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An evaluation of Winnipeg's photo enforcement safety program: Results of time series analyses and an intersection camera experiment

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ABSTRACT

The objective of this study was to evaluate the impact of Winnipeg's photo enforcement safety program on speeding, i.e., "speed on green", and red-light running behavior at intersections as well as on crashes resulting from these behaviors. ARIMA time series analyses regarding crashes related to red-light running (right-angle crashes and rear-end crashes) and crashes related to speeding (injury crashes and property damage only crashes) occurring at intersections were conducted using monthly crash counts from 1994 to 2008. A quasi-experimental intersection camera experiment was also conducted using roadside data on speeding and red-light running behavior at intersections. These data were analyzed using logistic regression analysis. The time series analyses showed that for crashes related to red-light running, there had been a 46% decrease in right-angle crashes at camera intersections, but that there had also been an initial 42% increase in rear-end crashes. For crashes related to speeding, analyses revealed that the installation of cameras was not associated with increases or decreases in crashes. Results of the intersection camera experiment show that there were significantly fewer red light running violations at intersections after installation of cameras and that photo enforcement had a protective effect on speeding behavior at intersections. However, the data also suggest photo enforcement may be less effective in preventing serious speeding violations at intersections. Overall, Winnipeg's photo enforcement safety program had a positive net effect on traffic safety. Results from both the ARIMA time series and the quasi-experimental design corroborate one another. However, the protective effect of photo enforcement is not equally pronounced across different conditions so further monitoring is required to improve the delivery of this measure. Results from this study as well as limitations are discussed.

1. Introduction

1.1. Background

Speeding and red light running are among the leading causes of road crashes in Canada and the United States (Goldenbeld and Van Schagen, 2005; McGee and Eccles, 2003; Tay, 2000). Driving above the speed limit has been shown to increase one's risk of crash involvement, injury and death. Likewise, red light running also increases the risk of crashing, injury, and death for obvious reasons (Kloeden et al., 2001).

The consequences of speeding and red light running vary in magnitude. In Quebec, red light running has been shown to be responsible for more than one quarter of all traffic injuries at intersections with traffic lights (Brault et al., 2007). According to an Ontario study (Ministry of Transportation Ontario, 1998), 42% of fatal crashes and 29% of injury crashes involved disobeying traffic signals. Therefore, approximately 61 fatal crashes and 4800 injury crashes occurred in Ontario each year as a result of drivers running red lights. The crashes that result from red light running also vary in severity. Red light running has generally resulted in right-angle crashes which have a higher injury and fatality rate than most other types of crashes, including rear-end crashes (Helai et al., 2008).

Intersections can be even more hazardous when drivers are speeding. Generally, as speed increases, so does the risk of being involved in a crash as well as the severity of that crash (Evans, 2006; Elvik, 2005; Hess, 2004). In fact, the risk of being involved in a crash increases proportionately to the increase in speed. Increasing the average driving speed by as little as 1% raises the risk of fatality by 4–12% (Evans, 2004); driving 10 km/h above the speed limit more than doubles the risk of being involved in a crash (Kloeden et al., 2001), while driving 20 km/h above the limit increases this risk up to six times.

Photo enforcement devices such as speed cameras and/or red light cameras are increasingly being used in conjunction with traditional police traffic enforcement techniques. In general, photo enforcement has been shown to bring about significant behavioral changes in motorists that have resulted in reduced disregard for

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traffic signals and designated speed limits (Blakey, 2003). However, there is considerable variation in the literature regarding the effectiveness of photo enforcement programs in general. While most studies have found an overall reduction in speeding, red light running, and associated crashes, some studies have not found any significant improvement (Andreassen, 1995; Burkey and Obeng, 2004) or found results that suggest photo enforcement is effective only at some locations or under certain conditions and that more research is needed to better understand the impact of photo enforcement and how this measure can best be employed (Erke, 2009; Garber et al., 2007; Kent et al., 1997).

Additionally, while some studies have found that photo enforcement works to reduce traffic violations at the camera sites alone, other studies suggest there is a spill-over or halo effect, i.e., a reduction in surrounding non-camera intersections as well (Chen et al., 2000; Hess, 2004; Ministry of Transportation Ontario, 1995; Retting and Kyrychenko, 2002; Retting et al., 1999; Shin and Washington, 2007), while some find no spillover effects; for example, in Phoenix, Arizona (Shin and Washington, 2007). Such spillover effects suggest a more generalized change in driver behavior. Further, it has been noted that spillover effects "are a key advantage of automated speed enforcement that are not generally achieved by traditional police speed enforcement" (Retting et al., 2008, p. 444).

Many studies have investigated the impact of photo enforcement devices at intersections on red-light running and found improvements in the overall safety of intersections (see McGee and Eccles, 2003). However, some researchers have voiced concerns about undesirable side effects of red-light cameras such as a possible increase in rear-end crashes. For example, a study conducted in 2005 examining the effects of red-light cameras using a before-after research design found a 25% decrease in right-angle crashes, but also found a 15% increase in rear-end crashes (Council et al., 2005). Unfortunately, if and how the effects of these devices change over time has not been studied.

Furthermore, while studies have looked at the effect of speed cameras in general (cf. Wilson et al., 2010; Pilkington and Kinra, 2005), few evaluations of the impact of photo enforcement devices on speeding behavior at intersections specifically have been conducted. The majority of studies on the effects of photo enforcement on speeding have focused on the use of mobile speed camera devices. When fixed cameras have been examined, the effects of both mobile and fixed cameras are often examined together (e.g., Pilkington and Kinra, 2005). It should also be noted that few photo enforcement programs have utilized photo enforcement cameras to detect "speed-on green" which is a type of photo enforcement that captures vehicles as they speed through intersections on green and amber lights. In Canada, only two jurisdictions, Alberta and Manitoba have used speed cameras in this way (CCMTA, 2010) and no evaluation has been conducted on the use of this technology in Canada. In fact, the City of Winnipeg was one of the first programs in North America to use the speed on green technology. Thus, there is little information available regarding the effectiveness of these devices on speeding at intersections in particular. For this reason, there is a need to evaluate the use of photo enforcement to detect speeding at intersections. This is the focus of this study.

1.2. The Winnipeg photo enforcement safety program

The City of Winnipeg photo enforcement safety program was established in 2003 to augment conventional traffic enforcement as a potential solution to enhancing traffic safety. The goal of the Winnipeg photo enforcement safety program is to reduce crashes and injuries by reducing red-light running and excessive speeding.

With respect to both speeding and red light running occurring at intersections the Winnipeg photo enforcement program utilizes a system that was designed by Gatsometer BV. This technology can detect both speeding and red-light offences.

To detect red-light running at intersections, the City of Winnipeg uses the "violation on entrance approach", meaning the automated photo enforcement system is activated only once the traffic signal has turned from amber to red. At this point, any vehicle that passes over the magnetic sensors will trigger the camera to photograph the violating vehicle as it passes through the intersection. Thus, only when the signal turns red, the sensors become active (in essence, this means vehicles that entered the intersection when the light was still amber but exit it when the light has already turned red are not in violation). This is different from the stricter "violation on exit" approach, where a violation is logged if the signal turns red upon exiting the intersection, even when the signal was not red when entering it (in essence, this means vehicles that entered the intersection when the light was still amber but exit it when the light has already turned red are indeed in violation).

In Winnipeg, when a vehicle is detected passing over the activated sensors two photographs are taken. The first photograph taken is of the vehicle outside the intersection (at the stop line) and shows that the signal is red. The second photograph shows the same vehicle in the intersection and must show that the light is still red. Any vehicle that is waiting to turn left or caught in the intersection due to traffic backlog would not be photographed. Note that these pictures are reviewed manually by photo enforcement staff as part of a validation process to avoid issuing tickets for false positives.

To detect speeding at intersections, these same sensors detect the presence of vehicles and calculate their speed using time and distance. If the speed of the vehicle exceeds the predetermined speed threshold, the camera will be triggered to photograph the violating vehicle as it passes through the intersection. The system's level of accuracy in measuring a driver's speed is accounted for by using tolerances (accuracy below 100 km/h is ±2 km; accuracy above 100 km/h is ±2%). While such tolerances are used, the City communicates to the public that speeding is enforced at the posted speed limits.

1.3. Objectives

The objective of this study was to evaluate the photo enforcement safety program in Winnipeg, Manitoba and determine the impact of the program on crashes and violations related to speeding and red-light running. The Traffic Injury Research Foundation (TIRF) was contracted by the City of Winnipeg to evaluate the Winnipeg Photo Enforcement Safety Program of the Traffic Safety Unit of the Winnipeg Police Service (see Vanlaar et al., 2011 for the full report about this evaluation).

This paper presents the results of time series analyses regarding crashes related to red-light running (right-angle crashes and rear-end crashes) and crashes related to speeding (injury crashes and property damage only crashes) occurring at intersections. Such analyses allowing for the examination of trends over time have not yet been widely applied to the study of photo enforcement as most evaluations have used a before/after research design rather than time series.

This paper also presents the results of a quasi-experimental intersection camera experiment using roadside data on speeding and red-light running behavior to assess the impact of the program on speeding and red-light running violations occurring at intersections.