Do Speed Cameras Reduce Collisions?

Jeffrey Skubic, DO, Steven B. Johnson, MD, Chris Salvino, MD
Department of Trauma, Banner Good Samaritan Medical Center, Phoenix, Arizona, USA

Steven Vanhoy, BS, Chengcheng Hu, PhD
University of Arizona, College of Medicine, Phoenix, Arizona, USA

ABSTRACT – We investigated the effects of speed cameras along a 26 mile segment in metropolitan Phoenix, Arizona. Motor vehicle collisions were retrospectively identified according to three time periods – before cameras were placed, while cameras were in place and after cameras were removed. A 14 mile segment in the same area without cameras was used for control purposes. Five cofounding variables were eliminated. In this study, the placement or removal of interstate highway speed cameras did not independently affect the incidence of motor vehicle collisions.

INTRODUCTION

Speed cameras are controversial in the United States (US), despite theoretically being considered valuable. By increasing speed enforcement along highways, they potentially reduce velocity which provides the largest contribution to kinetic energy ($ke = ½ mv^2$, representing kinetic energy, mass and velocity respectively). Kinetic energy transferred to the vehicle's occupants is the main mechanism for injury [Richter et al, 2006]. Although not definitively proven, it is argued that by reducing velocity of motor vehicles, speed cameras reduce kinetic energy and therefore severity of the collisions; less studied is if they reduce the <u>incidence</u> of motor vehicle collisions (MVC).

A combination of fixed location and mobile speed cameras were implemented in Arizona statewide in 2008 with the intent of reducing MVC and associated injury severity. However, due to considerable controversy the cameras were removed in 2010. [Davenport D, 2010] Those opposed to the program cited reasons such as "big brother" surveillance, less revenue than expected (many drivers ignored the tickets) and an accordion like effect (decreasing velocity and then increasing velocity as one passes a camera) on traffic as their reasons for opposition [Davenport P, 2010].

Because there are so few studies examining the effect of speed cameras on MVC in the US, and with the recent placement and subsequent removal of speed cameras in Arizona, this study was constructed to examine the effects of speed cameras on the incidence of MVC on Arizona interstates and to gain insight into the utility of these cameras with Americans. This retrospective study's research question was - "Did highway speed cameras reduce the number of MVC in Arizona?"

METHODS

After IRB approval was obtained, a retrospective review was performed of all motor vehicle crashes along a 20 mile bidirectional (40 miles total) segment of interstate I-10 in urban Phoenix. The speed limit is 65 miles per hour, and opposing traffic is separated by double sided concrete barriers. Collisions were identified using the Arizona Department of Transportation collision data for 2008-2011 collected by on scene police officers. [AZDOT, 2011] Within this 40 miles, there are 26 miles which contained cameras every two miles along its entire length during a portion of the evaluation period (EXPERIMENTAL segment) and 14 miles with no speed cameras (CONTROL segment). By having cameras every 2 miles in the experimental segment a vehicle was never more than 1 mile from a camera while traveling in this segment.

The cameras were deployed in October, 2008. Cameras were deactivated July, 2010 but not physically removed until October, 2010 (due to the transition period for removal, 2010 was excluded as a time frame for data evaluation). Three nine month periods of time were chosen for analysis as follows (Table 1): January 1 - September 31, 2008 when no cameras were in place (PRE-CAMERAS), January 1 – September 31, 2009 when cameras were in place (CAMERAS) and January 1 – September 31, 2011 when no cameras were in place (POST-CAMERAS). Total numbers of collisions during each time period were collected. We attempted to control for the five multiple confounding variables of: <u>traffic volume fluctuation</u> over time by comparing our experimental 26 mile segment to the 14 mile control segment; <u>seasonal changes (volume and weather)</u> by using the same time periods each year for the 3 groups; <u>geographical variability</u> by using a single 20 mile stretch of highway; <u>halo effect**</u> (time and distance); and <u>variability of distance between cameras</u> by choosing the 26 mile experimental segment which had a speed camera at approximately 2 mile intervals. Statistical analysis was

**The halo effect refers to the continued effect of a camera either after it is driven past (distance halo) or after it no longer exists in a given location (time halo). Time halos have been shown to be anywhere from 2 days to 8 weeks. [Armour, 1984; Hauer and Ahlin, 2002; Vaa, 1994] In this study, data from the first three months after cameras were removed was ignored in attempt to control for any time halo effect as drivers adapted to the change. Distance halos have been recorded as being anywhere from 3km (1.9 miles) to 22km (13.7 miles) in different European and Australian studies. [Cairney, 1988; Legget, 1988; Makinen, 2001] performed using chi-squared testing to compare the 26 miles containing cameras (experimental) to the 14 miles with no cameras (control) and *p* values < 0.05 were considered as being statistically significant.

Table 1 Camera presence according to highway segment and time period

	PRE-CAMERAS 1/1-9/31 2008	CAMERAS 1/1-9/31 2009	POST-CAMERAS 1/1-9/31 2011
EXPERIMENTAL 26 - Mile Camera Segment	NO cameras present	YES cameras present	NO cameras present
CONTROL 14 - Mile No Camera Segment	NO cameras present	NO cameras present	NO cameras present

RESULTS

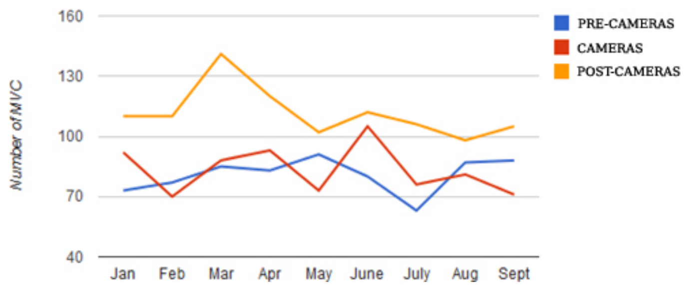
For the 26 mile experimental camera containing segment of interstate, there was a 1.5% (341 vs. 346, p=0.8) increase in MVC when cameras were placed (PRE-CAMERAS vs. CAMERAS) and a 28% (346 vs. 444, p=0.4) increase when cameras were removed (CAMERAS vs. POST-CAMERAS; Table 2). For the 14 mile segment without cameras, there were 3.6% and 39% increases in MVC between the same time periods, respectively. There was little month to month variation (see Figure 1) in the total number of collisions; however, an increase was seen in collisions in both the EXPERIMENTAL group and CONTROL group for the POST-CAMERAS time period. Although, exact traffic volume was not examined, after accounting for MVC increases in the control segment we found that neither camera placement nor removal had an independent impact on MVCs. In other words, speed cameras did not statistically contribute to an increase or decrease in the number of MVC.

Table 2 Number of MVC for each time period, Percent Increase in MVC (PRE-CAMERA TO CAMERA and CAMERA TO POST-CAMERA), and Statistical Summary

	PRE-CAMERAS	CAMERAS	POST-CAMERAS
EXPERIMENTAL 26 - Mile Camera Segment	341	346 (1.5%)	444 (28%)
CONTROL 14 - Mile No Camera Segment	388	402 (3.6%)	560 (39%)
STATISTICAL ANALYSIS PRE-CAMERA to CAMERA & CAMERA to POST CAMERA*		*p*=0.8	*p*=0.4

*Accounting for volume increase through inclusion of control segment.

Figure 1 Total number of collisions (EXPERIMENTAL + CONTROL) for the three time periods examined



DISCUSSION

There are approximately 100,000 motor vehicle collisions in Arizona annually. These result in 750 deaths and 50,000 injuries. 4,500 of these injuries are incapacitating; 5,500 are related to alcohol. Statewide economic loss is estimated at $2.9 billion annually. [Halikowski, 2012] Consequently, tools such as speed cameras would be of benefit if they were shown to decrease economic and medical impacts on society.

A recent Cochrane review examining 35 studies investigating the effect of speed cameras on speed and collisions concluded that although the quality of the studies was moderate at best, the consistency of all studies to report a positive reduction in either speed or collisions was impressive [Wilson et al, 2011]. Five of these studies were performed in the US with the remainder being largely European and Australian (speeding tolerances vary by country and driver attitudes toward speeding). [Cunningham et al, 2005; Retting et al, 2008; Retting and Farmer, 2005; Retting et al, 2008; Shin et al, 2009]. Only two of these US studies examined number of MVC specifically. One study examined a 6.5 mile stretch of highway in Scottsdale, Arizona during the six speed camera pilot program and reported an average 51% reduction in MVC. This program ran from January 2006 to October 2006. [Shin et al, 2009]. They analyzed data from a speed camera pilot program; however, despite a thorough analysis, the post camera period they measured was only 1.5 months long and started the day after the cameras were removed, therefore not taking any time halo effect into effect. In addition, the length of highway segment was short at only 6.5 miles and did not have a control. The other US study reporting on crash reduction of 12% was conducted from 2000-2004 in North Carolina [Cunningham, 2006]. Criticism of this study was that the cameras were only in place for 4 months.

In addition to the limited existing data on MVC incidence and the relationship to speed cameras, there is even less useful information on the relationship of speed cameras to injury severity.

In Arizona, after a pilot program in 2006, speed cameras were deployed statewide. A total of 52 fixed location cameras and 40 mobile cameras were deployed, although the original proposal allowed up to 120 fixed locations and 50 mobile units. Posted maximum speed limit throughout the segment examined remained constant during all time periods. Signs were placed 1000 feet before the cameras stating, "Photo Enforcement Zone." Vehicles exceeding the posted speed limit by 11 MPH were photographed and mailed a citation for $181.50 USD. Projected revenue for the first year was $90 million, but only $37 million was collected. Many drivers ignored the violation or could not be identified photographically. [Davenport D, 2010] Ultimately, the cameras were removed for what many speculate to be political reasons.

For this study, a segment of interstate I-10 running through Phoenix, Arizona which contained a high concentration of speed cameras was chosen to be analyzed specifically to look at the impact of speed cameras on the number of MVCs.

This study is unique in that it controlled for five confounding variables including traffic volume, seasonal changes (volume and weather), geographic variability, halo effect (time and distance) and variability of distance between cameras. In addition, there was no significant construction performed that we are aware of in either the control or experimental segments during the 3 time periods that would have had an effect on the crash rates. One confounding variable could not be accounted for and that was the occasional and random placement of mobile speed cameras in the 40 mile segment analyzed as well as the rest of the state. The placement of mobile cameras was considered infrequent and random in the study segment and most likely did not contribute to incidence of MVC in this study.

While the number of collisions in both the experimental and control segments increased as time progressed, it is interesting to note that statewide, the number of collisions in Arizona steadily decreased.[Halikowski, 2011] The majority of the state is rural, while our study was performed on an urban segment of interstate having a high concentration of speed cameras. We feel that the number of collisions going up in the control segment over the 3 time periods reflects an increase in traffic in general in the urban metro-Phoenix market as opposed to the rate of crashes in general in this segment.

In this study speed cameras did not statistically contribute to an increase or decrease in the number of MVC.

CONCLUSION

While studies have examined the effects of speed cameras, few have looked specifically at the relationship of speed cameras and total number of MVCs while also accounting for confounding variables.

This study evaluated a very specific and defined segment of Arizona interstate that contained speed cameras for a given period of time and attempts to answer the question "Did highway speed cameras reduce the number of MVC in Arizona?" Five critical confounding variables were eliminated in this comprehensive study looking at pre, during and post placement of fixed speed cameras. Our data did not show any statistical increase or decrease in total number of MVC with speed cameras. This study did not address injuries or fatalities. Although, speed cameras did not change the incidence of collisions in this study, it will be important to see if they affect injury severity independent of incidence. Further studies are needed to examine the effect speed cameras have on injury severity, admissions to trauma centers and hospital costs independent of total number of MVC.

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CORRESPONDING AUTHOR:
Jeffrey Skubic 925 E. McDowell Rd 2nd floor. Phoenix, AZ. 85006. email: jskubic@gmail.com