An Assessment of the Crash Reduction Effects of Passenger Vehicle Daytime Running Lamps DRLs

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1st NHTSA study on DRls

- Published June 2000
- Restricted to passenger cars
- Used make model, and model year data to identify vehicle with and without DRLs
- Two different comparison groups
  - Older similar model cars & Ford vehicles
- Simple odds and odds ratio

What are DRLs ?
DRL Configurations

- Upper beam headlamps at reduced power
- Low-beam headlamps at full or reduced power
- Turn signals
- Dedicated lamp – (Some GM light trucks)

Purpose of Daytime Running Lamps

- Increase the visual contrast of DRL equipped vehicles during daylight.
- Thereby:
  - reducing multiple vehicle opposite direction/angle crashes
  - reducing single vehicle crashes with non-motorists

Summary of Findings

Year	Investigators	Study Type	Country	Estimated Effects
1964	Allen & Clark	Fleet	USA	7.2% - 38%
1972	Anderson	Law	Finland	27%
1975	Attwood	Fleet	Canada	20% Defense
1977	Anderson et al	Law	Sweden	9% to 21%
1985	Stein	Fleet	U.S.	7%

Summary of Findings

Year	Investigators	Study Type	Country	Estimated Effects
1988	Elvik	Law	Norway	15% summer
1993	Arora et al	Law	Canada	11% 2 vehicle
1993	Hansen	Law	Denmark	up to 37%
1995	Hollo	Law	Hungary	7% - 14%
1997	Tofflemire	Law	Canada	5.3 %

Problems with U.S.A. DRL Analysis

- Law permits the use of DRLs
  but does not require DRLs
  - Some vehicles are equipped with DRLs
  - Other vehicles do not have DRLs.
- DRLs are being phased in over time.
- But problems can be advantages as well.

Data Sets Used

- Fatality Analysis Reporting System (FARS)
  - 1995 to 2001
- National Automotive Sampling System (NASS) General Estimates System (GES)
  - 1995 to 2001
  - (Property damage and injury crashes only)
    - No crashes involving a fatality.

Passenger Vehicle Types

- Passenger cars
- Pickups/light trucks
- Sport utility vehicles (SUVs)
- Vans

Vehicle DRL status

- Vehicles equipped with DRLs
- Vehicles without DRLs
  - As determined by analysis of the VIN
  - Vehicles with DRLs as an option were eliminated from the analysis

Crashes

- Target crashes [DRLs should have an effect]
  - Two vehicle
    - Head on
    - Angle
    - Sideswipe opposite direction
- Comparison crashes [DRLs have no effect]
  - Single vehicle crashes

Persons

- Target persons [DRLs should have an effect]
  - Non-motorists involved in single vehicle fatal crashes
    - Pedestrians and cyclists
- Comparison persons [DRLs have no effect]
  - Occupants of single vehicle fatal crashes

Time of Day

- Daytime
  - – DRLs should be effective
- Night
  - – DRLs should not have any effect

What is ignored?

- Effect on motorcycles/snowmobiles
- Drivers do not turn on head lamps at night
- A two vehicle crash may be avoided which becomes a single vehicle crash
- Possible increases in comparison crashes
- Climate/seasonal differences
- Interactions
- Burned out bulbs/very bright bulbs

Effectiveness is the measure of crash reduction due to a program

- Effectiveness
- The percent change in the number crashes that can be affected by the program

compared to

The percent change in the number of crashes that are not affected by the program.

General Effectiveness

- The General Effectiveness is defined as $E = 1 - e^{B}$

Where B is the coefficient of the equation:

$TC\_DT = B * DRL + SUM_i\ C_i * X_i + error$

$TC\_DT = 1$ if target crash & daytime

else 0

$DRL = 0$ if the vehicle has DRLs

else 1

A bivariate logistic fit of the data – maximum likelihood estimate

General Effectiveness (Degenerate Case)

- Let Omega = TD/(CD + TN +CN)
- The simple odds - Where:

TD = number of vehicles/persons in **T**argeted crashes during **D**aylight

CD = number of vehicles/persons in **C**omparison crashes during **D**aylight

TN = number of vehicles/persons in **T**argeted crashes at **N**ight

CN = number of vehicles/persons in **C**omparison crashes at **N**ight

General Effectiveness (Degenerate Case – No X_i terms)

- Then $e^B = Omega_{DRL}/Omega_{CMP}$ or
- $B = \ln(Omega_{DRL}/Omega_{CMP})$
- Effectiveness $= E = 1 - e^B$

  $= 1 - Omega_{DRL}/Omega_{CMP}$

Advantages of General Effectiveness Approach

- Calculates the statistical significance, p.
- Works for censuses and surveys.
- Can adjust for a variety of factors.
- Equivalent to the simple odds.
- Generalizations also exit for the odds ratio.

Why use the simple odds?

- The simple odds, Omega, is more stable, smaller standard error than the odds ratio, Psi where:

- Omega = TD/(CD+TN+CN)
  - $se^2 = 1/TD^2 + 1/(CD + TN + CN)^2$
- Psi = (TD/CD)/(TN/CN)
  - $se^2 = 1/TD^2 + 1/CD^2 + 1/TN^2 + 1/CN^2$

How effective are DRLs? Preliminary Results

- Two vehicle opposite direction/angle fatal daytime crashes **5%** ($p = 0.0680$)
- Two vehicle opposite direction/angle non-fatal daytime crashes **5%** ($p = 0.0751$)
- Single vehicle fatal non-motorist daytime crashes **12%** ($p = 0.0023$)

June 2000 Results

- Two vehicle opposite direction/angle fatal daytime crashes **5%** to –28% (nothing significant)
- Two vehicle non-fatal daytime crashes

  [From the State Data System] 22% to –16%
- Single vehicle fatal non-motorist daytime crashes 24% to 35% (nothing significant)

The effectiveness estimates dependent on vehicle type

Passenger cars, SUVs,Vans, and Pickups

- When adjusting for vehicle type the effectiveness estimates are:
- Two vehicle fatal daytime OD/A* crashes

  5% (p = 0.0799)
- Two vehicle non-fatal daytime OD/A* crashes

  4% (p=0.1333)
- Single vehicle fatal non-motorist daytime crashes

  13% (p = 0.0016)

*OD/A Opposite direction/angle

Preliminary Conclusions

- Daytime running lamps DRLs seem to reduce target crashes by 5% to 12%.
- The 5% reductions are not statistically significant, but 12 % reduction is.
- The effectiveness of DRLs is not dependent on the type of passenger vehicle.