WHAT WORKS: CRIME REDUCTION SYSTEMATIC REVIEW SERIES

No 11. RED LIGHT ENFORCEMENT CAMERAS TO REDUCE TRAFFIC VIOLATIONS AND ROAD TRAFFIC INJURIES: RESEARCH PROTOCOL

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ABSTRACT

Background

Signalised junctions are a fundamental way of regulating traffic, particularly in urban areas. Traffic violations occur when a driver enters an intersection after the traffic light signal has turned to red. These violations can have severe consequences when they result in collisions, causing damage to vehicles and road users. While such traffic crashes may cause damage to property only, they can be serious, particularly when colliding at speed into the sides of other vehicles.

Objectives

To update and expand a Cochrane systematic review of red light enforcement cameras.

Search strategy

We will search the following electronic databases: Ovid MEDLINE(R); Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations; Ovid MEDLINE(R) Daily and Ovid OLDMEDLINE(R); Ovid TRANSPORT (includes the Transport Research Information Services (TRIS), The International Road Research Documentation (IRRD) and The European Conference of Ministers of Transport (TRANSDOC) databases);National Police Library; Embase Classic+Embase (OvidSP); ISI WOS: SCI-EXPANDED & CPCI-S; PubMed (current); PROQUEST; EBSCO; Web of Knowledge; Heritage. We will search a broad range of websites for reports and grey literature.

Selection criteria

We will include both experimental and observational studies of red-light cameras. Experimental study designs will be used to provide evidence of effectiveness, and may include controlled-before-after (CBA) studies, controlled interrupted time series, and randomised controlled trials. Observational study designs will be included to provide details of mechanisms, moderators, implementation and economic costs, and may include cohort, cross-sectional, or case-control studies.

Data collection and analysis

Two review authors will independently examine the titles, abstracts, and keywords of electronic records for eligibility according to the inclusion criteria. The full-text reports of potentially eligible studies will be independently assessed for final inclusion in the review by two review authors using screening codes in EPPI-Reviewer 4. Any disagreements will be resolved by discussion with a third review author. Reference lists of all eligible trials will be searched for further eligible studies. Two review authors will independently code relevant data in EPPI Reviewer using a standardised data coding set. The primary outcome will be the number of red-light violations (i.e., number/proportion of vehicles passing through red lights, i.e. not amber). Secondary outcomes will include number of traffic crashes, number of traffic crashes resulting in injury, number of crashes resulting in fatalities or serious injuries, and number of damage only collisions. We will also seek data on economic outcomes (including costs of providing the intervention and income generated by the intervention) and process outcomes (e.g. data on implementation).

BACKGROUND

Signalised junctions are a fundamental way of regulating traffic, particularly in urban areas. Traffic violations occur when a driver enters an intersection after the traffic light signal has turned to red. These violations can have severe consequences when they result in collisions, causing damage to vehicles and road users. While such traffic crashes may cause damage to property only, they can be serious, particularly when colliding at speed into the sides of other vehicles (Transportation Research Board 2003). Drivers of vehicles approaching traffic lights may also decide that they have time to cross on an amber light and yet the vehicle in front has slowed and stopped, causing rear-end collisions.

A less traditional approach to reducing collisions at traffic lights is to extend the phase at which all lights are red. The all-red phase of traffic lights can be modified to account for any vehicles that are approaching the junction at high speed, thereby preventing collisions with vehicles about to enter the intersection. This approach is somewhat controversial as it accepts a level of offending (jumping the red light) in order to mitigate the risk of road traffic collisions and casualties (Abbas et al 2007).

Red-light (traffic stop signal) cameras are one method to enforce compliance with traffic signals. Cameras automatically capture images of vehicles as they violate a red traffic signal, and then, based on a review of the evidence, penalty tickets are sent to the address where the violating vehicle is registered. Red-light cameras thus have the potential to reduce traffic law offences by increasing offenders' perceptions of the risks of being caught and being brought to justice if they jump a red light.

The use of red-light cameras to enforce signalised junctions have a number of advantages. Traditional manual enforcement methods are resource intensive and high risk, whereas red-light cameras have the advantage of operating 24-hours a day and do not involve high-speed pursuits. Red-light cameras, unlike the police, are also immune from charges of discrimination, as they detect only those vehicles that have violated a traffic signal. Successful prosecution of offenders by red light cameras might also impact on recidivism rates.

The use red-light cameras, however, remains somewhat controversial. Public concerns have focused on their use to raise revenue for local governments and potential flaws with technology, while motoring groups have questioned whether the intervention results in safety improvements (Langland-Orban 2008). It may be that red light cameras reduce right-angle crashes but yet cause an increase in rear-end collisions. A previous systematic review by Aeron-Thomas et al. (2005) suggested that red-light cameras are effective in reducing total casualty crashes, but found inconclusive evidence of the effect of red-light cameras on violations and total collisions. The review concluded that larger and better controlled studies were needed.

Aims

We aim to update and expand a previous Cochrane systematic review to provide a comprehensive account of traffic red-light signal cameras employed worldwide. We will update the Cochrane review to include studies published after 2005, and we will expand the review include information for the EMMIE framework (Johnson et al. 2015) on mechanisms, moderators, implementation and economic costs of speed camera interventions. For each study we will describe the setting (e.g., nature of roads), theoretical basis for the intervention, characteristics of the intervention and the outcomes measured.

Quantitative analyses will be conducted to assess intervention effectiveness. Specifically, where well-designed controlled evaluations of programmes have been conducted, we will include

estimates of the effect of interventions on the defined primary outcome (i.e., red-light traffic signal violations) and secondary outcomes (e.g., road traffic crashes, injuries, fatalities), and where possible, identify the effectiveness of individual components of successful programmes. We will investigate potential moderators of intervention effects, and summarise different aspects of implementation of devices and their respective costs if economic data are available.

This review is being conducted jointly with Department of Criminal Justice, Florida International University, USA, and Cambridge University, UK.

METHODS

Criteria for considering studies

We will use broad inclusion criteria for considering studies, in order to include programmes that have undergone controlled evaluation, as well as those that have been assessed descriptively or qualitatively.

Types of study

We will include both experimental and observational studies of red-light cameras. Experimental study designs will be used to provide evidence of effectiveness, and will include controlled-before-after (CBA) studies, controlled interrupted time series, and randomised controlled trials. Observational study designs will be included to provide details of mechanisms, moderators, implementation and economic costs, and will include cohort, cross-sectional, or case-control studies.

Types of participants/areas

- All road users
- Intersections and areas assigned red-light cameras

Types of interventions

- Cameras at intersections to detect red-light violators/offenders
- Cameras at junctions
- Area-wide programmes where enforcement cameras operate at some of the signalised junctions.

Outcome measures

Primary outcome measures

The primary outcome variable will be the number of red-light violations (i.e., number/proportion of vehicles passing through red lights, i.e. not amber).

Secondary outcome measures

The secondary outcome variables will be number of traffic crashes, number of traffic crashes resulting in injury, number of crashes resulting in fatalities or serious injuries, and number of damage only collisions.

Other data

We will also seek data on economic outcomes (including costs of providing the intervention and income generated by the intervention) and process outcomes (e.g. data on implementation).

Identification of eligible studies and data extraction

Our search methods will comprise four parts: first, we will search electronic bibliographic databases for published work (see below for electronic databases to be searched); secondly, we will search the grey literature for unpublished work; thirdly, we will search trials registers for ongoing and recently

completed trials; finally, we will search reference lists of published studies, contact authors and specialist groups to enquire about unpublished studies. In order to reduce publication and retrieval bias we will not restrict our search by language, date or publication status. The sources to be searched have been chosen based on their coverage of the topic.

Electronic sources

We will search the following:

1. Ovid MEDLINE(R) 1946 to current
2. Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations
3. Ovid MEDLINE(R) Daily and Ovid OLDMEDLINE(R) 1946 to current
4. Ovid TRANSPORT (includes the Transport Research Information Services (TRIS), The International Road Research Documentation (IRRD) and The European Conference of Ministers of Transport (TRANSDOC) databases) 1968 to current;
5. National Police Library
6. Embase Classic+Embase (OvidSP) 1947 to current
7. ISI WOS: SCI-EXPANDED (1970) & CPCI-S (1990) to current
8. PubMed (current)
9. PROQUEST
10. EBSCO
11. Web of Knowledge
12. Heritage

Other sources

We will search a broad range of websites for reports and other grey literature (see appendices for details of websites). The search strategy will be adapted as necessary to search all listed sources including the internet search.

Screening and review process

All studies identified through the search process will be exported firstly to the EndNote bibliographic database for de-duplication. Once duplicate records have been removed the records will be imported into EPPI-Reviewer 4 software for screening and coding. This will allow the team to manage coding tasks, assess inter-rater reliability, and share the results (within the consortium and externally). Two review authors will independently examine the titles, abstracts, and keywords of electronic records for eligibility according to the inclusion criteria above. Results of this initial screening will be cross-referenced between the two review authors, and full-texts obtained for all potentially relevant reports of studies. The full-text reports of potentially eligible studies will be independently assessed for final inclusion in the review by two review authors using screening codes in EPPI-Reviewer 4. Any disagreements will be resolved by discussion with a third review author. Reference lists of all eligible trials will be searched for further eligible studies.

Data extraction

Two review authors will independently code relevant data in EPPI Reviewer using a standardised data coding set (*see Appendix 2 for draft data items*). Corresponding authors of studies will be contacted directly if the required data are not reported in the published manuscript.

Analysis

Descriptive analysis

We will describe all studies that meet the inclusion criteria, including:

1. Study design
    - Study design and quality (risk of bias)
    - Data collection methods, modes, and techniques; validity of tools
    - Statistical and other analyses
2. Participants (intervention and control if relevant)
    - Study setting (country, urban/rural location)
    - Nature of roads (Road type: motorway, major, minor, and speed limit)
3. Components of programme
    - Camera signing practice
    - Associated publicity campaigns
    - Covert or overt cameras
    - Theoretical basis used in the design of the intervention components
4. Outcomes
    - Primary outcomes (e.g. number/percentage of vehicles running red-lights)
    - Secondary outcomes (e.g. road traffic crashes, deaths and injuries, damage only collisions).

Assessment of risk of bias in included studies

Two review authors will independently assess the quality of the included studies and any discrepancies will be resolved by deferment to a third review author. Study quality will be based on six dimensions of study design, analysis and reporting. The review authors will rate the risk of bias in each domain as 'high risk', 'low risk', or 'unclear or unknown risk'. The six dimensions and criteria for risk of bias are:

1) Selection and matching of intervention and control areas

- The characteristics of the study and control sites were the same/similar
- There were no changes in the control sites during the study period
- The control sites were not adjacent to the intervention sites
- It is unlikely that the control group received the intervention

2) Blinding of data collection and analysis

- The outcome data were obtained from routine reporting systems
- The analysis was conducted blind to intervention and control groups

3) Lengths of data collection time periods pre- and post-intervention

- Length of before period is at least 1 year
- Length of after period is at least one year

4) Reporting of results

- Are the main findings of the study clearly described?
- Do the authors report uncertainty due to random variability (confidence intervals)?
- Are appropriate statistical tests used to assess the main outcomes reported (p-values)?

5) Control of confounders

- Do the authors describe potential confounders?
- Are the distributions of confounders in intervention and control sites assessed and similar?
- Do the authors discuss the effect of confounders on the results?

6) Control of other potential sources of bias

- Did the study control for potential bias due to regression to the mean?
- Did the study report, or control for 'spill-over' effects (e.g. use control sites located away from red-light camera sites and associated publicity)?
- Were any other sources of bias addressed?

Statistical analysis

Measures of treatment effect

To facilitate comparisons of studies we will devise a standardised and well-defined summary measure for each outcome. Summary measures will be based on relative effects, rather than difference in effect, where the outcome after intervention is divided by that before the intervention as an expression of the proportional change in outcome. We will calculate summary measures for all studies where possible (i.e. where required information is reported or adequate data is available for calculation).

We anticipate that the majority of studies will be CBAs reporting outcomes in intervention areas before and after the intervention, and for comparable time periods in a control area. We will estimate a rate ratio by dividing the count of the outcome post- and pre-intervention in the intervention area by the corresponding ratio in the control area.

For example, the estimated rate ratio for road traffic collisions would be:

$$\frac{\text{collisions after/collisions before in intervention area}}{\text{collisions after/collisions before in control area}}$$

Assuming that traffic volume remains the same on the roads post intervention in the control and intervention areas, this rate ratio estimates the change in the collision rate in intervention areas compared to that in control areas. For outcomes expressed as counts or rates we will estimate the intervention effect using rate ratios with a 95% confidence interval (CI).

Data synthesis

We will pool the results in a random-effects meta-analysis if three or more studies report the same outcome. We will pool the logarithm of the rate ratio its standard error (calculated assuming a Poisson distribution for the number of collisions in each area and time period). If there are too few studies for a meta-analysis the results of individual studies will be presented in a narrative review. Heterogeneity among the effect estimates will be assessed using a chi-squared test at a 5% significance level and the I^2 statistic, the percentage of between-study variability that is due to true differences between studies (heterogeneity) rather than due to sampling error. We will consider an I^2 value greater than 50% to reflect substantial heterogeneity. We will conduct sensitivity analyses in order to investigate possible sources of heterogeneity due to study quality (e.g., adequate vs. inadequate periods of outcome data collection). Details of each intervention will be presented in a table of study characteristics. We will use statistical software (Stata version 14) to conduct the meta-analysis.

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Langland-Orban, B., Pracht, E., and Large, J. (2008) Red Light Running Cameras: Would Crashes, Injuries and Automobile Insurance Rates Increase If They Are Used in Florida? *Florida Public Health Review*, 5: 1-7

Transportation Research Board. Impact of red light camera enforcement on crash experience. NCHRP Synthesis 310. Washington, DC: Transportation Research Board, 2003:57. ISBN 0309069556

APPENDICES

Appendix 1: List of specialized websites

- AA Foundation for Traffic Safety, USA - www.aaafoundation.org
- American Transportation Research Institute - http://atri-online.org/
- Australia and New Zealand Society of Evidence Based Policing - http://www.anzsebp.com/
- Australian Transport Safety Bureau (ATSB) - https://www.atsb.gov.au
- Belgian Road Safety Institute - http://www.ibsr.be/en
- Center for Evidence-Based Crime Policy, USA - http://cebcp.org/evidence-based-policing/
- Center for Problem-Oriented Policing, USA - http://www.popcenter.org/
- Centers for Disease Control and Prevention (CDC), USA – http://www.cdc.gov/
- Chalmers University of Technology, Area of Advance Transport, Sweden - http://www.chalmers.se/en/areas-of-advance/Transport/Pages/default.aspx
- CROW, Netherlands – http://www.crow.nl/english-summary
- Department of Transport Planning and Engineering, National Technical University of Athens, Greece - http://www.civil.ntua.gr/departments/transport/
- European Road Safety Observatory (ERSO) - http://ec.europa.eu/transport/wcm/road_safety/erso/index-2.html
- European Transport Safety Council - http://etsc.eu
- Federal Highway Administration (FHWA), USA - http://www.fhwa.dot.gov/
- Federal Highway Research Institute (BASt), Germany - www.bast.de/EN/Home/
- Finnish Transport Agency - http://portal.liikennevirasto.fi/sivu/www/e
- French Institute of Science and Technology for Transport, Development, and Networks (IFSTTAR) - http://www.ifsttar.fr/en/welcome/
- Institute for Road Safety Research (SWOV), Netherlands – http://www.swov.nl/index_uk.htm
- Institute for Transport Sciences (KTI), Hungary - http://www.kti.hu/index.php/home
- Institute of Transport Economics (TOI), Norway - https://www.toi.no/?lang=en_GB
- Institute of Transportation Engineers (ITE), USA – http://www.ite.org/
- Institute of Transport Studies (Monash), Australia - http://www.eng.monash.edu.au/civil/research/centres/its/
- International Transport Forum - http://www.internationaltransportforum.org/
- Justice Research and Statistics Association, USA - http://www.jrsa.org
- Laboratoire d'Economie des Transports (LET), France - http://www.let.fr/?lang=en
- National Highway Traffic Safety Administration (NHTSA), USA - http://www.nhtsa.gov/
- Police Executive Research Forum, USA - http://www.policeforum.org/
- Police Foundation, USA - http://www.policefoundation.org/
- Rand Corporation, USA - http://www.rand.org/
- Scottish Institute for Policing Research - http://www.sipr.ac.uk/
- Society of Evidence Based Policing, UK - http://www.sebp.police.uk/
- Swedish National Road and Transport Research Institute (VTI) - http://www.vti.se/en/
- Swiss Council for Injury Prevention (BFU) - http://www.bfu.ch/en

- Technion – Israel Institute of Technology - http://www.technion.ac.il/en/
- Trafikverket/The Swedish Transport Administration - http://www.trafikverket.se/en/startpage/
- Transport Canada (TC) - www.tc.gc.ca/eng/
- Transport Research Board (TRB), USA - http://www.trb.org
- Transport Research Center (CDV), Czech Republic - http://www.cdv.cz/en/
- Transport Research Laboratory (TRL), UK - http://trl.co.uk/
- Transport Safety Research Centre (TSRC), UK - http://www.lboro.ac.uk/departments/lds/research/groups/tsrc/
- United Nations Official Documents System - http://documents.un.org/
- Vera Institute of Justice, USA - http://www.vera.org/
- VTT Technical Research Centre of Finland, LTD (VTT) - http://www.vttresearch.com/
- World Health Organization (WHO) – http://www.who.int/en/

Appendix 2: EPPI Reviewer standardised data coding set

Study design

- Meta-analysis
- RCT
- Controlled interrupted time series
- Controlled before and after
- Before/after not controlled
- Cross sectional
- Case study
- Qualitative
- Commentary

Study length

- Dates of before period
- Dates of after period

Data collection details

- Data sources
- Creation of variables

Characteristics of intervention sites

Characteristics of control sites

Study setting and nature of roads

- Country
- Urban/rural
- Road type (motorway, major road, etc.)

Study aims

Intervention type

Intervention components

- Number of cameras
- Size of area covered

Implementation (what is needed to implement speed cameras)

Mechanism

- Theory or mechanism of change

Measures of exposure to speed cameras

Outcome measures:

- Number/Percentage of drivers crossing on red light at signal
- Number/Percentages of drivers crossing on red light in areas with and without cameras
- Road user deaths
- Road user injuries
- Road traffic crashes

Statistical Methods

Description and treatment of bias and confounding

- Matching of intervention and control areas (e.g. the comparability of the areas; whether control areas are adjacent to the intervention area)
- Blinding of data collection and analyses
- Lengths of data collection time period pre- and post-intervention
- Control of confounders (e.g. was there an assessment of the distribution of confounders between intervention and control groups?)
- Adjustment for time trends
- Any other potential sources of bias (regression to the mean, adjustments for seasonality)
- Selective reporting of results by study authors

Results - where in full text are quantitative results

- Difference between groups (include CI)
- Interpretation

Cost information