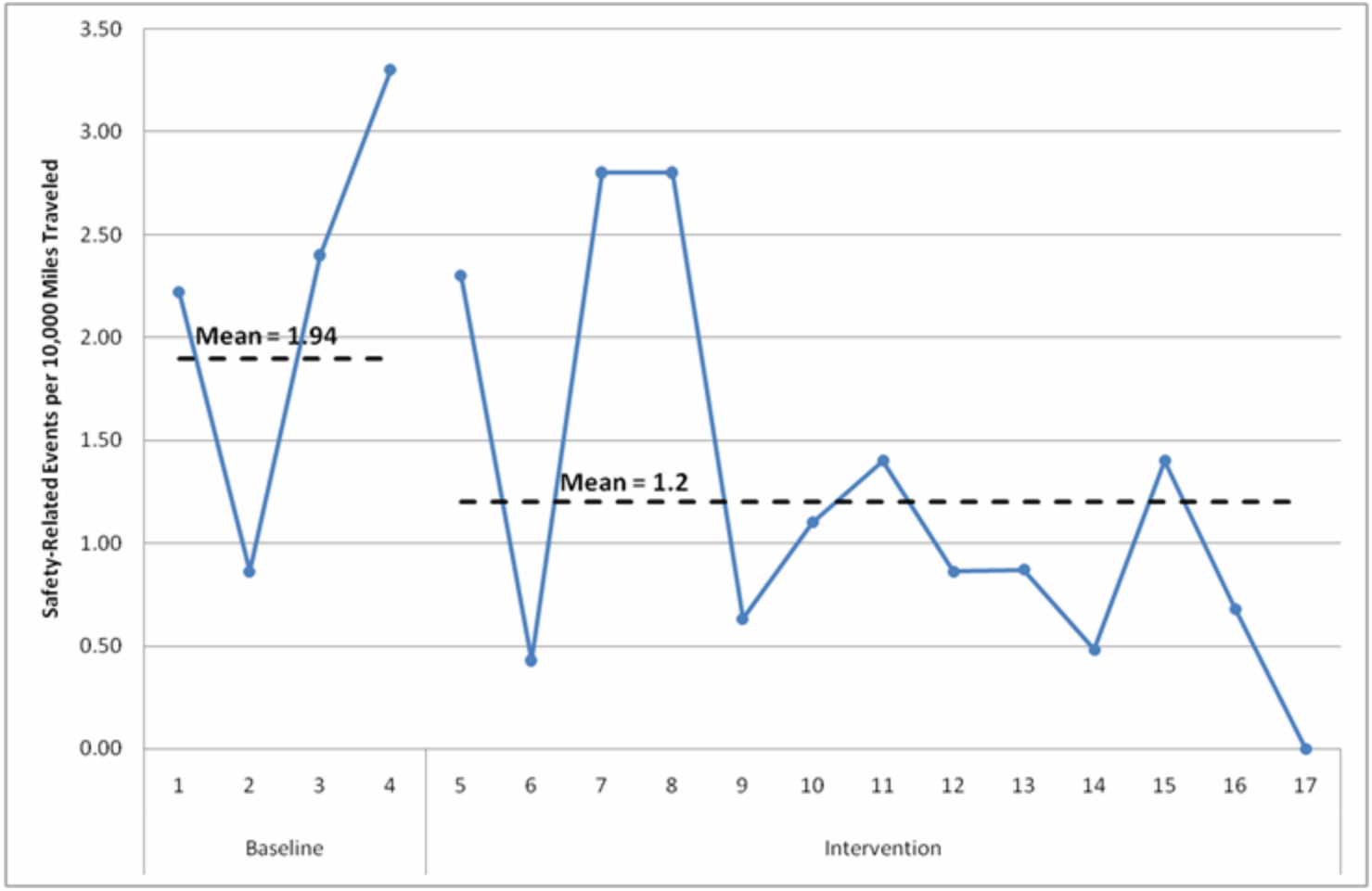
Carrier A Results (3)



38.1% reduction in the mean rate of safety-related events/10,000 miles

Carrier B: Results (1)

- 41 drivers included in the data analyses
  - 9 drivers quit, resigned, withdrew, and/or did not meet the minimum requirements to be included in the data analyses
  - 65 safety-related events during the Baseline phase (1 collision and 64 risky driving events)
  - 115 safety-related events during the Intervention phase (2 collisions and 115 risky driving events)

Carrier B: Results (2)

- The 41 drivers drove a total of 162,492 miles during the Baseline phase
  - The mean rate of safety-related events/10,000 miles during the Baseline phase was 4.02
- These same 41 drivers drove a total of 615,403 miles during the Intervention phase
  - The mean rate of safety-related events/10,000 miles during the Intervention phase was 1.93
- Paired sample t-test was significant ($t_{(40)} = 1.88$, $p = 0.03$)
  - Significant reduction in the mean rate of safety-related events/10,000 miles from the Baseline to Intervention phase

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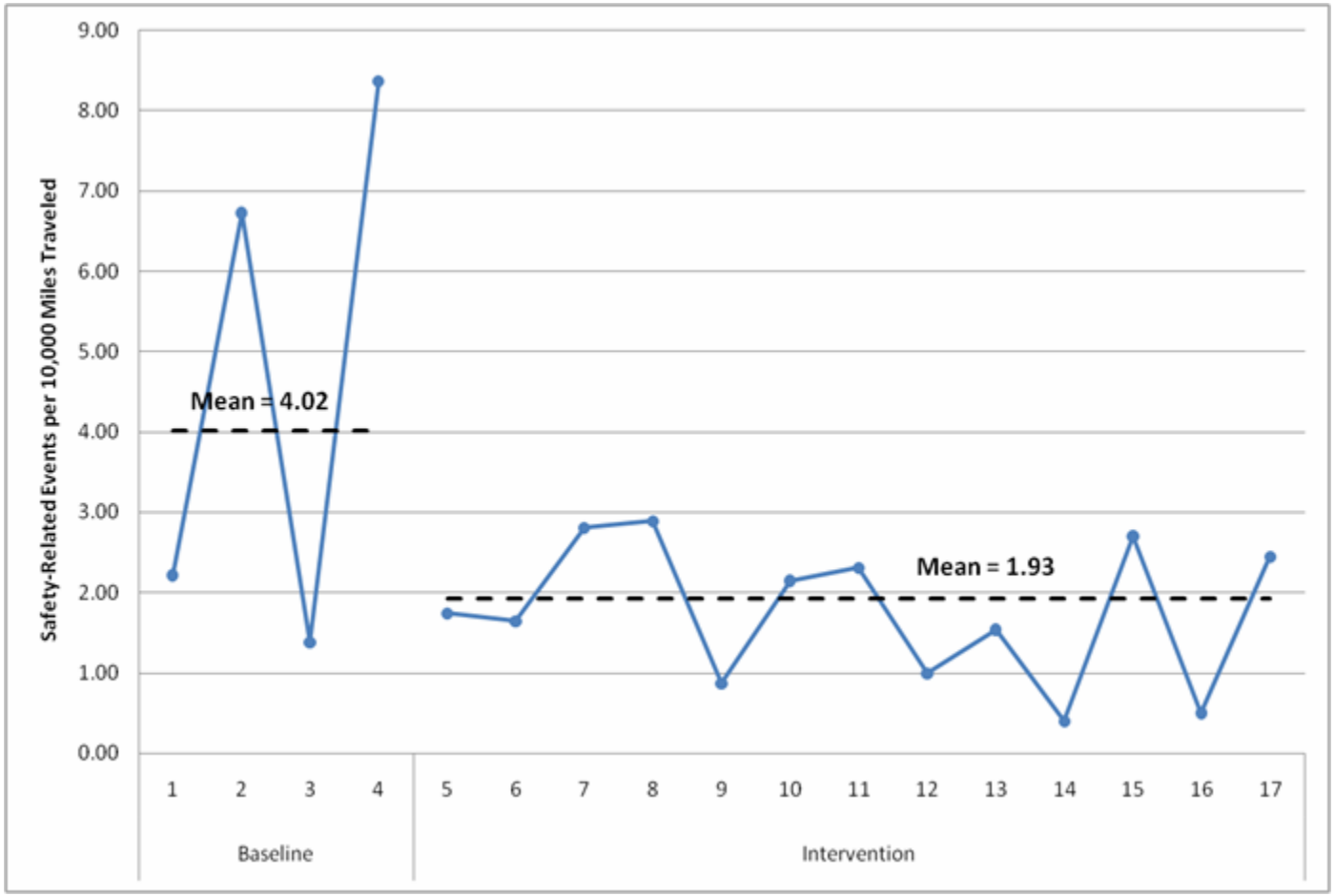
Carrier B Results (3)



52.2% reduction in the mean rate of safety-related events/10,000 miles

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Hypothesis 2

There will be a significant reduction in the mean rate of severe safety-related events from baseline to intervention

- A “severe” event was defined as any safety-related event with an Event Score > 3
  - 0 = collision; 3 = driver unbelted; 11 = driver involved in a near crash, while talking on a cell phone and unbelted
- DV was the mean rate of severe safety-related events/10,000 miles
  - Frequency of severe safety-related events was divided by the number of miles traveled

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Carrier A: Results (1)

- Total of 16 severe safety-related events (8.7%)
- The mean rate of severe safety-related events/10,000 miles
  - Baseline phase was 0.22
  - Intervention phase was 0.09
- 59.1% decrease in the mean rate of severe safety-related events/10,000 miles
  - Paired sample t-test was not significant ($t_{(35)} = 1.19$, $p = 0.121$)
    - Insufficient statistical power
    - Power analysis indicated 30 drivers; however, did not consider severe safety-related events
    - Still a noteworthy reduction

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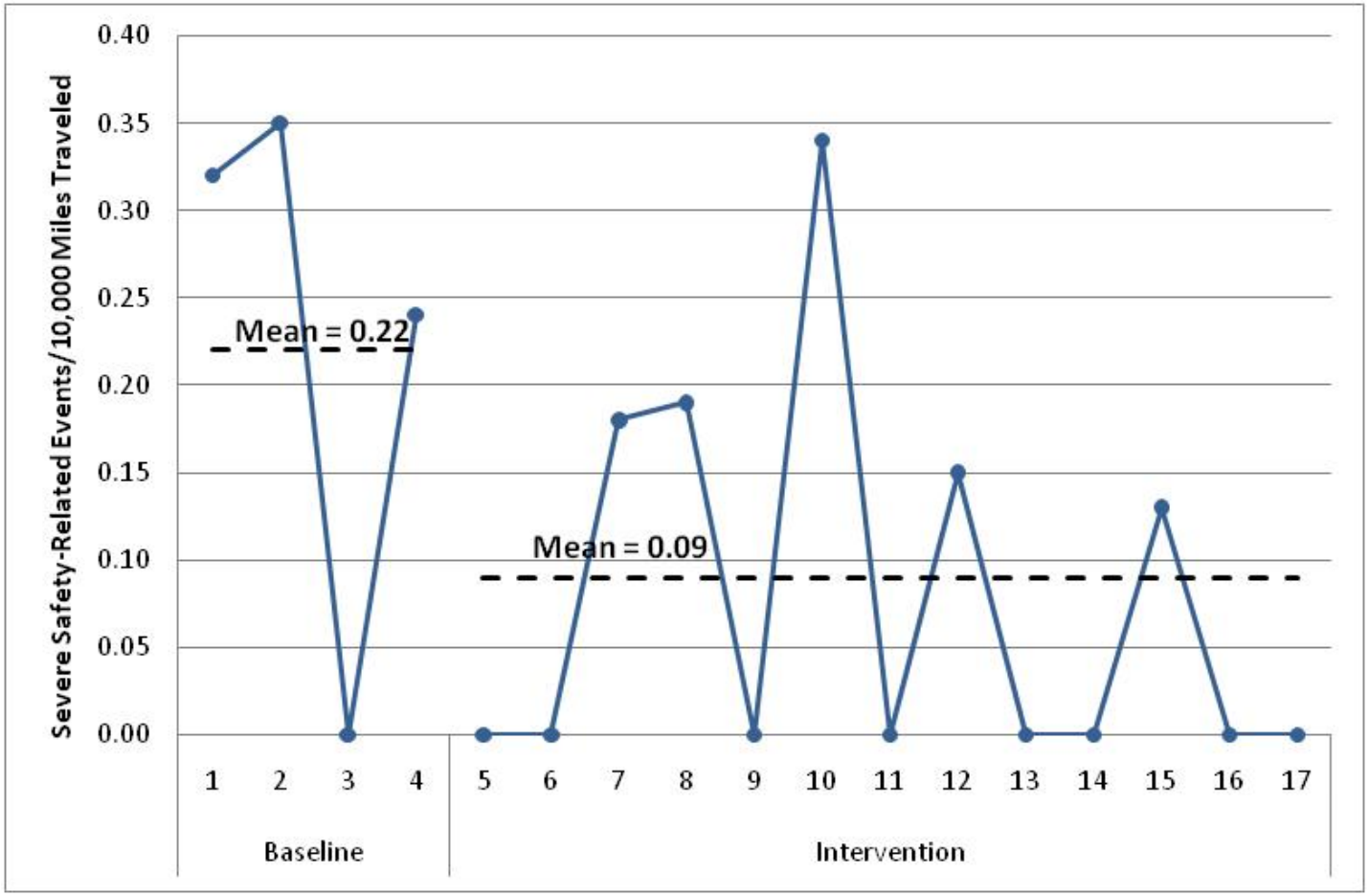
Carrier A: Results (2)



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Carrier B: Results (1)

- Total of 28 severe safety-related events (15.7%)
- The mean rate of severe safety-related events/10,000 miles
  - Baseline phase was 0.36
  - Intervention phase was 0.2
- 44.4% decrease in the mean rate of severe safety-related events/10,000 miles
  - Paired sample t-test was not significant ($t_{(35)} = 1.02$, $p = 0.16$)
    - Again, a noteworthy reduction

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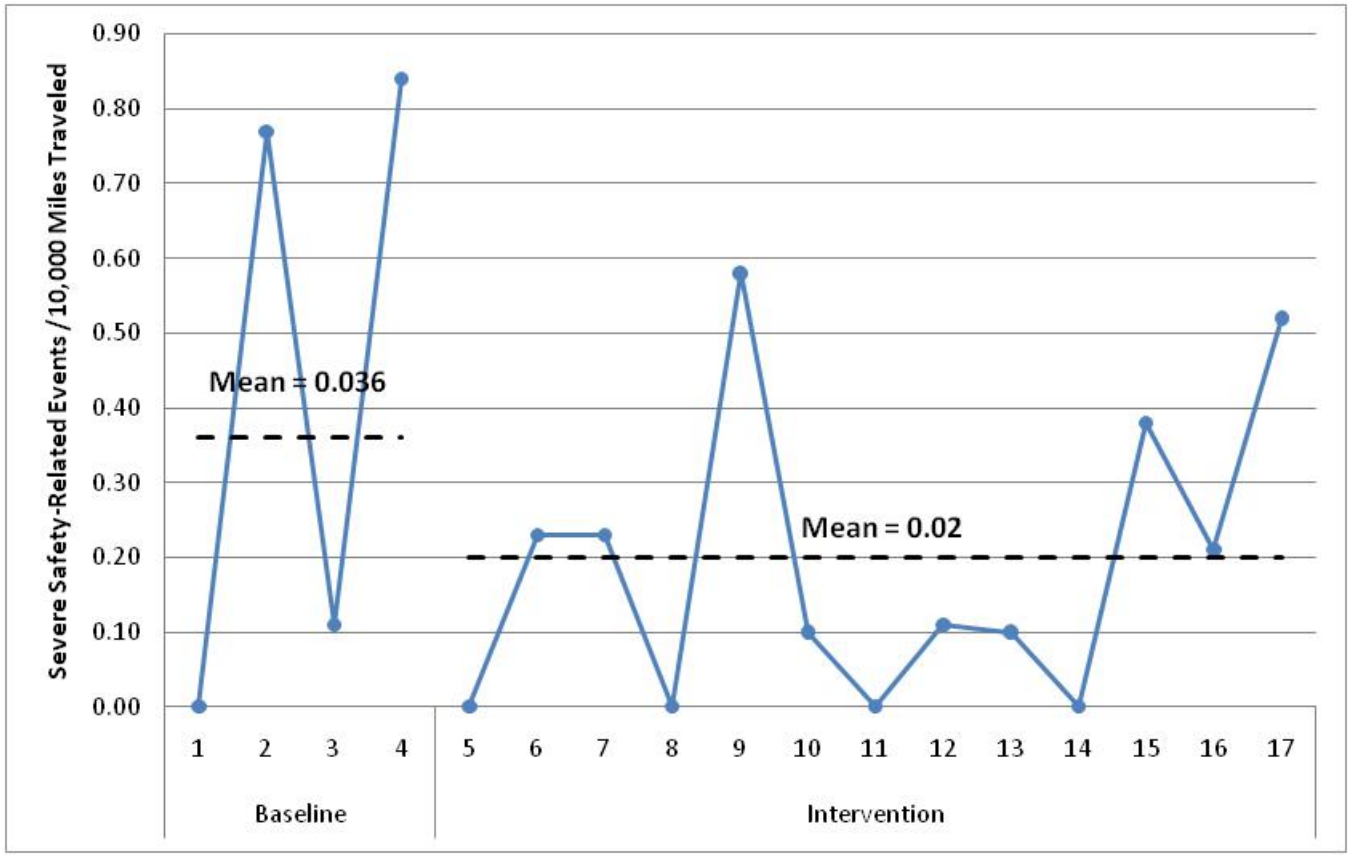
Carrier B: Results (2)



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In-Study Driver Questionnaire (1)

- 10-item questionnaire that served as a manipulation check on coaching protocol
  - VTTI research contacted each driver after coaching session
- At Carrier A there were a total of 32 coaching sessions
  - The average time between the safety-related event and the coaching session was 5.8 days
  - 25 of the coaching sessions involved a driver who signed an ICF
  - 10 questionnaires were completed (40 percent)

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In-Study Driver Questionnaire (2)

- At Carrier B there were a total of 37 coaching sessions
  - The average time between the safety-related event and the coaching session was 10.1 days
  - 28 of the coaching sessions involved a driver who signed an ICF
  - 14 questionnaires were completed (50 percent)

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In-Study Driver Questionnaire (3)

Item	Carrier A	Carrier B
1) Reviewed video during coaching session	8 out of 10 (80%)	1 out of 14 (7%)
2) How clearly was the “root cause” identified	Mean = 7.1 (Moderately Clear)	Mean = 1.0 (Very Unclear)
3) Identified ways to prevent future events	9 out of 10 (90%)	1 out of 14 (7%)
4) The coaching session was positive	Mean = 6.25 (Positive)	Mean = 3.0 (Moderately Negative)
5) How likely are you to use the information learned in coaching session	Mean = 7.8 (Moderately Likely)	Mean = 2.0 (Very Unlikely)
6) Length of coaching session	Mean = 10 minutes	Mean = 10 minutes

- Carrier A adhered to coaching protocol, while Carrier B did not
  - Why the 52.2% reduction in safety-related events/10,000 miles at Carrier B?
  - Feedback given to all drivers at Carrier B via dispatching device

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Post-Hoc Analyses (1)

- Additional analyses on data from Carrier A
- Assess impact of coaching sessions
- Drivers were grouped into one of two groups:
  - Fleet Manager Coaching: Drivers that participated in a coaching session where a video was reviewed (*n* = 13 drivers)
  - No Fleet Manager Coaching: Drivers that did not participate in a coaching session where a video was reviewed or did not participate in a coaching session of any kind (*n* = 23 drivers)
- Carrier B not included in analyses as there was no difference in these groupings

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Post-Hoc Analyses (2)

- The mean rate of safety-related events/10,000 miles in the Fleet Manager Coaching group
  - Baseline was 1.65
  - Intervention 0.95
    - Paired samples t-test was significant ($t_{(12)} = 2.13$, $p = 0.027$)
    - 42.4% reduction
- The mean rate of safety-related events/10,000 miles in the No Fleet Manager Coaching group
  - Baseline was 2.11
  - Intervention was 1.39
    - Paired samples t-test was not significant ($t_{(22)} = 1.13$, $p = 0.136$)
    - 34.1% reduction

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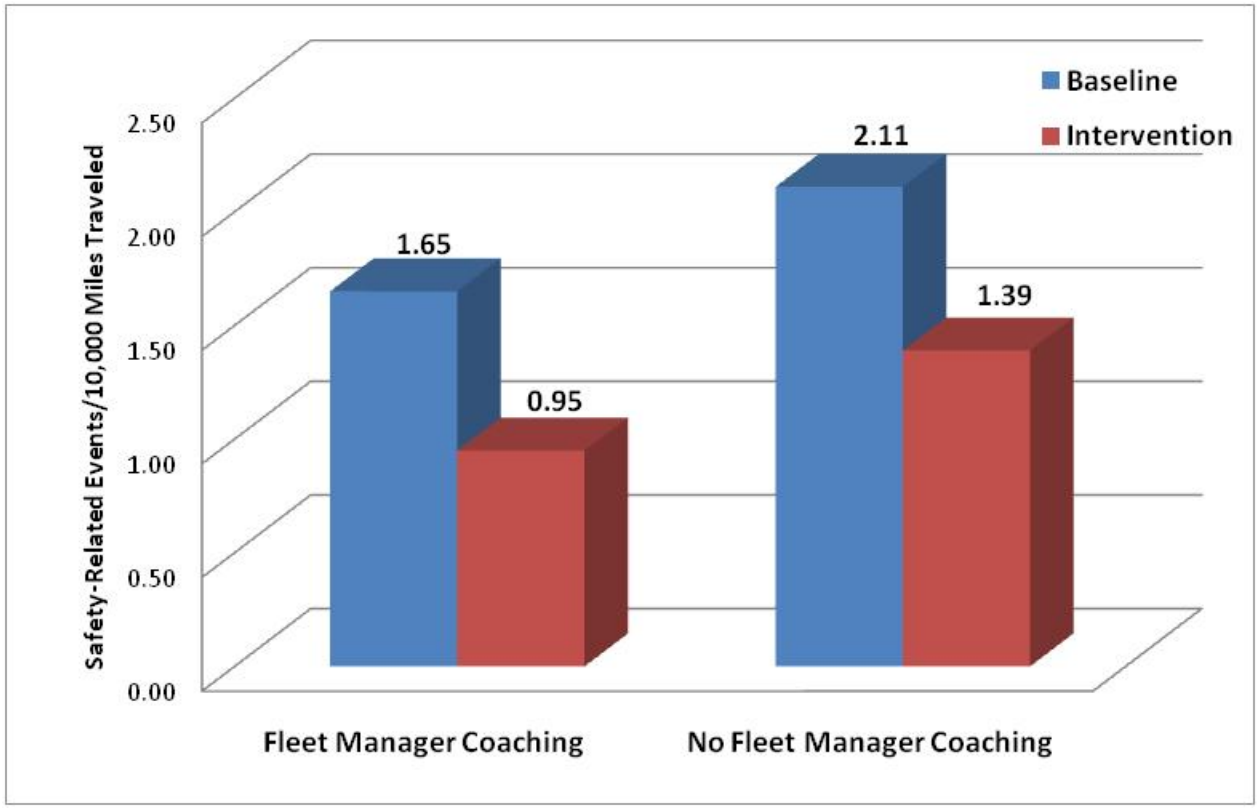
Post-Hoc Analyses (3)



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Post-Hoc Analyses (4)

- The mean rate of severe safety-related events/10,000 miles in the Fleet Manager Coaching group
  - Baseline was 0.53
  - Intervention 0.13
    - Paired samples t-test was not significant ($t_{(12)} = 1.56$, $p = 0.073$)
    - 75.5% reduction
- The mean rate of safety-related events/10,000 miles in the No Fleet Manager Coaching group
  - Baseline was 0.05
  - Intervention was 0.07
    - Paired samples t-test was not significant ($t_{(22)} = 0.27$, $p = 0.605$)
    - 28.6% increase

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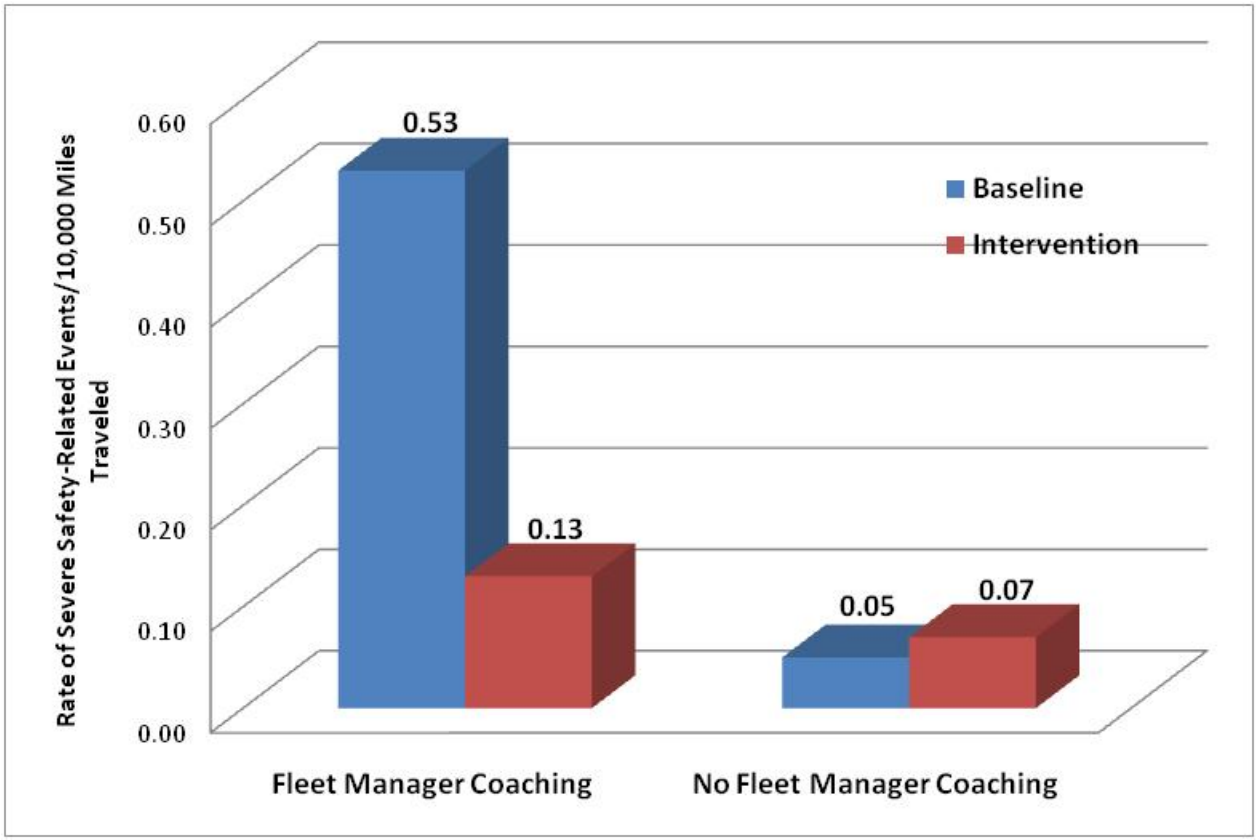
Post-Hoc Analyses (5)



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Post-Hoc Analyses (6)

- The power of the videos in reducing safety-related events was shown in the post-hoc analyses
  - Limited power restricted the ability to detect a statistically significant difference in severe events
- Those drivers involved in higher severity safety-related events, thus in need of a coaching session, received a coaching session where the video of the safety-related event was reviewed
- The trend was clearly in the right direction
  - Accounted for a 75.5% reduction in the Fleet Manager Coaching group

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Summary

- Quasi-experiment showed the effectiveness of a DBMS to decrease the risky driving behaviors of local/short-haul and long-haul truck drivers
- Hypothesis 1 (significant reduction in the mean rate of safety-related events) supported
- Hypothesis 2 (significant reduction in the mean rate of <u>severe</u> safety-related events) not supported
  - Limited statistical power
- Post-hoc analyses illustrated power of videos

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Conclusions (1)

- Concluding differential intervention impact between carriers is risky
  - Safety manager
  - Predominant roads traveled (L/SH vs. long-haul)
- Drivers aware of instrumentation; thus, there may have been reactivity
  - Unlikely this influenced intervention impact
    - Constant across phases
    - Event recorders installed weeks prior to data collection
    - Effects of reactivity are prominent at the beginning (Campbell, 1957)
      - Baseline may have been understated

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Conclusions (2)

- Technical difficulties at Carrier A likely had an adverse effect on intervention impact
  - 13 event recorders malfunctioned
  - Missing baseline data in 8 of these
  - Thus, Baseline phase was likely higher than shown
- Lack of instrumentation over entire fleet at terminal locations
  - Selection bias?
    - Safety managers selected trucks to be instrumented
  - Not able to determine “fleet-wide” benefits

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Conclusions (3)

- Current study relied on power of feedback to alter drivers' at-risk behaviors
  - Goals and feedback necessary to change behavior
    - Goal setting should be added to the intervention
  - VTTI was an independent evaluator; purpose was to assess a commercially available DBMS program
- Safety climate at each carrier differed
  - Drivers at Carrier A had rapport and trust with safety manager
    - Drivers were eager and willing to "give the program a chance"
  - Drivers at Carrier B did not have same rapport or trust
- Drivers were suspicious and circumvented the program

Conclusions (4)

- Drivers at Carrier B improved even though evidence suggested safety managers did not follow the coaching protocol
  - All drivers received some feedback
  - High rate of sabotage at Carrier B casts some doubt on results
  - 278 events where driver face camera was blocked
    - 2 in Baseline, 276 in Intervention
    - In-cab behaviors unable to be viewed

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