Evaluation of Automated Speed Enforcement in Montgomery County, Maryland

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ABSTRACT

Speeding is a major factor in motor vehicle crashes, and almost one-quarter of speeding-related fatalities occur on streets with speed limits of 35 mph or less. In 2007, Montgomery County implemented the state of Maryland's first automated speed enforcement program, with camera use limited to residential streets with speeds limits of 35 mph or less and school zones. Vehicle speeds were measured approximately 6 months before and 6 months after speed cameras were deployed, and signs were installed warning of the speed enforcement program. Relative to comparison sites in Virginia, the proportion of drivers traveling more than 10 mph above posted speed limits declined by about 70 percent at Montgomery County locations with both warning signs and speed camera enforcement, 39 percent at locations with warning signs but no speed cameras, and 16 percent on residential streets with neither warning signs nor speed cameras. Public opinion surveys found 74 percent of Montgomery County drivers thought speeding on residential streets was a problem. Six months after enforcement began, 60 percent of drivers were aware of the camera program and 62 percent supported it.

INTRODUCTION

Speeding is a major factor in motor vehicle crashes, especially those resulting in serious injuries (Elvik, 2005). In the United States, speeding — as defined on police crash reports as driving too fast for conditions, exceeding posted speed limits, or racing — was a contributor in about 32 percent of crash deaths in 2006, resulting in more than 13,500 fatalities (Insurance Institute for Highway Safety (IIHS), 2008). Although speeding is often associated with interstates and other high-speed roads, nearly 90 percent of speeding-related fatalities occur on roads other than interstate highways. In 2006 23 percent of all speeding-related fatalities occurred on streets with speed limits of 35 mph or less. Publicized police enforcement has been shown to reduce vehicle travel speeds and crashes (Stuster, 1995). However, many enforcement agencies do not have sufficient resources to mount effective speed enforcement programs. Staffing levels have not kept pace with the growth in motor vehicle travel. Between 1995 and 2005 the estimated number of vehicle miles traveled in the United States increased by 23 percent (Federal Highway Administration, 2007), but the number of municipal law enforcement officers grew by 12 percent (Federal Bureau of Investigation, 2007). In a survey of US drivers only 1 in 10 reported being stopped for speeding during the past 12 months, even though about three-quarters said they drove above speed limits on all types of roads (National Highway Traffic Safety Administration, 2002).

As a supplement to traditional police enforcement, speed cameras are used throughout the world to deter and punish speeding behavior. Speed cameras monitor traffic speeds and photograph drivers traveling above specified speeds, usually well above the speed limit. There are two methods for deploying speed cameras: mobile cameras accompanied by enforcement personnel that may be moved

among various locations, and fixed cameras that monitor speeds at specific locations and are unaccompanied by officers. A growing body of evidence, based primarily on studies conducted in Australia and Europe, shows that speed cameras can substantially reduce speeding violations and injury crashes (Pilkington and Kinra, 2005; Wilson et al., 2006). Although some US studies have been conducted (Berkuti and Osburn, 1998; Retting and Farmer, 2003), evidence of speed camera effectiveness in the United States is limited due to the relatively recent introduction of camera enforcement and the small number of US programs that have been formally evaluated.

The purpose of the present study was to evaluate the effects on traffic speeds and public opinions during the first 6 months of speed camera enforcement in Montgomery County, Maryland.

METHODS

The study was conducted in Montgomery County, Maryland, a large, populous suburb of Washington, DC. with a geographic area of 496 square miles and a population of about 930,000 residents (US Census Bureau, 2008). In 2006 Montgomery County became the first Maryland jurisdiction authorized to deploy speed cameras. Camera-based enforcement is permitted on residential streets with speed limits up to 35 mph and in school zones. Tickets can be issued for vehicles observed traveling at least 10 mph above the speed limit. The registered vehicle owner is subject to a $40 fine with no driver license points. Rear photography is used to capture an image of the rear license plate of a vehicle detected speeding. The driver is not photographed.

Program Description

Montgomery County officials sought to develop a model speed camera program designed to optimize the safety benefits of camera enforcement and to garner high levels of public support. The concept of developing a model program grew in part from recent research by Delaney et al. (2005) that identified common controversies associated with speed camera programs around the world and suggested techniques to address them. Controversies include fine revenue (claim that the aim of cameras is to raise revenue rather than increase safety), fairness (e.g., identification of vehicle owner rather than driver, lack of opportunity to explain the circumstances to a police officer on the spot), speeding not perceived as a safety problem, and privacy concerns.

In line with recommendations by Delaney et al. (2005), Montgomery County officials placed considerable emphasis on creating public awareness of the speed camera program and building public support for automated speed enforcement. Police officials developed a public information and education campaign that initially emphasized the dangers of speeding and the role of speed cameras, and later informed drivers that speed cameras were in use. The campaign included press releases, a program website, informational materials, a speakers bureau, and a logo to create public brand recognition of the

"Safe Speed" program (Figure 1). This logo was used by Montgomery County as well as three smaller municipalities within the county (Chevy Chase, Gaithersburg, and Rockville) that planned to implement speed camera programs.

Figure 1
Montgomery County Speed Camera Program Logo

Selection of sites for potential camera enforcement was based on several factors, including crash data, vehicle speed data, and input from citizen advisory boards. Speed camera enforcement was preceded by a 30-day warning period, during which cameras photographed violators, but no tickets were issued. A press conference held at the start of the warning period attracted extensive media coverage, including print and broadcast media and local and regional coverage. A second press conference, held when enforcement began, also generated extensive media coverage. Signs advising motorists of speed camera enforcement were posted on major roadways entering Montgomery County, and "photo enforced" placards were installed below the speed limit signs on roads designated for camera enforcement (Figure 2).

Figure 2
"Photo Enforced" Placard Notifying Drivers of Automated Speed Enforcement

The initial camera enforcement consisted of six mobile cameras deployed in marked vans by specially trained, radar-certified police employees operating in two shifts per day. The vans were in service from approximately 6 a.m. to 9 p.m., Monday through Saturday, and rotated among 10-12 locations. During the first 6 months of enforcement, mobile cameras were deployed at about 60 locations and resulted in the issuance of approximately 40,000 citations. Mobile cameras later were supplemented by two fixed speed cameras, with the first one installed about 5 months after mobile enforcement began, and the second site operational about 1 month later.

Study Design

The study examined traffic speeds and driver attitudes toward speeding and automated speed enforcement approximately 6 months before and 6 months after the start of the speed camera program in May 2007.

Traffic Speed Measurements

One year in advance of the camera program, Montgomery County police identified 40 locations as potential camera enforcement sites. Of these locations, 20 were randomly selected for evaluation. Although all 20 of the study locations were on roads where "photo enforced" warning signs were posted, cameras were deployed at only 5 of the 20 locations during the initial 6-month enforcement period. The police deployed speed cameras at about 60 locations throughout the county during the 6-month study period, so these 5 "camera" sites represented about 1 in 12 camera-enforced locations. Nineteen of the 20 study sites were residential streets with speed limits that ranged from 25 to 35 mph. One of the sites with warning signs but no camera enforcement was located within a school zone on an arterial street with a speed limit of 40 mph. At the school zone site the speed limit was lowered from 40 to 30 mph for about 1 hour at the beginning and 1 hour at the end of each school day, with flashing yellow beacons indicating the reduced speed limit.

To examine potential spillover effects of camera enforcement to nonenforced locations within the same county where neither warning signs or speed cameras were deployed, 10 sites were randomly selected from 20 Montgomery County locations that had similar characteristics (e.g., roadway geometry, traffic volumes, residential land use) as most of the camera-enforced locations, but were ineligible for speed cameras because they had 40 mph speed limits. A fourth group of study sites located in nearby areas of Virginia was selected to control for external factors that might affect traffic speeds (e.g., seasonal variability in travel patterns). Ten comparison sites were randomly selected from 20 locations on residential streets in Arlington County and Fairfax County, Virginia, that had roadway characteristics and traffic volumes similar to those of potential camera-enforced locations in Montgomery County. Speed limits at the Virginia comparison sites ranged from 25 to 35 mph. One site was located within a school

zone. The speed limit at this site was lowered from 35 to 25 mph at the beginning and at the end of each school day, with flashing yellow beacons indicating the reduced speed limit.

Traffic speeds were recorded at all study sites using speed camera technology similar to the equipment used for the enforcement program. The study cameras were deployed on the roadside in a covert manner by a photo enforcement vendor not affiliated with the Montgomery County speed camera program. The equipment was concealed in a metal housing and electronically recorded the speeds of all passing vehicles. At each location traffic speeds were measured from approximately 10 a.m. to 4 p.m. on weekdays.

Telephone Surveys

To assess public awareness of the speed camera program and attitudes toward camera enforcement, telephone surveys were conducted approximately 6 months in advance of camera enforcement and the public education campaign, and then approximately 6 months following implementation of the speed camera program. Random-digit-dialing methods were used to select representative samples of 800 licensed drivers ages 18 and older residing in the county.

Analyses

Summary measures of vehicle speeds included mean speeds and the proportion of vehicles exceeding posted speed limits by more than 10 mph. Although the amount of time spent at each study site was approximately the same in the before and after periods, changes in traffic volume at some sites led to large differences in the before and after sample sizes. Thus some sites accounted for a much larger portion of the sample in the after period compared with the baseline sample. To ensure consistent representation of each study site in the two time periods, overall statistics for each group of sites were computed as a weighted average of the statistics for each site, with weights defined as the proportion of vehicles observed at each site during the before period. Changes in mean speed were evaluated using linear regression models, including terms for site-to-site variability and expected variability over time. Logistic regression models were used to estimate the effect of the program on the proportion of speeding vehicles.

Survey results were evaluated statistically using chi-square (χ^2) tests of homogeneity.

RESULTS

Traffic Speeds

A total of 180,196 speed measurements were recorded at all sites during all phases of data collection. About 1,200 observations were excluded at two sites (one Montgomery County site with warning signs but no camera enforcement, and one Virginia comparison site) during times when reduced

"school zone" speed limits and flashing yellow beacons were in effect, leaving a total of 178,954 observations (99 percent of the original sample).

Table 1 summarizes mean traffic speeds and the proportion of vehicles exceeding speed limits by more than 10 mph for the four groups of study sites.

Table 1
Traffic Speeds before and after Implementation of Speed Camera Program

Location type	Number of sites	Mean speeds (mph)		Percent exceeding speed limit by >10 mph	
		Before	After*	Before	After*
Maryland sites					
Signs installed, cameras deployed	5	42	38	30	10
Signs installed, cameras not deployed	15	39	37	25	16
Similar sites with 40 mph speed limits	10	43	41	10	6
Virginia comparison sites	10	36	36	12	10

*Computed as weighted averages across sites, where the weights equal the proportion of vehicles observed at each site during the before period.

Mean speeds and the proportion of vehicles exceeding speed limits by more than 10 mph declined at all 30 of the Maryland sites and 9 of the 10 Virginia sites. However, the declines were greater at the Maryland sites, particularly at those sites with cameras deployed. At the 5 locations where "photo enforced" signs were installed and speed cameras were deployed, the decline in mean speeds ranged from 5 to 18 percent, and the average decline was 10 percent.

Tables 2 and 3 summarize results of the regression models. The time effect represented an estimate of the change that occurred apart from the influence of the speed camera program (i.e., at the Virginia comparison sites). So according to Table 2, mean speeds at the Virginia comparison sites

Table 2
Estimated Effects of Speed Camera Program on Mean Speeds

Effect	F-value	p-value	Estimate	Percent reduction*
Site	2333.98	<0.0001		
Time (2007 vs. 2006)	186.86	<0.0001	-0.0195	1.9
Signs and cameras vs. comparison	1517.32	<0.0001	-0.0933	8.9
Signs only vs. comparison	604.86	<0.0001	-0.0426	4.2
Spillover vs. comparison	120.80	<0.0001	-0.0199	2.0

*As the dependent variable was the natural logarithm of each measured speed, percent reduction was computed as 1 minus the inverse logarithm of the estimate.

Table 3
Estimated Effects of Speed Camera Program on Exceeding Speed Limit by >10 mph*

Effect	Odds ratio	Percent reduction	95% confidence limits	
			Lower	Upper
Time (2007 vs.2006)	0.70	30	25	35
Signs and cameras vs. comparison	0.30	70	66	73
Signs only vs. comparison	0.61	39	33	44
Spillover vs. comparison	0.84	16	7	24

*Logistic regression on the odds of exceeding the speed limit by >10 mph.

declined by about 2 percent. At Montgomery County locations where "photo enforced" signs were installed and speed cameras were deployed, mean speeds declined by another 9 percent (an estimated decline of 11 percent minus the 2 percent decline observed at the Virginia comparison sites). The proportion of vehicles exceeding speed limits by more than 10 mph declined by 70 percent at these sites relative to the Virginia comparison sites (Table 3). Relative to the Virginia comparison sites, at Montgomery County locations with warning signs but no camera deployment, mean speeds declined by 4 percent and the proportion of vehicles exceeding speed limits by more than 10 mph declined by 39 percent. At the noncamera enforced "spillover" sites in Montgomery County, mean speeds declined by 2 percent and the proportion of vehicles exceeding speed limits by more than 10 mph declined by 16 percent, relative to the Virginia comparison sites.

Telephone Surveys

Samples of drivers surveyed before and after the start of enforcement included similar proportions of drivers by age group and gender. When asked if speeding was a problem on residential streets, about 74 percent of drivers during both study periods said it was; about 18-19 percent said it was not, and about 7-8 percent did not know. Among drivers who said speeding was a problem, close to half during both study periods said it was a big problem. During both study periods about 78 percent of female respondents thought speeding was a problem compared with 67-68 percent of males (before enforcement: $\chi^2 = 8.4$, $p = 0.0151$, $df = 2$; during enforcement: $\chi^2 = 15.1$, $p = 0.0005$, $df = 2$). There were no consistent differences by age group.

Drivers were asked if speed cameras currently were in use on residential streets in Montgomery County (table not shown). Before camera enforcement 46 percent of drivers responded correctly that speed cameras were not in use (32 percent said cameras were in use, and 22 percent said they did not know). Six months after enforcement began 60 percent of drivers responded correctly that speed cameras were in use (20 percent said cameras were not in use, and 20 percent said they did not know). During camera enforcement young drivers (ages 18-34) were more likely than drivers ages 35-64 and 65 and older to respond correctly that speed cameras were in use (68 versus 61 and 53 percent, respectively; $\chi^2 = 12.5$, $p = 0.0142$, $df = 4$).

Drivers were asked their opinions about the use of speed cameras on residential streets in Montgomery County (Table 4). Those who thought cameras were in use were asked "Do you favor the use of cameras to enforce laws against speeding on residential streets in Montgomery County?" Those who thought cameras were not in use or did not know were asked "Would you favor the use of cameras…" Results in Table 4 were combined for both groups of drivers. The proportion of drivers who favored speed cameras was 58 percent before camera enforcement and 62 percent 6 months after

Table 4
Responses of Montgomery County Drivers Concerning Approval of Speed Cameras on Residential Streets before and after Start of Enforcement (percent)

	Before enforcement				During enforcement			
	N	Favor	Oppose	Don't know	N	Favor	Oppose	Don't know
Overall	800	58	33	9	800	62	31	8
Ages 18-34	107	52	36	11	106	58	37	5
Ages 35-64	518	56	36	8	519	60	33	7
Ages 65+	175	69	21	10	175	69	21	10
Male	299	53	40	7	309	54	40	6
Female	501	62	29	10	491	67	25	8

enforcement began. In both surveys support for speed cameras was higher among females (before enforcement: $\chi^2 = 11.7$, $p = 0.0029$, $df = 2$; during enforcement: $\chi^2 = 20.0$, $p < 0.0001$, $df = 2$) and among older drivers (before enforcement: $\chi^2 = 15.6$, $p = 0.0036$, $df = 4$; during enforcement: $\chi^2 = 11.8$, $p = 0.0192$, $df = 4$).

In the survey conducted during camera enforcement, drivers opposed to speed cameras (n = 245) were asked if they were opposed to surveillance cameras used by law enforcement agencies in general, or only those that ticket speeders. One-third of respondents said they were opposed to surveillance cameras in general, about half (45 percent) were opposed only to speed cameras, and 21 percent had no opinion (table not shown). Drivers aware of the camera program (n = 479) were asked if the speed cameras had caused them to reduce their speeds when traveling on residential streets in Montgomery County; 57 percent said they had (table not shown).

In the survey conducted during camera enforcement, drivers were asked if the speed camera program should be expanded to include major arterial streets and interstate highways. The level of support for expanding camera enforcement to arterial streets was 62 percent, the same proportion of drivers that favored use of speed cameras on residential streets. By comparison, 47 percent of drivers favored expanding the use of speed cameras to interstate highways (table not shown).

DISCUSSION

The present study found large and significant reductions in speeding 6 months after implementation of Maryland's first speed camera program in Montgomery County. The size of the effect on speeding 10 mph or more above the speed limit varied by type of study site — 70 percent on streets with both warning signs and speed cameras, 39 percent on streets with just warning signs, and 16 percent on residential streets in the same county with neither warning signs nor speed cameras. The finding of speed reductions beyond the specific locations where cameras were deployed during the initial enforcement period is evidence that highly visible automated enforcement can promote community-wide changes in driver behavior. So-called "distance halo effects" are a key advantage of automated speed

enforcement that generally are not achieved by traditional police speed enforcement (Zaal, 1994). Field studies by Barnes (1984) and Hauer et al. (1982) found speed reductions associated with traditional speed enforcement lasted only several kilometers after police were encountered.

Increasing the perceived risk of detection is one of the most important objectives of all speed enforcement strategies (Ostvik and Elvik, 1990). In most communities with automated speed enforcement programs the number of speed cameras is relatively small compared with the number of roads, so it is important to promote a perception of widespread camera use through highly visible public information and education activities. Informing drivers about the dangers of speeding and the role of automated enforcement, and alerting drivers that cameras are in use, help to build broad support for camera enforcement and are needed throughout the life of the enforcement program.

To maximize potential safety benefits of community automated speed enforcement programs, the primary criterion for camera deployment should be a history of crashes and, to the extent possible, a history of speed-related injury crashes. Other factors such as complaints of speeding, documented speeding problems, and geography should be given secondary consideration.

Although a majority of drivers supported automated speed enforcement on residential streets in Montgomery County, about one-third opposed it. Opponents can express strong views that generate controversies wherever speed cameras are used. Jurisdictions planning to implement speed camera programs should draw on international experience to anticipate the controversies that generally arise (Delaney et al., 2005) and take steps in advance to address them. These steps include (1) targeting locations or corridors with a history of crashes; (2) conducting highly visible public information and education campaigns to create awareness of the dangers of speeding and scope of the community's speeding problem, awareness of the speed camera program, and support for automated speed enforcement; (3) making camera enforcement conspicuous with warning signs and marked vehicles to maximize deterrent effects; and (4) limiting the responsibility of camera vendors to a supporting role.

In Montgomery County support for automated speed enforcement varied by road type, with 62 percent of drivers in support of speed cameras on surface streets and 47 percent in support on interstate highways. The level of support on residential streets and arterials is about equal to results from a recent nationwide telephone survey that found 60 percent of drivers favored speed cameras (Insurance Research Council, 2007). Differences in the level of support by road type might reflect the extent to which drivers perceive speeding is a safety problem or the extent to which they think it is acceptable to speed on these roads. In a recent study of automated speed enforcement on a high-speed urban freeway in Scottsdale, Arizona, 77 percent of drivers favored the use of speed cameras. This relatively high level of support occurred simultaneously with widespread concerns about speeding; about 80 percent of drivers said speeding was a problem on the freeway where speed cameras were deployed (Retting et al., 2007).

The current study did not evaluate crash outcomes because of the short amount of time speed cameras had been in effect. Research from countries with more extensive speed camera use has established crash and injury reductions associated with automated speed enforcement (Pilkington and Kinra, 2005; Wilson et al., 2006). Longer term studies are needed to assess effects of sustained speed camera enforcement on vehicle speeds and injury crashes in Montgomery County.

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