Evaluating the Effectiveness of Red Light Running Camera Enforcement in Cedar Rapids

tech transfer summary

The installation of red light running cameras as well as speed enforcement cameras at select approaches provided a somewhat unique opportunity to evaluate the two countermeasures together.

Problem Statement

Red light running (RLR) is a problem in the US that has resulted in 165,000 injuries and 907 fatalities each year from 2000 through 2008. In Iowa, RLR-related crashes make up 24.5 percent of all crashes at signalized intersections and account for 31.7 percent of fatal and major injury crashes at signalized intersections.

RLR crashes are a safety concern due to the increased likelihood of injury compared to other types of crashes. One tool used to combat red light running is automated enforcement in the form of RLR cameras. Automated enforcement, while effective, is often controversial.

Background

Cedar Rapids, Iowa installed RLR and speeding cameras at seven intersections across the city. The intersections were chosen based on crash rates and whether cameras could feasibly be placed at the intersection approaches. The cameras were placed starting in February 2010 with the last one becoming operational in December 2010.

Photo Enforced sign at 42nd Street NE in Cedar Rapids, Iowa

Center for Transportation Research and Education

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RESEARCH PROJECT TITLE
Evaluating the Effectiveness of Red Light Running Camera Enforcement in Cedar Rapids and Developing Guidelines for Selection and Use of Red Light Running Countermeasures

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Objective

The objective of this research was to assess the safety effectiveness of the red light running program that has been implemented in Cedar Rapids.

Research and Results

Cedar Rapids also installed speed enforcement cameras at select approaches where RLR cameras were installed because they felt speed reduction at those locations was important in improving safety along with reducing red light running. This provided a somewhat unique opportunity to evaluate the two countermeasures together.

The research objective was accomplished by analyzing data to determine the following metrics:

- Reductions in red light violation rates based on overall changes, time of day changes, and changes by lane
- Effectiveness of the cameras over time
- Changes in seconds into the red that vehicles running the red light enter the intersection
- Changes in the average headway between vehicles entering the intersection

Mast arm and Radio Frequency antennae setup

Analyses

At the end of the project, most of the cameras had been in place for only one year. As a result, it was not yet feasible to conduct a crash analysis. Consequently, several different types of analyses were completed to evaluate the effectiveness of the RLR cameras using violation and other data collected by the cameras, such as headway and time into red.

Cameras were installed at different times between February and December 2010. Once cameras were installed at each intersection, data were collected for three days to a week before warnings or citations were given (referred to as "stealth mode").

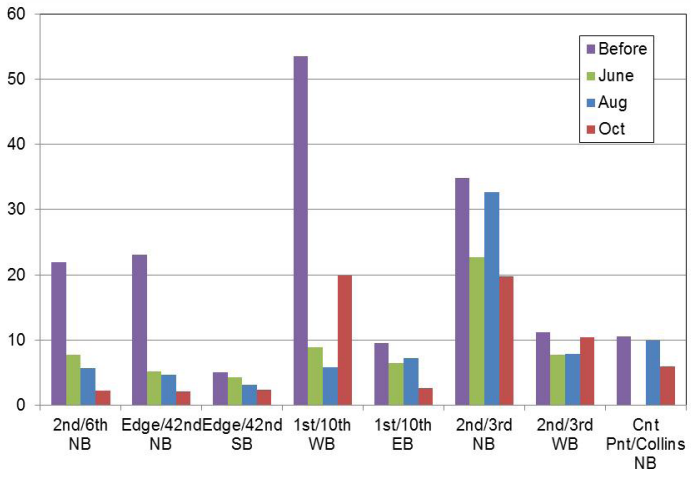
During stealth mode, the cameras were present but Photo Enforced signs to alert drivers to the cameras were not yet installed and Cedar Rapids was not issuing citations. Data collected during this time period were used as before data.

Next, the cameras were set to collect violations and warnings were given for a 30 day period before actual citations were issued. Data were collected for three different after periods, which occurred after the cameras had been issuing citations actively for at least a month. Data were extracted in June, August, and October 2010 for the same number of days as for the before period.

Change in Red Light Running Violation Rates

RLR violation rates were compared from the before to after periods. Violation rates reflected violations per 10,000 vehicles. Violation rates were first compared by approach. Decreases were noted for all three after periods.

As shown in the chart, some approaches had substantial decreases. Decreases ranged from 16 to 83 percent for the June after period; 6 to 89 percent for the August after period; and 7 to 91 percent for the October after period.



2010 decrease in RLR violation rates by intersection

Time-of-Day Analysis

Violations were also compared for daytime versus nighttime to determine whether time of day was relevant. Several intersections go into flashing mode during late night hours so only four approaches were included in the analysis.

All approaches evaluated experienced decreases for the daytime period with decreases in violation rates from 29 to 92 percent for the June after period, 12 to 93 percent for the August after period, and 51 to 86 percent for the October after period.

Nighttime results were similar for the June after period with decreases from eight to 100 percent. Two approaches experienced increases in the violation rate for the August after period (15 percent and 104 percent) with the other two approaches experiencing decreases (48 percent and 81 percent). The final after period (October) had reductions at three approaches (from 38 to 66 percent) with one approach having an increase of 73 percent at night.

The time-of-day results suggest the cameras may be more effective in reducing RLR violations during the daytime.

Evaluation of Change in Red Light Running Violations over Time

Most studies that have assessed the effectiveness of red light cameras in reducing RLR violations conduct their analysis for a single after period, which is usually fairly close in time to installation of the cameras. It is not well understood if the cameras have the same impact over time.

In some cases, countermeasures become less effective over time because drivers become accustomed to the treatment. On the other hand, enforcement countermeasures may be more effective over time given drivers who speed or run red lights may change their behavior when they or someone they know receives a ticket.

To test this theory, a negative binomial model was used to evaluate whether RLR violations increased or decreased over time. Data were available for eight approaches from zero to 12 months, depending on the intersection and approach.

The model was used to calculate the expected violations per 10,000 vehicles over time. The variables for both intersection ID and month after installation were statistically significant. The model indicated that for each additional month an average decrease of 9.3 percent in violations is predicted.

Time into Red Analysis

Another analysis assessed whether cameras are effective in reducing late red light runners. Opponents of RLR cameras suggest that the cameras are not effective in reducing RLR crashes because they are only likely to change the behavior of drivers who run the red light within seconds of the red indication. These drivers are typically running the red light intentionally. The rationale is that late red light violations are unintentional due to driver distraction, impairment, or fatigue and that cameras are not likely to have an impact on unintentional red light running.

Time-stamped violation data were obtained for seven of the approaches where RLR cameras were installed. RLR violations were binned by time into red by 0.0 to less than 1.0 second, 1.0 to less than 3.0 seconds, and, finally, 3.0 or more seconds into the red. These particular intervals were used given other research indicated crashes are unlikely in the first second into the red, only left-turn-opposed crashes are likely to occur from 1 to 3 seconds into the red, and both left-turn-opposing and right-angle crashes occur 3 or more seconds into the red.

The violation rate per 10,000 vehicles was calculated for the seven approaches collectively. During the June after period, the violation rate decreased from 5.29 to 2.69 per 10,000 vehicles (a 49.1 percent decrease) for the 0.0 to < 1.0 second interval. A decrease from 1.97 to 0.73 (or 63.0 percent) was noted for the 1.0 to < 3.0 second interval. The largest reduction occurred for violations that were 3.0 or more seconds into the red with a change from 10.35 to 2.87 (or 72.3 percent).

RLR camera setup

During the August after period, decreases were noted for all of the time intervals with the largest decrease occurring for violations that were 3.0 or more seconds into the red, with a decreased violation rate from 10.35 to 2.59 (or 75.0 percent). The 0.0 to < 1.0 second interval had a decrease from 5.29 to 2.59 (or 51.1 percent) and the 1.0 to < 3.0 second interval had a decrease from 1.97 to 0.56 (or 71.4 percent).

The October after period also had decreases in violation rates for all of the time intervals. The 1.0 to < 3.0 and 3.0 or more second intervals both experienced a 79.6 percent decrease, from 1.97 to 0.4 and 10.35 to 2.82, respectively. The 0.0 to < 1.0 second interval experienced a decrease of 67.9 percent from 5.29 to 1.70.

As noted, violations that were 3.0 or more seconds into red experienced the greatest decrease in violation rate in terms of magnitude. That interval also experienced the greatest percentage decrease for the June and August after periods.

Analysis of Change in Headway

One of the largest concerns when installing red light cameras is that the presence of the cameras causes more people to slam on their brakes resulting in more rear-end crashes. Drivers may be more likely to attempt to stop during the yellow interval to avoid an RLR violation when they would have otherwise proceeded through the intersection.

An unexpected stop by a preceding driver may result in a rear-end crash if the following driver is following too close. Alternatively, drivers who are aware the cameras are in place may leave larger gaps between them and the vehicle in front, anticipating that the lead driver is more likely to stop quickly.

The RLR cameras record time and speed for all vehicles whether or not they commit RLR violations. Headway was next sorted into bins of different lengths and the percent in each bin was found. The bins used were less than 1 second, 1 second, 2 seconds, 3 seconds, 4 seconds, and 5 or more seconds.

At 5 seconds, the gap is sufficiently large enough that even under adverse conditions, the following vehicle will have sufficient time to stop without rear-ending the lead vehicle. More bins were used for the smaller gaps to better determine the cameras' effects on these drivers. Finally, the change in percentage for each bin was found by subtracting the percentage in the before period from the percentage in each after period (for each intersection approach).

Data were summarized for seven approaches. The analyses showed the percentage of drivers in any headway bin experienced little change between the before and any of the three after periods. In other words, results suggest that driver headway is not affected by presence of the RLR cameras.

Summary of Key Findings

- Red light running violation rates decreased from 6 to 91 percent over the three after analysis periods.
- Comparison of changes in violation rates for daytime versus nighttime suggest that the cameras are more effective in reducing violations during the day.
- An analysis showed that the cameras were more effective the longer they were in place. There was an expected 9.3 percent reduction for each additional month the cameras were in-place (evaluated over an eight-month period).
- The cameras were more effective in reducing late red light running violations (3 or more seconds into the red) than violations from 0.0 to < 1.0 second or 1.0 to < 3.0 seconds.
- The cameras did not appear to have any impact on the amount of headway between vehicles.