Cincinnati Traffic Unit officers stand with their vehicles. Photo courtesy of the Cincinnati, Ohio, Police Department.

Cincinnati CARS: A Crash Analysis Reduction Strategy

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National Highway Transportation Safety Administration statistics show that every year in the United States, more people die in traffic crashes than from any other cause not related to disease or illness. Traffic crashes are the leading cause of death for people between the ages of 3 years old and 34 years old.[1] One traffic crash fatality occurs every 15 minutes in the United States.[2] In 2009, traffic crashes nationwide had an estimated economic cost of $299.5 billion, of which an estimated $3.3 billion annually was attributed to vehicle crashes in Cincinnati, Ohio, alone.[3]

In spite of the large number of deaths throughout the United States, law enforcement has traditionally taken a decidedly reactive approach to the problem of fatal traffic crashes. A primary reason is that, out of the estimated 12,575 local police departments operating in the United States during 2007, 50 percent employed fewer than 10 officers, and fewer than 50 agencies employed 1,000 or more officers.[4] Smaller law enforcement agencies do not have the personnel to dedicate specialized resources solely to traffic enforcement or crash prevention. Traffic safety thus becomes a secondary priority. Yet the combination of the number of yearly deaths and injuries from traffic crashes, along with their associated economic costs, should make crash reduction an organizational priority.

In 2005, the city of Cincinnati, Ohio, had its worst year for traffic crash fatalities in more than one decade, with 36 fatal crashes and 37 people killed. Five years later, Cincinnati had the fewest traffic fatalities in fifteen years and fewer than any large city in the state of Ohio. This transformation did not occur by accident. It is attributed to the efforts of a comprehensive plan: the Crash Analysis Reduction Strategy (CARS).

CARS Theory Development

Based on the 2005 increase in traffic fatalities, in 2006, the Cincinnati Police Department (CPD) identified traffic safety as a core patrol strategy and developed CARS to guide traffic enforcement efforts across the entire department. The foundation for initial CARS development was the crime prevention theory of problem-oriented policing (POP). POP is a police strategy that seeks to address the underlying factors that give rise to safety problems faced by the public.

The three elements that compose safety problems are incidents that

- can be grouped (not singular events);
- can be connected in some meaningful way (not random or arbitrary); and
- are disturbing to members of the public (not just the police).[5]

In order to correctly identify and ultimately resolve a problem, police must structure a process that ensures the underlying factors that create the problem are correctly identified and acted upon. Using the scanning, analysis, response, and assessment (SARA) model, police are able to organize the four principles of POP:

1. Define the problem with specificity.
2. Study problems in depth.
3. Conduct a broad search for solutions.
4. Focus on outcomes to evaluate the police response and allow for timely modification of the response if needed.[6]

CARS also was based on situational crime prevention, the primary tool of POP and intelligence-led policing, where responses are created to change the decisions made by offenders.[7] While POP focused attention on specific traffic safety problems, situational crime prevention helped guide the development of solutions to these core problems.

The purpose of CARS was to reduce fatal injuries, serious injuries, and overall traffic crashes. The hypothesis was the CARS interventions would decrease opportunities for traffic crashes to occur; increase violator risk and effort; and increase guardianship in frequent traffic crash locations. Decreased traffic crash opportunity, combined with increased violator risk and effort and increased guardianship, would then lead to a reduction in the number of fatal and overall traffic crashes in the city.

CARS Interventions

Annually, the three primary causes of fatalities in traffic crashes both in Cincinnati and throughout the United States are

1. speed and aggressive driving,
2. operating a vehicle while impaired by alcohol and or drugs of abuse, and
3. failure to wear a seat belt when one is available.[8]

In response, specific interventions were designed and applied to each of the three traffic focus areas: high-visibility patrol, consistent enforcement, and analysis of hot spots. In addition, the physical environment of some frequent crash sites was examined to find ways to make these road segments less risky. Specific CARS interventions included

- a partnership with the Ohio State Highway Patrol (OSHP);
- the use of air speed-enforcement on all interstate highways;
- strategic use of operating a vehicle under the influence (OVI) checkpoints;
- analysis of traffic data to determine high traffic crash locations, times, and causative factors; and
- the microgrinding of precise Cincinnati street and interstate highway locations.

The overall goal of these new interventions was to achieve both short- and long-term reductions in fatal and serious injury crashes, along with the total number of traffic crashes within the city of Cincinnati.

Data Analysis

Prior to 2006, the CPD lacked the ability to precisely target its enforcement actions in the area of traffic safety. Traffic Unit officers concentrated their efforts on the interstate highways and on serious injury and fatal traffic crash investigations. Traffic safety efforts on the remaining city streets were tasked as the responsibility of the five patrol

districts. District-level enforcement efforts were haphazard. Resources were deployed at the discretion of individual shift commanders, and deployment decisions often were based on personal experiences. Patrol officers assigned on every shift could identify specific locations where they responded daily to traffic crashes, but this information was never compiled in a meaningful way and no attempt at data analysis or problem solving was attempted. Responding to traffic crashes was seen as a routine part of every daily shift, and no efforts to prevent them were initiated.

In early 2006, the initial sworn officer position of traffic analyst was created in the Traffic Unit to analyze citywide traffic patterns, all traffic crash data, and OVI arrest data. The selection criteria for the traffic analyst position specified that applicants must be experienced traffic officers and required current certification in traffic crash reconstruction. These requirements were necessary to ensure the analyst was able to readily identify unusual traffic crash patterns, was able to look for underlying causative factors, and already possessed sufficient knowledge to recommend actions to remedy the causative factors on a long-term basis.

Both citywide and individual patrol district traffic data analyses for the previous 30-day period were then provided monthly to each patrol district captain and to the Traffic Unit commander. Reported analyses included the overall number of traffic crashes, along with a precise listing of the top 10 percent of crash locations, days, times, and primary causative factors. Based on the SARA model, the new monthly traffic report was designed to encourage problem solving about reoccurring traffic problems. Every month, the traffic analyst scanned and analyzed both citywide and district-level traffic data and provided the information in an actionable format to the district and the traffic commanders who were able to custom tailor a timely response to their current traffic problems. An immediate assessment of the effectiveness of the response was conducted, which allowed for quick modification of the response plan if needed. Monthly problem-solving projects involving traffic safety were entered and tracked in the department's problem-solving tracking system. Once entered, these projects were then available for review by other department commanders who may have been experiencing similar traffic problems.

High-Visibility Patrol

To increase law enforcement visibility and citizen awareness, the CPD partnered with the OSHP in March 2006 to conduct

joint patrols that focused combined enforcement efforts on all three of the primary causative factors of traffic fatalities. This was the first time the two agencies had ever formally partnered on a traffic safety initiative.

Speed Violations and Aggressive Driving

A two-part strategy was implemented that targeted speed and aggressive driving violations by motorists for law enforcement action and sought to inform the public about roadway safety. Early enforcement action focused on the state routes that serve as the main traffic arteries in the city and later was expanded to the interstate highways. Initial enforcement action was conducted using CPD Traffic Unit officers and OSHP troopers patrolling jointly on state route locations that analysis revealed as historical hot spots for speed-related traffic crashes. The hot spot patrols were specifically tailored to reduce the opportunity for violations and to increase capable guardianship in the targeted areas, which theoretically would lead to a reduction in traffic crashes. Tandem joint patrols that saturated identified hot spot areas with officers and troopers were implemented. The joint patrols were purposefully deployed in a high-profile manner to raise the awareness level of the public and the media about the importance of roadway safety. For the first time, motorists saw CPD officers and OSHP troopers side by side on major traffic arteries during peak travel periods.

In the six years prior to the implementation of CARS, the city of Cincinnati averaged nearly six fatal traffic crashes per year on interstate highways within the city limits (segments of interstates 71, 74, 75, 275, and 471 run through the city of Cincinnati). CPD officers assigned to the Traffic Unit had primary responsibility for patrol of these highways but lacked a systematic deployment strategy. The CARS team undertook the first analysis of historical interstate and highway fatal crash data and found that excessive speed and OVI were the primary causes for traffic crash fatalities. Initial analyses also showed that crashes were randomly distributed across all five interstates with no discernible pattern. If excessive speed increased the severity of the traffic crashes, it was hypothesized that a reduction in vehicle speed would at least reduce crash severity.

To reduce interstate highway speeds, increased enforcement was initiated using OSHP aircraft to monitor vehicle speed from the air and relay violator information to road officers and troopers strategically positioned after the speed measurement area. The road officers and troopers would then stop violators and issue citations for the speed violation and a seat belt citation if the driver or the passengers were not wearing theirs when stopped.

Simultaneous to the initiation of air speed-patrols, the Traffic Unit began a community-based public education campaign that focused on speed reduction and seat belt usage. The campaign used the television and print media along with donated billboard space near frequent traffic crash interstate highway locations to remind the driving public to slow down and to make an extra effort to buckle their seat belts.

OVI Checkpoints

The next intervention involved dramatic changes in the CPD's method of OVI enforcement. In 2005, 47 percent of drivers involved in a fatal traffic crash in the city of Cincinnati were operating a vehicle while under the influence of alcohol, drugs of abuse, or both.[9] Traditionally, the CPD was reactive in its approach to locating and apprehending OVI drivers. Other than some limited federal grant funding allocated specifically for OVI detection, OVI drivers were primarily apprehended when they were noticed in the course of regular random patrol or when an officer received a call for service to a traffic crash and upon arrival found an OVI driver.

To both deter impaired driving and increase awareness of the harm caused by those who operate a vehicle while impaired, the CPD took a proactive approach. In September 2006, OVI checkpoints were implemented for the first time. The exact checkpoint locations were determined after an extensive analysis of both traffic patterns and crash rates throughout the city. OVI checkpoints consist of 20 to 40 CPD traffic officers and OSHP troopers jointly manning fixed posts for two- to four-hour periods, briefly stopping each vehicle that drives through the area. Once stopped, the driver was engaged in a brief conversation that explained the purpose of the checkpoint while the officer looked for visible signs of alcohol impairment, drug impairment, or both. Additional marked patrol units not assigned to the actual checkpoint posts were assigned to patrol the surrounding side streets looking for those persons who might have been driving while impaired but who were trying to avoid the checkpoint area.

Prior to the checkpoints' implementation, informational presentations about OVI checkpoints were made to judges, prosecutors, various neighborhood community councils, and the media. The presentations explained the purpose of the checkpoints, the analysis behind the selection of locations, and what citizens could expect if a checkpoint was conducted in their neighborhood.

Consistent Enforcement and Analysis of Hot Spots

Although separate concepts, consistent enforcement and analysis of hot spots are mutually beneficial and therefore are described together. In order to maximize effectiveness, "police should focus their actions on the places, the times, and the people who pose the highest risks to public safety rather than dilute their crime prevention potency by spreading them thinly across the urban landscape."[10] Consistent enforcement cannot be achieved without analysis to determine the peak locations and times that targeted events are occurring. Analysis to determine hot spots and underlying causative factors without follow-up action to remove the cause is time wasted.

Microgrinding

In 2005, three fatal traffic crashes occurred in a three-block area of Montana Avenue, a main traffic feeder artery to Interstate 74 that receives heavy morning and afternoon rush hour traffic volume. During roughly the same time period, River Road, a primary east-west traffic artery that receives heavy traffic volume at all hours, had two fatalities and two life-threatening injury traffic crashes. The Montana Avenue and River Road crash locations were the first projects assigned to the CPD traffic analyst. Analysis of the traffic crashes revealed serious injury and fatal traffic crashes were occurring at higher rates in inclement weather compared to other times. The CARS team hypothesized this was because of the sharp bends in both roadways that became slippery when the road surface was wet from rain or snow. Both roadways also had 11-foot-wide travel lanes instead of the currently mandated 13 feet, thus reducing margins for driver error. The combination of wet pavement and narrow lanes caused vehicles to slide across the double yellow line and into oncoming traffic. This led to an increased number of head-on collisions, which resulted in fatalities and life-threatening injuries at both locations. Traditionally, rumble strips like those on winding expressway ramps or grooves on the road surface are designed to keep vehicles from sliding on wet pavement. Both of these solutions are extremely noisy, however, and cannot be used in residential neighborhoods.

Using the information developed by the analyst, the Traffic Unit convinced the City of Cincinnati Division of Traffic Engineering to work with their outside paving contractors to develop a new grind of the roadway surface that would increase traction without increasing noise. Experimentation by the police, traffic engineers, and contractors resulted in a *microgrind* that roughened the top one-fourth inch of the pavement surface to give vehicle tires the necessary traction in wet weather, but is still quiet enough that neighborhood residents are not disturbed by increased vehicle noise. As a result of this successful analytical and operational police–outside agency–private business partnership, seven additional street locations in the city and three interstate highway locations have received the microgrind intervention.

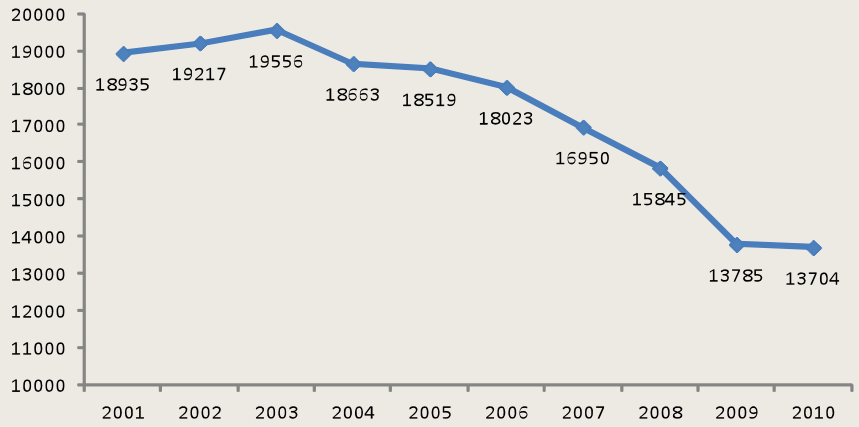
CARS Assessment

Using 2005 traffic crash numbers as the baseline measure, Cincinnati experienced a reduction in fatal traffic crashes, life-threatening injury traffic crashes, and

overall traffic crashes after the interventions were implemented (see figure 1).

However, during the same time period, Hamilton County, Ohio; the state of Ohio; and the United States as a whole also experienced declines in vehicle crashes, injuries, and fatalities. Was the reduction experienced in Cincinnati the result of local, state, and even national trends, or did CARS specifically reduce crashes, injuries, and fatalities more in Cincinnati compared to the county, state, and the country? To answer this question, the CARS team partnered with researchers from the Institute of Crime Science (ICS) at the University of Cincinnati to conduct a systematic outcome evaluation.[11]

Figure 1. Overall Cincinnati Traffic Crashes



Nonfatal Crashes

First, ICS researchers conducted time series count regression models to examine traffic crashes in Cincinnati between 2003 and 2010, using the precise dates of implementation for the various interventions. Cincinnati's results were then compared to similar analyses for Hamilton County, the state of Ohio, and broader U.S. trends. For overall traffic crashes as well as serious automobile crashes (that is, those resulting in injury), Cincinnati experienced a significant change between pre-intervention and post-intervention. The Cincinnati traffic crash reduction was larger than those reductions experienced during the same time in Hamilton County, the state of Ohio, and the United States—none of which received the interventions implemented in Cincinnati. The comparisons between Cincinnati and the remainder of Hamilton County are graphically displayed in figure 2.

Table 1. Fatal Traffic Crash Reductions (2005 and 2009)

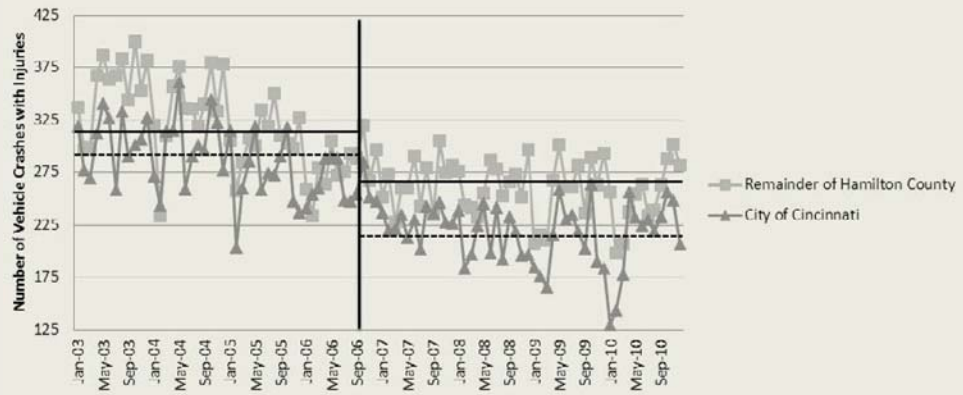
	Cincinnati	Hamilton County (excluding Cincinnati)	State of Ohio	United States
2005 Fatal Traffic Crashes	36	57	1,229	43,510
2009 Fatal Traffic Crashes	19	41	945	33,646
2005-2009 Reduction (%)	47	28	23	23

Fatal Crashes

Initial analysis of pre-intervention and post-intervention traffic crash data showed that Cincinnati achieved greater reductions in fatal traffic crashes over the five-year intervention period than did Hamilton County, the state of Ohio, and the United States. Table 1 illustrates the numerical and percentage reductions for each entity for the baseline year of 2005 and the year 2009—the last year full data are available for all four entities.[12]

The reductions for Hamilton County and the state of Ohio are consistent with the national decline. Yet Cincinnati's reduction stands out; it is nearly twice the reduction of the national decline. Pre-intervention (that is, 2000–2005), Cincinnati interstate highways had a total of 35 fatal traffic crashes—an average of 5.8 annually. Post-

Figure 2. Trends in Hamilton County Vehicle Crashes (2003–2010)



intervention (that is, 2006–2010), Cincinnati interstate highways had a total of 21 fatal traffic crashes—an average of 4.2 annually. This is a 40 percent reduction in crashes overall and a 28 percent reduction in annual crashes.

More detailed time series count regression models, however, showed that although there were reductions in fatal crashes, these reductions did not reach the threshold of statistical significance; this is likely due to the small total number of fatalities, making it difficult for the statistical models to detect a significant decline. While we cannot rule out the possibility that the reduction in fatal crashes is attributable to random chance, it is more likely that fatalities were reduced by CARS rather than based on local, state, and national trends. The CPD reasoning is simple. There are many crashes and crashes with injuries. The factors that cause them also cause fatal crashes, which are far less frequent. So if CARS reduced nonfatal crashes by changing these factors, it probably also changed the factors that create fatal crashes.

Precise scientific tests for each individual intervention could not be conducted. However, each intervention demonstrated positive results that were unique to the specific intervention. The effects of CARS were measured for overall traffic crash numbers during the period of 2006–2010 compared to the period of 2000–2005.

Air Speed-Enforcement

As noted above, serious and fatal crashes declined during the intervention period. The average speed of violators on interstate highways was reduced 7.8 miles per hour after the implementation of air speed-enforcement. Prior to air speed-enforcement, speeding citations on Cincinnati interstates averaged 82 miles per hour, or 27 miles per hour above the speed limit. After the implementation of air speed-enforcement, the average speeding citation on Cincinnati interstate highways was 74 miles per hour, or 19 miles above the speed limit. Unfortunately, three of the fatalities in 2008 occurred on dates, times, and locations where air speed-enforcement was scheduled but was cancelled because of inclement weather.[13] Figure 3 graphically displays the average miles per hour speed reduction on Cincinnati interstate highways and the average fatality reduction after the intervention of regular air speed-patrols.

Reduction in OVI-Related Crashes

In 2005, 47 percent of the drivers involved in a fatal traffic crash in Cincinnati were found to be operating a vehicle while under the influence of alcohol, drugs of abuse, or both. After the implementation of regular OVI checkpoints in September 2006, the number of impaired drivers involved in a fatal traffic crash in Cincinnati was reduced to 33 percent in 2010, which is a 30 percent overall reduction in crashes involving OVI.[14]

Microgrinding of Roadways

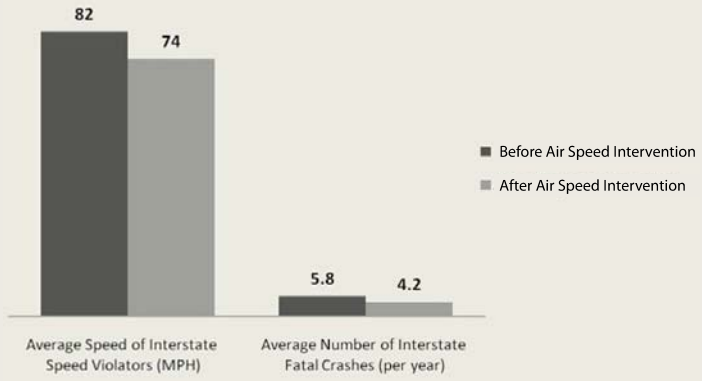
The Montana Avenue and River Road high traffic crash locations received microgrinding in October 2006. No life-threatening injuries or fatal traffic crashes have occurred at either location since. Seven additional locations on city streets and interstate highways also received the microgrind intervention. Again, no-life threatening injury or fatal traffic crashes have occurred at these additional locations since the intervention. In these specific locations, so far, fatal vehicle crashes have been eliminated.

Intervention Specific Effects

The overall number of traffic crashes in Cincinnati has declined annually since traffic data analysis was implemented across CPD and used for traffic problem solving. Over the five-year period the interventions have been in place, a 26 percent reduction in the number of annual traffic crashes has occurred. This is a reduction of more than 4,800 traffic crashes annually.

Using a conservative estimate of one hour of an officer's time for every traffic crash call for service, the CPD now has an additional 4,800 hours of discretionary patrol time that can be

Figure 3. Comparisons of Interstate Highway Vehicle Speeds pre/post Air Speed-Intervention (2005–2010)



used for neighborhood problem-solving activities. Based upon a standard 40-hour workweek, each of the city's five patrol districts has 24 additional weeks of discretionary patrol time for one officer. This increase in patrol time was accomplished through the use of CARS at no additional cost to the CPD.

Conclusion

The empirical evaluation strongly suggests that CARS had its desired effect. The number of Cincinnati's fatal and overall traffic crashes has been reduced at greater rates than the comparison areas of Hamilton County, the state of Ohio, and the United States. Areas that did not receive specific CARS interventions; each individual intervention was associated with a reduction in traffic-related harms. This reduction in traffic-related harms did not occur by accident. The CPD's CARS strategies have been successfully applied to traffic problems. When specific traffic safety interventions are developed and applied that reduce opportunity, increase violator risk and effort, and increase guardianship on streets and highways, traffic crash reductions will occur and police resources will be freed for other tasks. And, ultimately, lives will be saved. ❖

Notes:

[1]National Highway Traffic Safety Administration, *Fiscal Year 2012 Budget Overview,* 3, http://www.nhtsa.gov/staticfiles/administration/pdf/Budgets/FY2012_Budget_Overview-v3.pdf (accessed May 17, 2012).

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[3]*Crashes vs. Congestion: What's the Cost to Society?* by Cambridge Systematics Incorporated for AAA (Bethesda, Md., November 2011), 15, A1, http://www.camsys.com/pubs/2011_AAA_CrashvCongUpd.pdf (accessed May 17, 2012).

[4]Brian A. Reaves, *Local Police Departments, 2007,* NCJ 231174 (U.S. Department of Justice, Office of Justice Programs, Bureau of Justice Statistics, December 2010), 9, http://bjs.ojp.usdoj.gov/content/pub/pdf/lpd07.pdf (accessed May 17, 2012).

[5]John E. Eck, "Police Problems: The Complexity of Problem Theory, Research, and Evaluation," *Crime Prevention Studies* 15 (2003): 82, http://www.popcenter.org/library/crimeprevention/volume_15/04eck_problem_theory.pdf (accessed May 18, 2012); and Herman S. Goldstein, *Problem-Oriented Policing* (New York: McGraw-Hill Publishing, 1990).

[6]John E. Eck and William Stelman, *Problem-Solving: Problem-Oriented Policing in Newport News,* NCJ 111964 (Washington, D.C.: Police Executive Research Forum, 1987).

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[8]National Highway Traffic Safety Administration, "Speeding," *Traffic Safety Facts 2008 Data*, DOT HS 811 166, http://www-nrd.nhtsa.dot.gov/Pubs/811166.PDF (accessed May 23, 2012).

[9]Daniel W. Gerard, "Saving Lives with Traffic Safety Interventions" (unpublished master's thesis, University of Cincinnati, Ohio, 2011).

[10]Anthony A. Braga, "The Effects of Hot Spots Policing on Crime," *The Annals of the American Academy of Political and Social Science* 578, no. 1 (2001): 105.

[11]Nicholas Corsaro et al., *Cincinnati CARS* (a report to the Cincinnati Police Department), 2012.

[12]Gerard, "Saving Lives with Traffic Safety Interventions."

[13]Ibid.

[14]Ibid.