The Impact of Newark's Operation Ceasefire on Trauma Center Gunshot Wound Admissions

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THE IMPACT OF NEWARK'S OPERATION CEASEFIRE ON TRAUMA CENTER GUNSHOT WOUND ADMISSIONS

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Abstract

We examined the impact of Newark's Operation Ceasefire on gunshot wound admissions (GSW) to the Level 1 Trauma Center at University Hospital for a three-year period. Interrupted time series analyses revealed that there were no statistically significant reductions in GSW rates in the Ceasefire Zone after the introduction of Ceasefire in Newark. Similarly, there were no statistically significant changes in GSW rates in the matched comparison zone or the Trauma Center's wider catchment area. A dual kernel density hot spot map confirmed these findings by identifying changes in hot spots that were non-systematic, with no consistent pattern of change over time. Future research should focus on conducting both process and outcome evaluations of the various adaptations of the Ceasefire model in order to help inform policy makers' decisions regarding the selection of violence reduction programs.

Injuries resulting from interpersonal violence exact substantial costs for individual victims as well as society. Data collected from the National Electronic Injury Surveillance System revealed that in 2001 approximately 1.8 million individuals were treated in emergency departments for non-fatal, assault-related injuries across the United States (Vyrostek, Annest, & Ryan, 2004, table 4). In Newark, New Jersey, the focus of the present study, individuals are treated in emergency departments for assault-related injuries at a rate of 1,341 admissions per 100,000 residents annually, with African-American males being admitted at the highest rate of 2,854 per 100,000 (Boyle & Hassett-Walker, 2008, p. 1017).

In response to these and other research findings, researchers, public health practitioners, and criminal justice professionals have turned their attention to efforts seeking to prevent violence, and have proposed programs to accomplish this. Boston's Operation Ceasefire and CeaseFire Chicago are two widely known programs aimed at reducing firearms violence. Reports of the success from these two programs have led to their adaptation and adoption in many jurisdictions across the United States dealing with violence that is not responding to traditional law enforcement measures.

As a result of fears over the climbing annual number of murders and an uptick in gun violence, a collaborative working group of stakeholders in Newark, New Jersey, adopted Operation Ceasefire, a hybrid of the Boston and Chicago models, to address gun violence in one of its most violent neighborhoods. The present study employs data on gunshot wounds (GSW) treated at an urban Level 1 Trauma Center (hereafter, Trauma Center), collected as part of an ongoing GSW surveillance system, to examine the impact of Newark's Operation Ceasefire on GSW admissions to the Trauma Center. The authors of the present study are not affiliated with the Ceasefire program, and the surveillance system described in this manuscript is unrelated to the initiation of the Ceasefire program in Newark.

⊛ Operation Ceasefire Newark

Newark has a population over 273,000, making it the largest city in New Jersey (U.S. Census, 2000). It also has the most crime of any New Jersey municipality. Of the top 15 urban centers profiled by the State Police for 2005, Newark had the highest crime index and the largest number of violent crimes of any city statewide (State of New Jersey, 2006, p. 108). Beginning in 2002, Newark experienced a steady increase in murders and the use of firearms. Despite law enforcement efforts, the number of murders rose steadily each year from 68 in 2002 (State of New Jersey, 2003, p. 108) to 107 in 2006 (State of New Jersey, 2007, p. 108). The inability of traditional law enforcement efforts to reduce gun violence along with increased public fear led researchers and criminal justice professionals to look for a new solution to the intractable problem of gun violence in the city.

Operation Ceasefire Newark was implemented by the Police Institute, a university-based organization with an extensive history of community-based, collaborative partnerships involving law enforcement, social service and treatment providers, and the clergy, to address violence in the Greater Newark area. After analyzing the nature of violence in Newark, the working group decided that both the law enforcement model used in Boston's Ceasefire and the public health approach adopted by CeaseFire Chicago might be necessary to address Newark's violence problem. As a result, Newark's Ceasefire program is a hybrid of the Boston and Chicago models.

Operation Ceasefire Newark adopted the five-component design used in Chicago. The five essential components of CeaseFire Chicago are public education, community mobilization, youth outreach, faith-based leader involvement, and criminal justice participation (Skogan, Hartnett, Bump, & DuBois, 2008). These five components address risk and protective factors that, theoretically, will reduce gun violence.

Outreach workers distribute public education materials in the Ceasefire target zone, advertise the message that violence is unacceptable, and highlight the consequences of gun violence (Skogan et al., 2008). The target zone is continually recanvassed and saturated with public education materials with the same, consistent messages. The public education materials serve the purpose of delivering Ceasefire's message to the target audience, those who would engage in gun violence, and mobilizing the community.

Community mobilization is intended to build a base of support for the initiative in the Ceasefire target area. Community events are also used to mobilize additional members of the neighborhood, and reinforce the goals of Ceasefire.

Outreach is an important part of Operation Ceasefire. The outreach workers in Newark are tasked with attempting to affect the way high-risk individuals in the community think and act. The outreach workers make contact with the high-risk population in the streets that they frequent during non-traditional hours when violence is most likely to occur—in the late night hours and on the weekends (Skogan et al., 2008). During these meetings, the outreach workers discuss the short- and long-term positive impact that education, jobs, and counseling can have on their lives. Often the outreach workers give information on where services are available during these street encounters. The outreach workers are also called into play when a shooting occurs, reaching out to the family and friends of the victim(s) at the hospital and in the community in efforts to prevent retaliatory acts of violence and to provide them with information about services that they may need. Like CeaseFire Chicago, Ceasefire Newark recruited ex-offenders to serve as outreach workers, arguing that former offenders who had similar experiences as the high-risk population are better able to establish rapport with them (Skogan et al., 2008). Newark also trained many church congregants affiliated with the involved clergy to serve as outreach workers. Unlike Chicago, Ceasefire Newark's outreach workers did not establish formal caseloads (M. Wagers, personal communication, February 5, 2010) and the Newark program did not use violence interrupters (see Skogan et al., 2008, for a description of violence interrupters).

Faith-based leaders serve the function of providing safe havens for members of the high-risk population. Members of the clergy often counsel and mentor these individuals, and attempt to guide them down a pro-social path. Clergy also play a part in community mobilization and thwarting retaliatory violence (Skogan et al., 2008). They try to mobilize their congregations by encouraging them to get involved in the campaign to stop the gun violence. When a shooting response is necessary, they travel to the scene of the shooting and preach nonviolence.

Finally, law enforcement collaboration is identified as a component in Operation Ceasefire. The criminal justice system needs to make it explicitly clear that the target behavior, gun violence, will be vigorously suppressed and prosecuted (Skogan et al., 2008). Newark gives law enforcement a strong role in Operation Ceasefire, which is reflective of the Boston model, in which police played a central role, and a departure from the Chicago model, where police played a peripheral role. The law enforcement teams, known as "shooting teams," are composed of detectives from the New Jersey State Police, the Newark Police Department, and the Irvington Police Department. They have sole responsibility for the aggressive investigation of shootings that occur in the Ceasefire target zone. A point person in the shooting team on-call notifies project staff and the Ceasefire community partners when a shooting incident occurs, so that the partners can mobilize to prevent retaliations. Police also attend community events to build positive relationships with the community residents. In addition to police, the Newark model involves parole officers, which is also reflective of the Boston model. When a shooting occurs, parole officers involved with Ceasefire make timely home visits to parolees who reside in the vicinity of the shooting and remind them of the purpose of Ceasefire and the consequences of gun violence.

A factor that varied across all three cities is the role of the U.S. Attorney's Office in the Ceasefire efforts. In Boston, the U.S. Attorney was actively involved in the Ceasefire working group and its activities (Kennedy, Braga, & Piehl, 2001). In Chicago, the U.S. Attorney was not involved in the implementation of Ceasefire. However, Project Safe Neighborhoods (PSN), a federally funded gun crime reduction strategy administered through the U.S. Attorney in each federal district, was active in and near several of the target and comparison zones in Chicago (Skogan et al., 2008). In Newark, the U.S. Attorney was invited to participate in the Ceasefire working group. However, the U.S. Attorney played a marginal role by sending a representative to the working group meetings, but not engaging in any activities relative to Ceasefire (G. Kelling, personal communication, February 5, 2010; M. Wagers, personal communication, February 5, 2010).

Ceasefire Newark did not focus on gangs as the source of violence. In Boston, gangs were targeted as the unit upon which to apply pressure in an attempt to reduce gun violence. As McGloin (2005) explains, gangs were targeted for collective accountability in Boston due to the belief that gangs, or at least those gangs and gang members engaged in violence, were cohesive enough for collective accountability to be an effective deterrent. The Chicago model dealt with violent, gang-involved

individuals, but the efforts at deterrence were geared toward individuals rather than gangs. Newark took after Chicago in this respect. Research indicates that gangs in Newark are not organized or cohesive enough to target for collective responsibility (McGloin, 2007; McGloin 2005; McGloin, 2004). Ceasefire Newark aimed to prevent gun violence in the target zone and aggressively investigated all shootings that occurred in the zone, rather than targeting specific gangs.

The Newark working group used police data to conduct a city-wide gun violence hot spot analysis, and started to narrow its focus to determine in which of the areas it would implement the Ceasefire intervention. In November 2004, there was an execution-style quadruple homicide next to a church, which was another example of the escalating violence in Newark. This event created a sense of urgency to implement new violence-reduction strategies. Subsequently, the working group decided to focus on shootings in an area of approximately two square miles, referred to as the Ceasefire zone (CF Zone)[1] that they believed had a high frequency and high rate of gun violence compared to other parts of Newark. They started training outreach workers while the shooting teams were established and a protocol for shooting-incident communication was established.

Operation Ceasefire officially launched in Newark on May 11, 2005. The outreach workers began regularly distributing public education materials featuring slogans like, "Don't shoot. I want to grow up." They also had a regular presence in the community by walking through the CF Zone sharing the Ceasefire message during daytime and nighttime hours. When a shooting occurred, a series of activities was set in motion. A "shooting team" would arrive on the scene and begin the investigation. Outreach workers and the clergy would converge in the area of the shooting to preach nonviolence to the neighborhood residents. Outreach workers also began visits with victims, family members, and friends in efforts to prevent retaliatory violence. Parole officers identified the parolees living in the vicinity of the shooting, and made unannounced visits immediately following the shooting to underscore the message that violence would not be tolerated, and that shootings were being aggressively investigated. Implementation was tracked by the Police Institute to ensure fidelity to program design (M. Wagers, personal communication, February 5, 2010).

❀ Methodology

The purpose of the present study is to examine the impact of Operation Ceasefire on GSW from Newark's CF Zone. To do this, we conducted three separate interrupted time series analyses of the rates of GSW in the CF Zone, as well as a matched

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[1] The target zone includes a section of Newark, a mid-sized city, and Irvington, a smaller municipality that shares Newark's western border. For the purposes of this paper, we will refer to it simply as the CF Zone

comparison zone (hereafter, Comp Zone) and the Greater Newark area net the CF Zone (hereafter, Citynet)[2] before and after implementation of the program. We also examined the spatial pattern of GSW in the CF Zone and Comp Zone to look for changes in the hot spots before and after program implementation.

Setting and Data Source

The present study employs data on GSW treated at the Trauma Center to examine the impact of Operation Ceasefire on serious firearm-assault injuries. The Trauma Center is located at University Hospital in Newark, New Jersey. It is a Level 1 trauma treatment facility that serves more than one million individuals statewide. Prior population-based surveillance research examining treatment for all patients receiving emergency department care for assault-related injuries in the City of Newark indicates that 92% of all GSW victims were treated at the Trauma Center (Boyle, 2001). For the purpose of the present study, it is likely that all GSW patients were treated at the Trauma Center since the CF and Comp Zones are geographically close to the Trauma Center.

The first author of the present study initiated a GSW surveillance system to collect data on non-self-inflicted GSW victims treated at the Trauma Center from January 1, 2004, through December 31, 2006.[3] Trained medical student research assistants went to the Trauma Center every day, including weekends, to determine if any GSW victims had been admitted. If a GSW victim was admitted, then the research assistants reviewed the medical charts of the GSW patient(s). Data extracted from the medical records included patient demographics (e.g., gender, age, race/ethnicity), seriousness of injury (e.g., whether the patient was treated and released, admitted to the hospital, or died), any past medical treatment for intentional assault injuries, any evidence of current or past criminal involvement, and the address at which the shooting took place as recorded by the Emergency Medical Services (EMS) workers. All addresses were collected on data collection forms, entered into a database, and any address format variations were reconciled prior to analyses.

Matching a Comparison Zone

A matched comparison zone was empirically derived using ArcView 9.3 software in order to examine changes in GSW rates in an area comparable to the CF Zone during the same time period as a means of controlling for overall

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[2] The GSW data cover the Greater Newark area, which includes the City of Newark and the neighboring municipalities of Irvington and East Orange. Citynet reflects the statistics for the Greater Newark area minus the CF Zone.

[3] The GSW surveillance study was approved by the University of Medicine and Dentistry of New Jersey (UMDNJ) Institutional Review Board (IRB) as a review of existing medical records. The IRB reviews each proposal for compliance with research regulations, ethics, and the Health Insurance Portability and Accountability Act (HIPAA).

trends in GSW. The Comp Zone has a level of GSW similar to the CF Zone, and was matched to the CF Zone on number of Census block groups, population, resident race and ethnicity, median resident age and household income, concentrated poverty,[4] and vacant housing units from the U.S. Census (2000). Homicide and gun assaults were not used to match areas because we did not have access to offense location data. A buffer zone of block groups between the CF Zone and the Comp Zone was created to address the possibility of intervention work crossing slightly over the CF Zone borders. The match criteria measures are presented in Table 1.

❀ Table 1

Ceasefire and Comparison Zone Characteristics

Match Criteria	CF Zone	Comp Zone	t value	p
PreCF GSW rate per week per 100,000 residents	2.89	2.63	0.45	.657
Number of block groups	33	33		
Population	35,526	27,830	1.87	.096
Race[a]				
African-American (%)	89.05	92.91	0.39	.696
Caucasian (%)	4.43	2.18	2.25	.028*
Other (%)	6.51[b]	4.9[b]	2.64	.011*
Hispanic ethnicity (%)	6.83	4.88	1.83	.072
Mean of block groups' median age in years	28.9	30.4	-1.21	.232
Mean of block groups' median household income	$29,321	$27,405	0.82	.416
Concentration of poverty (%)	27.8	30.8	0.67	.507
Vacant housing units (%)	12.59	13.95	0.04	.966

Note. These data were obtained from the surveillance system used to collect the GSW data and the 2000 U.S. Census.

[a] Percentages in each zone's racial categories (i.e., African-American, Caucasian, and Other) may not total 100% due to rounding error.

[b] The "Other" racial category includes American Indian/Alaskan Islanders, Asians, Native Hawaiian/Other Pacific Islander, individuals who self-identify as some other race, and those who are two or more races.

* $p < .05$

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[4] Concentrated poverty was calculated as the ratio of the population with income below the poverty level (Census 2000 variable P087002) to the population for whom poverty status is determined (Census 2000 variable P087001).

As displayed in Table 1, there are similar levels of pre-intervention GSW rates in the CF and Comp Zones; the CF Zone had an average rate of 2.89 GSW (per 100,000 residents) per week before the implementation of Operation Ceasefire, while the Comp Zone had an average rate of 2.63. The CF Zone and the Comp Zone each comprise 33 block groups. The population of the zones ranged from 27,830 to 35,526 (U.S. Census, 2000). The percentage of the population that is African-American ranged from 89% to approximately 93%, the percentage of Caucasian residents ranged from 2.2% to 4.4%, and the percentage of residents who were categorized as other[5] ranged from 4.9% to 6.5% (U.S. Census, 2000). The percentage of residents who identified themselves as being Hispanic ranged from 4.9% to 6.8% (U.S. Census, 2000). The median age of residents in the two zones was roughly the same, at 29 years of age in the CF Zone and 30 years of age in the Comp Zone (U.S. Census, 2000). Median household income was about $29,000 in the CF Zone and $27,000 in the Comp Zone (U.S. Census, 2000). The concentration of poverty was 28.7% in the CF Zone, and 30.8% in the Comp Zone (U.S. Census, 2000). In the CF Zone, 12.6% of the housing units were vacant, compared to 14% of vacant units in the Comp Zone (U.S. Census, 2000). The only two statistically significant differences between the zones on the match criteria were the percentage of Caucasian residents $t(64)$ = 2.25, $p < .05$, and the percentage of residents included in the "other" race category $t(64)$ = 2.64, $p < .05$.

The Citynet had an average rate of 1.02 pre-intervention GSW per week from 311 block groups and a population of 368,414 (U.S. Census, 2000). African-Americans represent 62% of the Citynet population, while Caucasians represent 20.8%, and those residents categorized as other represent 17.2% (U.S. Census, 2000). Hispanic ethnicity was claimed by 22.7% of the Citynet population (U.S. Census, 2000). The median resident age is 31.6 years (U.S. Census, 2000). The median household income is $30, 661, the concentration of poverty is 24.6%, and the percentage of vacant housing units is 8.2% (U.S. Census, 2000). Overall, the Citynet has a lower weekly average of GSW, is more racially and ethnically diverse, slightly older, and slightly better on the measures of economic health than the CF Zone and the Comp Zone.

Study Design

This study employs a pre- and post-implementation design. Trauma Center GSW admissions (dependent variable) from the CF Zone, Comp Zone, and Citynet were aggregated at the weekly level for 156 weeks for the study period

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[5] Individuals included in the other racial group are American Indian/Alaskan Islander, Asian, Native Hawaiian/Other Pacific Islander, those who self-identify as some "other" race, and those who are two or more races.

from January 1, 2004, through December 31, 2006. Operation Ceasefire officially launched on May 11, 2005. The study was divided into two periods consisting of 71 weeks prior to the implementation of Operation Ceasefire (PreCF) and 85 weeks after the implementation of Operation Ceasefire (PostCF). We created Autoregressive Integrated Moving Average (ARIMA) interrupted time series models for the CF Zone, Comp Zone, and Citynet with SAS 9.2 software.

ARIMA models are used because they represent the integration of the dynamic autoregressive, integrated, and moving average processes and account for preceding events (Xu, 2008). In this study, the preceding events or observations are GSW. The ability to account for prior observations is an important model attribute to consider when examining community violence, as these events don't generally occur in a vacuum as lone events. Rather, acts of community violence, such as shooting incidents, tend to be part of the violent milieu within a community and may be the result of revenge or retaliatory acts of violence. An analytical method that does not account for prior events, such as Poisson regression, operates on the assumption that any given act of violence was not related to any prior act of violence and will not influence any future act of violence, thereby disregarding the possibility of retaliatory violence (Berk, 2005). The ARIMA models also allowed us to appropriately consider gradual program implementation through the weighting process. The Akaike Information Criterion (AIC; Akaike, 1974; Burnham & Anderson, 2002) and the Schwarz Bayesian Criterion (SBC; Schwarz, 1978) were used to ensure that the best fit models were selected.

There are numerous ARIMA models that can be constructed depending on the type of data or length of time to be studied (Tabachnick & Fidell, 2007). The ARIMA procedure analyzes several dynamics in a time series and is modeled in a function that accounts for preceding scores (p), trends in the data (d), and persistence of random shocks (q) (Tabachnick & Fidell, 2007). The ARIMA models utilized for these analyses are "step functions" created to test the impact of an intervention (e.g., Operation Ceasefire) that will continue over time (Tabachnick & Fidell, 2007).

In these analyses, we assumed that implementation would occur gradually over time (i.e., not an abrupt and full implementation on May 11, 2005, which is the date that Ceasefire officially began). That is, we assumed that while the program kick-off event took place on May 11, 2005, full implementation would take longer. This is known as a gradual, permanent effects time series model (Tabachnick & Fidell, 2007). Fixsen and colleagues (Fixsen, Naoom, Blase, Friedman, & Wallace, 2005) explain that implementation is very complex, requires change, and that change does not occur simultaneously or evenly across all parts of an organization, or in this case, multiple organizations. When a program is first implemented, there is a period of adjustment during which all partners are learning to carry out their roles with proficiency and skill while also attempting to overcome potential obstacles (Fixsen et al., 2005; Joyce & Showers, 2002). In the case of Operation Ceasefire, members of diverse groups with different orientations and

missions had to come together at unpredictable times and places to make the intervention happen. It is to be expected that it would take some time for all partners to become proficient in carrying out their responsibilities. The program is not fully implemented until all program partners are working together in a coordinated way.

We assumed that the initial implementation phase took six months and that Operation Ceasefire was fully operational and implemented at the six-month mark.[6] Gradual implementation is reflected in the CF Zone model with the first shock of 50% fitted into the model at the beginning of week 72 when Operation Ceasefire was launched and continued for 12 weeks (period = 0.5). The intervention shock was increased to 75% at the beginning of week 84 and continued for 12 weeks (period = 0.75). The intervention shock was increased to 100% at the beginning of week 95 and remained at 100% for the remainder of the study period (period = 1.0). The use of these shock intervals was based on the gradual implementation of Operation Ceasefire with the assumption that after 24 weeks the program became fully organized, operational, and functional. The intervention shock for the Comp Zone and Citynet was added at the beginning of week 72 (period = 1.0). Gradual implementation was not used in the Comp Zone and Citynet because these zones did not receive the intervention.

CrimeStat 3.0 mapping software was used to geocode the addresses at which GSW incidents took place and create hot and cool spot maps using the dual kernel density function. The dual kernel density function can be used to estimate the density of crimes in a particular area as opposed to simple point data for individual crime incidents, and can be used to identify hot spots, cool spots, and changes in hot and cool spots over a period of time (Mollenkopf, Goldsmith, McGuire, & McLafferty, 2003; Levine, 2007). In these analyses, the changes measured are increases and decreases in GSW for the CF Zone and Comp Zone after the implementation of Operation Ceasefire.

▨   Results

There was a total of 239 GSW from the CF Zone and Comp Zone during the study period—128 GSW from the two zones during the PreCF period and 111 GSW in the PostCF period. The CF Zone had 74 GSW in the PreCF period and 62 GSW in the PostCF period, while the Comp Zone had 54 PreCF GSW and

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[6] Dr. Michael Wagers, who served as the Executive Director of the Police Institute during the planning and implementation of Operation Ceasefire, confirmed that our model of gradual implementation is appropriate and accurate based on the data the Police Institute collected to track implementation and fidelity to program design.

49 PostCF GSW. The Citynet had 268 GSW in the PreCF period and 318 GSW in the PostCF period for a total of 586 GSW during the three-year study period.[7] We constructed ARIMA interrupted time series models to examine GSW rates among the population of each zone through the 156-week study period (three-month moving averages are displayed in Figure 1).[8]

✸ Figure 1

Time Series for Rates of GSW Incidents by Week for the Ceasefire and Comparison Zones (1/1/04 – 12/31/06)
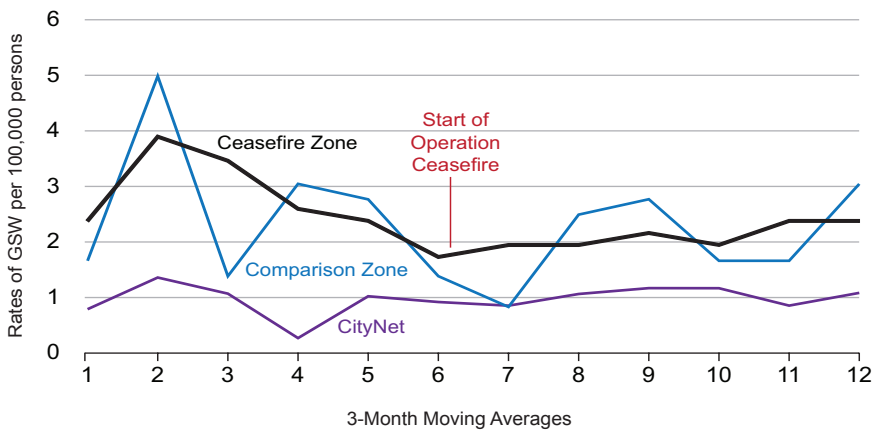
All three zones were tested for the best ARIMA model fit. According to the AIC and SBC scores, which are goodness of fit measures for the ARIMA time series procedure, the best fit model for the CF Zone is (0,0,1) and the best fit model for the Comp Zone and Citynet is (0,0,0). However, the moving average term for the CF Zone (0,0,1) model is not statistically significant and the AIC score for the (0,0,1)

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[7] The GSW frequency distribution is based on calendar date (i.e., PreCF GSW are those that occurred from January 1, 2004, through May 10, 2005, and PostCF GSW are those that occurred from May 11, 2005, through December 31, 2006.). However, the times series analyses are conducted at the weekly level, and May 11, 2005, the date of implementation, was a Wednesday. Since we couldn't split the week for the purpose of time series analyses, we removed the data for the week of Sunday, May 8, 2005, through Saturday, May 14, 2005. This resulted in 1 less GSW from the CF Zone, 2 less GSW from the Comp Zone, and 2 less GSW from the Citynet in the PreCF period for the time series analyses.

[8] We analyzed data at the weekly level. However, we report three-month moving averages in Figure 1 for ease of visual interpretation.

model is only tenths of a point better than the (0,0,0) model (i.e., AIC for CF Zone [0,0,1] is 756.47 and the AIC for CF Zone [0,0,0] is 756.8). Based on these statistics, we determined that the (0,0,0) models were the best fit for all three series.

The ARIMA time series models are presented in Table 2. All three models have zero auto-regressive terms ($p = 0$), meaning that each observation in the series is dependent upon zero preceding scores. All three models are also stationary ($d = 0$), meaning that the series vary around a constant mean level, neither decreasing nor increasing systematically over time, with constant variance (Tabachnick & Fidell, 2007). Finally, all three models have zero moving average terms ($q = 0$), indicating that there is no moving average.

⊗ Table 2

ARIMA Time Series Models

| Zone	Interval	# Intervals	ARIMA	Impact	SE	t value	p	Gradualness of Impact	SE	t value	p
CF Zone	week	71+12+12 +61 = 156	(0,0,0)	-1.422	1.01	-1.40	.163	-0.80	0.84	-0.95	.34
Comp Zone	week	71+85 = 156	(0,0,0)	-0.560	0.54	-1.04	.301				
Citynet	week	71+85 = 156	(0,0,0)	0.005	0.10	0.05	.959				

The time series analyses indicate that there is a decline in GSW in the CF Zone (impact parameter = -1.422) after the implementation of Operation Ceasefire, but that the decline is not statistically significant, with $t = -1.40$, $p > .05$. We also found that the gradual impact model did not have a statistically significant impact on the findings, with $t = -0.95$, $p > .05$. Analyses also indicate that there is a small decline in GSW in the Comp Zone (impact parameter = -0.560) during the same post-implementation period, but the decline is not statistically significant, with $t = -1.04$, $p > .05$. Additionally, there was a minuscule increase in GSW in the Citynet (impact parameter = 0.005), but this increase was not statistically significant, with $t = 0.05$, $p > .05$.

A dual kernel density hot spot map (see Figure 2) revealed that there were changes in hot and cool spots within and between the CF Zone and the Comp Zone. That is, hot spots are areas where there were increases in the rate of GSW after Ceasefire's implementation, and cool spots indicate areas where there were decreases in the rate of GSW in the post-intervention period. Of particular note is the development of an intense hot spot in the buffer zone between the CF Zone and the Comp Zone (as indicated by the darker shading in Figure 2). However, due to the nature of our data, we are unable to explore the origins of this and

other new hot and cool spots. Changes in the density of GSW hot and cool spots appear to be non-systematic, or random. The diverse distribution of both hot and cool spots within and between the zones is consistent with the ARIMA time series analyses, which indicate that there are no statistically significant increases or decreases in the rate of GSW in either of the zones after the implementation of Operation Ceasefire.

▓ Figure 2

Dual Kernel Density Hot Spot Map of GSW Locations in Ceasefire and Comparison Zones (1/1/04 – 12/31/06)

⠿ Increase in GSW after Ceasefire   ▨ Decrease in GSW after Ceasefire
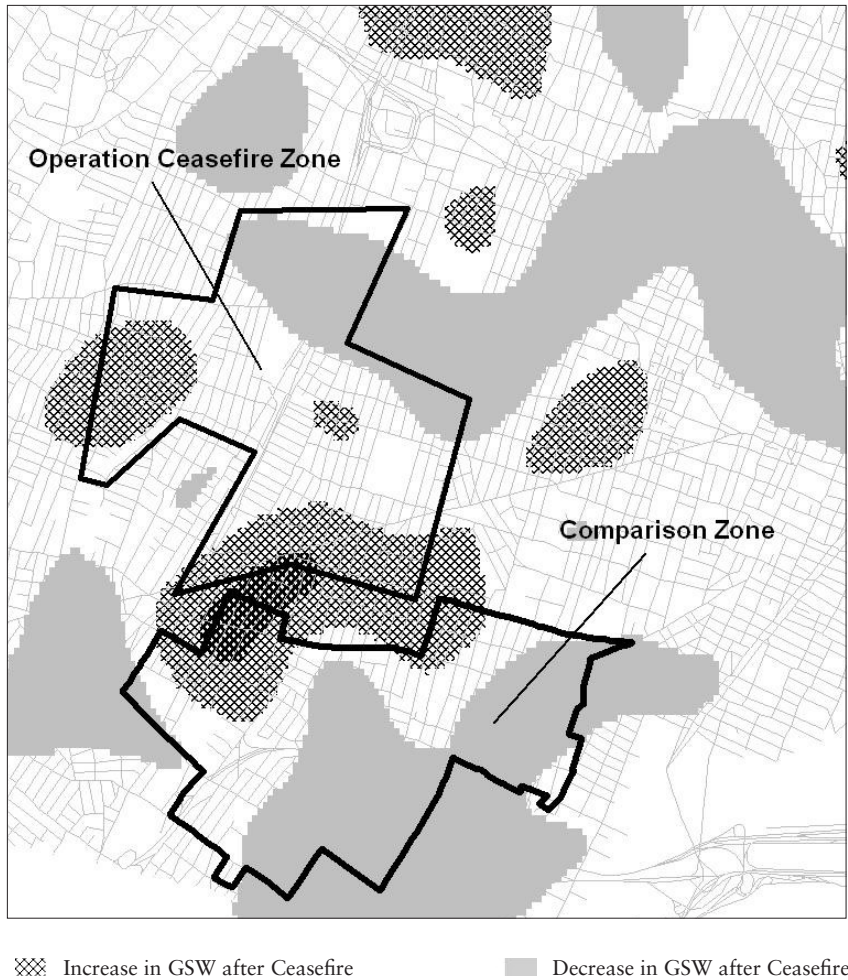
❈ Discussion

In the present study, we examined the effect of Newark's Operation Ceasefire on the rate of GSW admissions to the Level 1 Trauma Center serving northern New Jersey. We included two safeguards in the analyses to ensure that we analyzed a fully implemented program with fidelity to program design and that we controlled for overall trends in the rate of GSW in the city. First, we assumed that Operation Ceasefire would be gradually implemented over a six-month period, which was reflected in the ARIMA time series models. We took this approach to ensure that we were evaluating the effect of a fully rather than partially implemented violence-reduction initiative. In order to determine if the lack of statistically significant changes in GSW were attributable to the gradual, permanent effects model, we also ran an abrupt, permanent effects model. The abrupt, permanent effects model assumed the intervention was fully functional from the beginning (period =1.0 at the beginning of week 72). This model also resulted in no statistically significant findings, indicating that our findings were not an artifact of model specification.

Second, we intended for the Comp Zone and Citynet to function as controls for overall trends in GSW; the Comp Zone served as a control for trends in GSW in an area similar to the CF Zone in terms of rates of GSW and demographic composition, and the Citynet served as a control for city-wide trends in GSW. We ensured that the Comp Zone served this role by creating a buffer zone of block groups contiguous to the CF Zone for which we did not analyze changes in GSW. The buffer zone allowed us to avoid the analytical complications associated with the diffusion of crime control benefits or the immediate spatial displacement of crime (Clarke & Weisburd, 1994; Weisburd, Wyckoff, Ready, Eck, Hinkle, & Gajewski, 2006). A public information campaign could have an impact beyond the CF Zone's borders, particularly in the fringe areas. An outreach worker might distribute public education materials in areas on the periphery of the CF Zone resulting in an unintentional extension of the intervention beyond the target zone. While the spillover of program work may be positive for the neighborhood, it complicates evaluation.

With these two safeguards in place, we found a small decrease in the rate of GSW in the CF Zone throughout the study period, but the decrease did not achieve statistical significance. The rate of GSW in the Comp Zone experienced non-systematic increases and decreases throughout the study period, resulting in a small, but statistically insignificant decrease in PostCF GSW. Finally, the Citynet rate of GSW remained relatively constant throughout the study period. Therefore, we must conclude that Operation Ceasefire did not result in a statistically significant change in the rate of GSW in the CF Zone. It is important to note that these findings do not suggest that Operation Ceasefire is ineffective at reducing gun violence, as we only examined changes in GSW admissions to the Trauma Center. It is possible that Ceasefire had an impact on shootings that resulted in less serious injuries that did not require treatment at the Trauma Center and on gun-related homicides, which are beyond the scope of the present study.

Limitations of the Study

Our analyses utilized GSW Trauma Center admissions as the dependent variable, rather than all gun-related crimes of violence. Gun assaults resulting in GSW are less frequent than other types of gun assaults. Therefore, our findings address the impact of Operation Ceasefire on a subtype of gun violence, rather than all assaults and homicides committed with a firearm.

Regression toward the mean could be a confounding factor as well. The rate of GSW in the CF Zone was very high between April and June 2004. It is possible that the rate of GSW in those three months was anomalous, and the rate of GSW began to return to normal levels prior to the implementation of Ceasefire. It is also possible that the spike in gun violence and subsequent GSW from the CF Zone during this period resulted in an increased police presence in this area. Increased police presence may have led to a decrease in gun violence, which resulted in a decrease in the rate of GSW from the CF Zone prior to the implementation of Ceasefire. If the law enforcement component is the most critically important component of Newark's model, then it is possible that the implementation of the additional four components as of May 11, 2005, may not have resulted in additional decreases in GSW from the CF Zone.

It is also possible that there were other state and federally funded violence-reduction initiatives in effect at the same time as Ceasefire, which could have impacted rates of gun violence and injuries throughout the City of Newark. Project Safe Neighborhoods (PSN) is one possible confounding variable for violence reduction programs across the country due to its widespread implementation. PSN is a nationwide platform for gun violence reduction that began in 2001. PSN strategic interventions have been active in all 94 federal judicial districts in the United States and the coordinated efforts are run through the United States Attorney's Office in each district. The impact of PSN on gun violence in Newark is unknown.

Future Research and Conclusions

Future research should focus on conducting process evaluations as well as outcome evaluations for violence intervention programs, including the various adaptations of the Ceasefire model and formula. Such measures could include, for example, frequency and quality of contact between outreach workers and at-risk youth, dollars expended on public information campaigns, and how the program's purpose and message were interpreted by the target population. In addition, multiple sources of data, including police and hospital data examined over a longer period, should be utilized. Consistent with Hassett-Walker and Boyle (2007), we argue that hospital data can provide accurate data on assaults that may not appear in police records if victims are reluctant to report or discuss their victimization. Hospital data also provide the location of the shooting if EMS transported the GSW victim, thus facilitating spatial analyses.

The design of violence-reduction programs should take into consideration methods for identifying and quantifying crime displacement and diffusion of benefits. Guerette (2009) provides a methodology for how to conduct an analysis

of displacement and diffusion. It is in the best interest of those implementing a violence-reduction initiative to include this analysis from the beginning of implementation to ensure that the necessary data are available to conduct the analysis. Weisburd and Green (1995) explain that these analyses can be used to design out problems and prevent displacement, if necessary, and to increase the overall benefit of programs. We suggest that municipalities considering implementing Operation Ceasefire or other violence-reduction programs include an analysis of displacement and diffusion in their analytical plan.

Variations of the Boston and Chicago Ceasefire models have spread to multiple jurisdictions with areas of concentrated gun violence. The Boston model featured an innovative use of collaborative partnerships to implement a focused deterrence program to address youth gun violence in Boston. The Chicago model featured an innovative use of the public health approach and collaboration amongst stakeholders with different roles in the community to address the scourge of gun violence. Newark's model, like the approach of many other cities, is a hybrid of the two models. Additional peer-reviewed evaluations of the Chicago model, as well as adaptations of the Boston and Chicago models—such as that implemented in Newark—are needed to help inform policy makers' decisions regarding the selection of violence reduction programs.

❁ References

Akaike, H. (1974). A new look at the statistical model identification. *IEEE Transaction on Automatic Control, AC-19*, 716–723.

Berk, R. A. (2005). Knowing when to fold 'em: An essay on evaluating the impact of Ceasefire, Compstat, and Exile. *Criminology and Public Policy, 4*(3), 451–466.

Boyle, D. J. (2001). Emergency department surveillance data for patients treated for gunshot wound injuries. Unpublished raw data.

Boyle, D. J., & Hassett-Walker, C. (2008). Individual-level and socio-structural characteristics of violence: An emergency department study. *Journal of Interpersonal Violence, 23*(8), 1011–1026.

Burnham, K. P., & Anderson, D. R. (2002). *Model selection and multi-model inference: A practical-information-theoretic approach* (2nd ed.). New York: Springer.

Clarke, R. V., & Weisburd, D. (1994). Diffusion of crime control benefits: Observations on the reverse of displacement. In R.V. Clarke (Ed.), *Crime prevention studies, Vol. 3* (pp. 165-183). Monsey, NY: Criminal Justice Press.

Fixsen, D. L., Naoom, S. F., Blase, K. A., Friedman, R. M. & Wallace, F. (2005). *Implementation research: A synthesis of the literature* (FMHI Publication # 231). Tampa, FL: University of South Florida, Louis de la Parte Florida Mental Health Institute, The National Implementation Research Network.

Guerette, R. T. (2009). *Analyzing crime displacement and diffusion* (Problem-Oriented Guides for Police Problem-Solving Tools Series Guide No. 10). Washington, DC: Office of Community Oriented Policing Services.

Hassett-Walker, C., & Boyle, D. J. (2007). Conducting criminological research in a hospital: The results of two exploratory studies and implications for prevention. *Justice Research and Policy, 9*(1), 75–94.

Joyce, B., & Showers, B. (2002). *Student achievement through staff development* (3rd ed.). Alexandria, VA: Association for Supervision and Curriculum Development.

Kennedy, D. M., Braga, A. A., & Piehl, A. M. (2001). Developing and implementing Operation Ceasefire. *Reducing gun violence: the Boston Gun Project's Operation Ceasefire* (NIJ Grant No. 94-IJ-CX-0056). Washington, DC: National Institute of Justice.

Levine, N. (2007). CrimeStat: A Spatial Statistics Program for the Analysis of Crime Incident Locations (v 3.1). [Computer software and manual]. Retrieved from http://www.icpsr.umich.edu/CRIMESTAT/. Accessed February 10, 2009.

McGloin, J. M. (2004). *Associations among criminal gang members as a defining factor or organization and as a predictor of criminal behavior: The gang landscape of Newark, New Jersey*. Doctoral dissertation, Rutgers University, 2004.

McGloin, J. M. (2005). Policy and intervention considerations of a network analysis of street gangs. *Criminology and Public Policy, 4*(3), 607–636.

McGloin, J. M. (2007). The organizational structure of street gangs in Newark, New Jersey: A network analysis methodology. *Journal of Gang Research, 15*(1), 1–34.

Mollenkopf, J., Goldsmith, V., McGuire, P., & McLafferty, S. (2003). *Identification, development and implementation of innovative crime mapping techniques and spatial analysis*. Washington, DC: U.S. Department of Justice.

Schwarz, G. (1978). Estimating the dimension of a model. *The Annals of Statistics, 6*(2), 461–464.

Skogan, W. G., Hartnett, S. M., Bump, N., & DuBois, J. (2008). *Evaluation of CeaseFire-Chicago* (NIJ Grant No. 2005-Mu-Mu-003). Evanston, IL: Institute for Policy Research, Northwestern University.

State of New Jersey, Division of State Police. (2003). *Crime in New Jersey: 2002 Uniform Crime Report*. West Trenton, NJ: Uniform Crime Reporting Unit.

State of New Jersey, Division of State Police. (2006). *Crime in New Jersey: 2005 Uniform Crime Report*. West Trenton, NJ: Uniform Crime Reporting Unit.

State of New Jersey, Division of State Police. (2007). *Crime in New Jersey: 2006 Uniform Crime Report*. West Trenton, NJ: Uniform Crime Reporting Unit.

Tabachnick, B. G., & Fidell, L .S. (2007). Time-series analysis. In *Using Multivariate Statistics* (5th ed.). Retrieved from http://www.ablongman.com/tabachnick5e. Accessed September 8, 2008.

U.S. Census. (2000). *Census 2000 data for New Jersey*. Retrieved from http://www.wnjpin.state.nj.us/OneStopCareerCenter/LaborMarketInformation/lmi25/index.html. Accessed September 13, 2007.

Vyrostek, S. B., Annest, J. L., & Ryan, G. W. (2004). Surveillance for fatal and nonfatal injuries-United States, 2001. *Morbidity and Mortality Weekly Report Surveillance Summaries, 53*(SS07), 1–57.

Weisburd, D., & Green, L. (1995). Measuring immediate spatial displacement: Methodological issues and problems. In J. E. Eck & D. Weisburd (Eds.), *Crime and Places* (pp. 349–361). Monsey, NY: Criminal Justice Press.

Weisburd, D., Wyckoff, L. A., Ready, J., Eck, J. E., Hinkle, J. C., & Gajewski, F. (2006). Does crime just move around the corner? A controlled study of spatial displacement and diffusion of crime control benefits. *Criminology, 44*(3), 549–592.

Xu, Y. (2008). Characteristics of homicide events and the decline in homicide clearance. *Criminal Justice Review, 33*(4), 453–479.

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