Is the Punishment More Certain? An Analysis of CCTV Detections and Enforcement

Eric L. Piza
Joel M. Caplan
Leslie W. Kennedy
School of Criminal Justice
Rutgers University

Abstract:

The primary preventive mechanism of CCTV is considered to be deterrence. However, the relationship between CCTV and deterrence has been left implicit. Empirical research has yet to directly test whether CCTV increases the certainty of punishment, a key ingredient of deterrence. This study analyzes CCTV's relation to punishment certainty in Newark, NJ. CCTV detections and calls-for-service are compared on numerous factors. Across eight crime categories, CCTV and calls-for-service case processing times and enforcement rates are compared through Mann Whitney U and Fisher's Exact tests, respectively, with a Holm-Bonferroni procedure correcting for multiple comparisons. ANOVA and negative binomial regression models further analyze the frequency of CCTV activity and the impact of various factors on the (downward) trend of detections and enforcement. Findings suggest that CCTV increases punishment certainty on a case-by-case basis. However, a reduction of CCTV activity caused by specific "surveillance barriers" likely minimized the effect of the enhanced enforcement.

Keywords: CCTV, deterrence, police response, Holm-Bonferroni correction, negative binomial regression

Citation:
Piza, E., Caplan, J. and Kennedy, L. (2014). Is the Punishment More Certain? An Analysis of CCTV Detections and Enforcement. *Justice Quarterly, 31*(6): 1015-1043.

Introduction

While scholars have offered a wide range of mechanisms by which CCTV may prevent crime (Gill & Spriggs, 2005; Pawson & Tilley, 1994), the practical application of CCTV predominately relates to deterrence (Farrington, Gill, Waples, & Argomaniz, 2007; Ratcliffe, 2006). From a rational choice perspective (Cornish & Clarke, 1986), the primary utility of CCTV is the triggering of a perceptual mechanism within an offender so that he or she considers the risk of crime commission to outweigh any potential benefits (Ratcliffe, 2006: p. 8). This perceived mechanism is reflected in the literature, with most evaluations exclusively testing CCTV's deterrent effect though "pre" and "post" tests of crime in target areas (see Gill & Sprigss, 2005 and La Vigne, Lowry, Markman, & Dwyer, 2011 for noteworthy exceptions). Little thought has been given to precisely how CCTV can generate deterrence. It is implicitly assumed that the simple presence of cameras is sufficient to deter offenders. However, empirical findings from the deterrence literature put this assumption in doubt. Firstly, perceived certainty of punishment is a key ingredient in producing deterrence (Durlauf & Nagin 2011). Secondly, experience with punishment results in offenders' adjusting their perception of punishment certainty upward (Apel, in press). These findings suggest that CCTV's deterrent effects go beyond camera presence and are related to its ability to generate increased law enforcement actions in target areas, thus increasing offenders' perceived certainty of punishment. While recent reports have noted that systems that are most effective are often highly integrated into police functions (Cameron, Kolodinski, May, & Williams, 2008; La Vigne et al., 2011; La Vigne & Lowry, 2011) research has yet to directly test CCTV's effect on actual certainty of punishment.

The current study addresses this relationship. CCTV detections and 9-1-1 calls-for-service occurring over a three-year period in Newark, NJ are compared on case processing times

and closure rates (e.g. whether the incident resulted in a police enforcement action). In addition, we examine the frequency of CCTV activity and the impact of various factors on the (downward) linear trend of surveillance activity. Our findings support the notion that CCTV increases punishment certainty on a case-by-case basis, with CCTV-reported incidents more often resulting in case closure via police enforcement than calls-for-service. A drastic reduction of surveillance activity caused by specific "surveillance barriers"—namely, the rapid installation of cameras absent an increase in personnel—likely compromised the benefits of the enhanced enforcement. In particular, the infrequent occurrence of CCTV activity likely prevented the "certainty of punishment" via CCTV from being translated into offender knowledge or "word on the street." The paper concludes with a discussion of the policy implications of these findings. We begin with a review of the literature that provides a conceptual framework for this study.

Review of Relevant Literature

CCTV, Apprehension, and Deterrence

Theoretical perspectives of surveillance are rooted in the Rational Choice perspective of criminality (Cornish & Clarke, 1986). Whereas deterministic theories view crime as an inevitable byproduct of social ills, Rational Choice considers crime as "purposive behavior designed to meet the offender's commonplace needs" (Clarke, 1997: p. 9-10). Under this perspective, offenders decide whether or not to offend on a case-by-case basis. While these decisions often occur in a state of "bounded rationality" constrained by the limits of time and information (Clarke & Cornish, 1985), the offender nonetheless rationally ponders the situation at hand. The decision to offend is "the outcome of an appraisal process which…evaluates the relative merits

of a range of potential courses of action, comprising all those thought likely in the offender's view to achieve his or her current objective" (Cornish & Clarke, 1987: p. 935).

As per the Rational Choice doctrine, CCTV presence must communicate that crime commission poses an increased level of risk to offenders in target areas for deterrence to be realistically expected. While one may intuitively consider the risk of apprehension to be heightened in the presence of cameras, the actions of offenders suggest that such cognitive processes are not automatic. Numerous studies have documented offender willingness to operate illegally in sight of CCTV (Ditton & Short 1998; Butler 1994; Gill & Turbin 1998). During interviews with prisoners, Gill and Loveday (2003) found that most offenders did not consider surveillance cameras as a serious threat. This disregard for CCTV was related to the fact that the presence of a camera did not guarantee that criminal infractions would result in enforcement. As noted by Gill and Loveday, "offenders appear to believe that the notification of an incident [via CCTV] carries no guarantee that the police are able to respond quickly" (p. 19). However, while most offenders did not worry about CCTV when planning and committing their offenses, prisoners previously caught or convicted through CCTV footage were significantly more likely to report that surveillance cameras increase the likelihood of apprehension. Indeed, Gill and Loveday (2003) observed the offenders were more concerned with police presence and the ability of the police to respond to crime observed on camera than the cameras themselves.

The findings of Gill and Loveday (2003) have significant implications for the use of CCTV by suggesting that the mere presence of a camera does not generate deterrence unless it is known to be accompanied by a real threat of apprehension. Previous research supports this proposition. While early deterrence research was described in terms of an offenders' "perception" of punishment, contemporary research supports Paternoster's (1987) notion of the

"experiential effect," which he describes as "the effect of prior behavior on currently held perceptions" (p. 173). As argued by Apel (in press), "individuals who commit crime and 'get away with it' by avoiding punishment might be expected to 'update' their risk perceptions; specifically, by adjusting them downward. One the other hand, individuals who commit crime and are apprehended might realize that they were overly optimistic about the true likelihood of apprehension and, therefore, update their risk perceptions upward" (p. 6). In this sense, "punishment avoidance" (Paternoster & Piquero, 1995) is associated with lower risk perceptions (Apospori & Alpert, 1993; Piquero & Pogarsky, 2002; Pogarsky & Piquero, 2003). As argued by Clarke and Cornish (1985), a successful crime act provides an offender "direct knowledge about the consequences and implications of that behavior" which becomes "much more salient to future decisions about continuance or desistance" (Clarke & Cornish, 1985: p. 164).

These examples illustrate the importance of punishment in high-visibility policing efforts, such as CCTV. Sherman (1990) noted that offenders often learn "through trial and error that they had overestimated the certainty of getting caught at the beginning of the crackdown" (p. 10). Conversely, enforcement actions can manipulate offender risk perceptions in a manner that maximizes deterrence (Nagin, 1998). The effect of sanction is not limited to the specific offender subjected to enforcement, but rather influences the general population as potential offenders learn from acquaintances that the risk of punishment has increased (Cook, 1980; Cusson, 1993). Enforcement need not be particularly severe to have such an effect. In arguing this point, Durlauf and Nagin (2011) discussed Hawaii's Project Hope (Hawken & Kleiman, 2009) and a randomized experiment conducted by Weisburd, Einat, and Kowalski (2008). Both projects utilized short, but highly certain, jail sentences to produce deterrence. While the punishments were relatively minor in both projects, Weisburd et al. (2008) and Hawken and Kleiman (2009)

observed a significant reduction in failures of defendants to pay court ordered fines and rates of positive drug tests, missed appointments, and arrests in probationers.

Recent research suggests such a relationship between enforcement and deterrence in respect to CCTV. Discussing San Francisco's CCTV system, a police officer was quoted as saying "when the type of stuff that they're (offenders) involved in kept happening and they realized they weren't getting arrested, nothing was happening because of those cameras. I don't think (the camera program) works as a deterrent at all….because there's no immediate consequence to the behavior" (King, Mulligan, & Raphael, 2008: p. 87). In their study of surveillance systems in three U.S. cities, the Urban Institute (La Vigne et al., 2011) found the systems that effectively reduced crime were those which were actively monitored and heavily incorporated into the police function. Similarly, La Vigne and Lowry's (2011) analysis of photographic cameras[1] in commuter parking lots found no effect on crime reduction, which they attributed to budget cuts preventing police from integrating the cameras into law enforcement activities. These studies are further supported by research that found passive CCTV systems, which incorporate no active monitoring, to have little effect on crime (King et al., 2008).

The Practical Application of CCTV and Surveillance Barriers

Despite the assumption that CCTV cameras increase the certainty of punishment, the practical application of CCTV may negatively affect an operator's ability to detect incidents of concern. For example, despite the fact that most documented cases of police-operated CCTV systems report that operators are given the primary responsibility of proactively monitoring cameras for the purpose of detecting incidents of crime and disorder (Armitage, Smythe, & Pease, 1999; Caplan, et al., 2011; Ditton & Short, 1999; Farrington et al., 2007; Gill et al., 2005;

[1] While this analysis was of photographic cameras, rather than video (CCTV) cameras, the goal of the program was similar to most CCTV programs; deterrence of offenders through the conspicuous presence of recording technology. Therefore, the implications of this study relate to the use of CCTV as well as photographic cameras.

Norris & Armstrong, 1999a,b; Norris & McCahill, 2006; Ratcliffe, Taniguchi, & Taylor, 2009; Smith, 2004), the detection of criminal events by CCTV operators is rare (Norris & Armstrong, 1999a,b). Ditton and Short (1999) found that operator activity led to only one arrest per 967 hours of monitoring in two Scottish city centers while Sarno, Hough, and Bulos (1999) reported that a London CCTV unit provided police with footage of crime incidents a mere 8 times over a 12-month period. General monitoring activity of surveillance operators (as opposed to enforcement activity) is similarly low. Over 592 hours, Norris and McCahill (2006) documented 888 targeted surveillances, which they defined as an operator observation "that lasted more than one minute on an individual or group of individuals, or where the surveillance was initiated from outside the system, for example, by police or private security" (Norris & Armstrong, 1999a: p. 161). Norris and McCahill (2006) found that proactive surveillance activity initiated by the operators occurred only once every four hours across numerous CCTV systems in Britain (p. 108). An obvious consequence of such low levels of surveillance activity is the potential for offenders to consider the "certainty of punishment" to be minimal in CCTV areas.

This lack of proactive CCTV activity can be explained by factors common to police-led CCTV operations, which we term "surveillance barriers." For one, the size of many surveillance systems places a heavy burden on camera operators. Norris and Armstrong (1999a) estimated that the twenty cameras in a British surveillance system created over 43 million unique "images" on a daily basis (p. 159). This issue is obviously compounded when CCTV systems include a much larger number of cameras, which appears to be the norm (Farrington et al., 2007). High camera to operator ratios has the predictable result of crime occurring within sight of a camera going undetected. The following quote from a CCTV operator adds perspective: "I cannot tell you how many things we've missed when we have not been watching the other screens. Break-

ins, assaults and car thefts have been going on whilst we've been operating the other cameras" (Smith, 2004: p. 385). Certain offenders are cognizant of this fact, with Gill and Loveday (2003) quoting a prisoner as saying "We've got so many cameras man, they cannot all be watched. They have to find you, guess what you're going to do and then do something about it" (p. 19).

In addition to the large numbers of cameras typically present in CCTV systems, operators often have additional duties that can take them away from their proactive monitoring function. Tasks unrelated to surveillance—such as answering phones or manning front desks—can limit the proactive surveillance activity of an operator (Leman-Langlois, 2002). Even tasks related to other aspects of CCTV, such as burning footage onto disc, can impede upon active camera monitoring. King et al. (2008) reported that burning one-hour of footage onto discs took about two hours in San Francisco. Similarly, Gill et al. (2005) reported that the management of footage for evidentiary purposes comprised up to 35% of an operator's shift in several UK systems.

Surveillance barriers may also be present in the police response to CCTV detections. Upon detection of an incident, CCTV operators primarily report the event via the Computer Aided Dispatch (CAD) system, similar to how citizen calls-for-service are reported to police (LEITSC, 2008). Police Communications systems, especially in large urban areas, regularly experience high call volumes. Immediate dispatch of an officer to all incidents is not a realistic nor, in certain cases, a desirable option. It is standard procedure for requests for police service to be addressed in a "differential response" manner, with incidents of a higher priority being dispatched before those of lower priority. All calls awaiting dispatch are stored in the "call pending queue" in order of priority—from highest priority to lowest priority (LEITSC, 2008). Consequently, while CCTV can observe crime incidents "in-progress," CCTV detections may face similar processing delays as calls-for-service. While there has yet to be a large scale study

of the process times associated with CCTV detections, anecdotal evidence suggests that delays in police dispatch may negatively affect CCTV operations (Gill & Hemming, 2004; Gill et al., 2005; Lomell, 2004; Norris & Armstrong, 1999a,b; Norris & McCahill, 2006).

Scope of the Current Study

This study focused on the Newark, NJ surveillance unit's detection of criminal events, subsequent responses and actions taken by patrol units, and its relation to deterrence via certainty of punishment in the form of sanction by police. Four research questions guided the analysis: 1) Are case process times shorter with CCTV, as compared to calls-for-service? 2) Does CCTV produce a heightened level of enforcement compared to calls-for-service? 3) How often did surveillance activity occur over the study period? 4) What effect did various surveillance barriers have on the steady reduction of surveillance activity?

Research Setting

Newark, NJ has installed 146 public CCTV cameras throughout the city. Live video footage from the cameras is monitored from a centralized control room at the police department's communications center. The control room is staffed by the Newark Police Department's Video Surveillance unit. Two video surveillance operators under the supervision of a police sergeant monitor the cameras during all shifts. As per the departmental order establishing the video surveillance unit, the primary aim of the operators is the monitoring of the cameras for the purpose of detecting incidents of crime and disorder. Upon detecting an incident of concern, operators report the event via the department's CAD system. Reported incidents (both CCTV events and 9-1-1 calls for service) are stored in CAD's "calls pending queue" and are addressed in a "differential response" manner by the police dispatcher, in accordance with

accepted standards of police dispatch (LEITSC, 2008). The Newark Police Department's deployment policy places added priority on CCTV detections by increasing all incidents reported via CCTV by one priority level. For example, if a camera operator reports an incident of unverified drug activity, which has a departmental priority code of "443," the incident priority is upgraded to "543" in an attempt to minimize the incident's time in the "calls pending queue."

Potential "surveillance barriers" identified in previous research may be present in Newark. Given the current size of the system (146 cameras) each operator is responsible for watching 73 cameras at a time. Cameras were installed over a total of five phases, each causing a substantial increase in the total number of cameras.[2] In addition to active monitoring, other duties are expected of the operators, particularly creating discs of footage and monitoring the department's gun-shot detection system. Footage is needed for evidentiary purposes for each arrest incident in which a CCTV camera provided probable cause. In addition, detectives often request extended hours of footage for investigative purposes. The gunshot detection system was installed in August of 2009 and is monitored by the surveillance operators. While La Vigne et al. (2011) advocate the integration of CCTV and gun-shot detection technology, monitoring the system may take operators away from their active monitoring functions. When a gun-shot detection occurs, video operators manually review acoustic recordings of the gun-shots to determine their validity (e.g. whether the sound was a gun-shot or other loud noise, such as a firecracker). This process can take several minutes to complete, an issue exacerbated by a large number of "false positives." Newark Police records show from 2009 through December 2010, an average of 101.5 "gun-shot detections" occurred per month. However, operators only classified an average of 21.7 incidents per month as valid gun-shots.

[2] Phase 1: 6/8/07 (11 cameras installed), Phase 2: 3/15/08 (49 cameras installed, system size increased to 60), Phase 3: 7/31/08 (51 cameras installed, system size increased to 111), Phase 4: 12/10/09 (25 cameras installed, system size increased to 136), and Phase 5: 4/23/10 (10 cameras installed, system size increased to 146).

The Newark Police Department's CCTV operation, and the agency as a whole, was negatively impacted by police layoffs occurring in November 2010, in which 13% (167 of 1,265) of police officers were terminated due to the city's fiscal crisis. In preparation for the layoffs, personnel in "non-essential" assignments were often temporarily reassigned to core assignments in an attempt to minimize overtime expenditures, a practice which began early in 2010. In the case of the surveillance unit, camera operators would occasionally be reassigned as 9-1-1 call takers, which would leave the surveillance function at less than full capacity.[3]

Data Sources and Operationalization of Key Concepts

This study focuses on the period from November 2007 through the end of 2010.[4] Data for this study was compiled from the Newark Police Department's weekly Video Surveillance Unit (VSU) activity reports, which list all incidents that occurred in CCTV-areas of the city (both CCTV detections and 9-1-1 calls-for-service).[5] These reports contain the following data for each incident: event number, date, time, location, incident type, the camera used to view the incident, whether it was a CCTV detection or call-for-service, and whether an arrest occurred.

Each incident appearing on the VSU weekly activity reports was individually referenced in the CAD system to collect additional data. Researchers first recorded the following time variables: time of the incident (report time), time of police dispatch, and time of officer arrival on the scene. Researchers calculated the number of minutes and seconds between these time intervals to create three variables: queue time (minutes between report time and dispatch time),

[3] Similar measures were taken in respect to patrol, with officers detailed to specialized foot-patrol posts being reassigned to motorized patrol, which have city-mandated minimum levels, in order to avoid overtime expenditures (Piza & O'Hara, in press).

[4] While the CCTV operation began in June 2007, a full-time supervisor (who instituted procedures to track the activity of the unit) was not assigned to the unit until November 2007.

[5] While installed in areas throughout the city, the CCTV cameras cover a fraction of Newark's total geography. The CCTV viewsheds, denoting areas visible by the cameras while in panning mode, total 0.57 square miles (Piza, 2012). While the cameras are able to see distances beyond their viewsheds when manually controlled by an operator, the CCTV coverage area is a fraction of Newark's total geography of 26 square miles.

response time (minutes between dispatch and arrival), and total process time (a sum of the previous two time intervals). Additional information was also collected on the event disposition. While the VSU reports identify whether or not an arrest occurred, there exists a multitude of alternate event outcomes. A detection of disorderly person, for example, may be grounds for a quality of life summons rather than an arrest. Case outcomes are additionally influenced by officer discretion. An officer may deem an incident undeserving of arrest (even if there are legal grounds for arrest) and decide to issue a less punitive sanction (Bittner, 1990). Dispositions were categorized as "arrest," "other enforcement action," or "no police action taken."[6]

A total of 13,368 incidents are included in the weekly VSU reports and were referenced in the aforementioned manner. Following the data collection, we decided to exclude some incidents from the analysis based on specific criteria, in order to strengthen the construct validity of the analysis (see Table 1).[7] The first excluded category was incidents with mostly predetermined outcomes. For example, a call of a "pedestrian struck by automobile" requires the responding police officer to block-off the scene and monitor the status of the injured person until an ambulance arrives. In this scenario, the case outcome is not likely to vary based on the method of reporting (CCTV vs. 9-1-1). Eighteen incident types were identified for exclusion based on this criterion.[8] Likewise, incidents for which a police response was cancelled were excluded. Cancelation primarily occurs for three reasons. One, the reporting party informs the police that a response is no longer necessary. Two, CCTV operators notify police dispatch that no visual evidence exists to support a complainant's claim that a crime occurred. For example,

[6] A "hierarchy rule" was applied in which researchers recorded the most punitive enforcement action when more than 1 was enacted. For example, if a police officer issued a summons and arrested a suspect, the disposition was recorded as an arrest.
[7] Most of the excluded categories were identified through their case dispositions or incident codes. It is noted when cases are otherwise identified for exclusion.
[8] Given limited space, all of the incident types excluded from the analysis are not discussed. This information is available from the primary author upon request.

while a caller may state that a large fight is taking place on a certain street corner, a CCTV operator may report that no such incident is taking place. Thirdly, an officer can arrive on scene and determine that no evidence exists to support the complainant's claim. Officer initiated incidents were excluded since the analysis focused on the differential impact two crime reporting methods (CCTV vs. 9-1-1) have on aspects of police response and case closure. Officer-initiated events fall into neither of these categories, but rather represent an entirely different method of crime discovery. Motor vehicle violations and property crime were excluded due to their infrequent occurrence, in respect to either CCTV or calls-for-service. Property crimes only accounted for 16 of the 1,859 CCTV detections, which does not lend itself to reliable statistical analysis. Motor Vehicle Violations (such as "speeding" or "illegal parking"), on the other hand, were rarely reported to police via calls for service (see Table 2).[9] Lastly, all incidents not falling within one of the aforementioned categories were reviewed to ensure that they were reported while "in-progress." As noted by Eck and Spelman (1987), the ability of police to apprehend an offender is severely compromised in "discovery crimes" where a victim learns of the crime well after its occurrence (e.g. auto theft or burglary). CCTV can do little to generate punishment if an offender is not present. Therefore, the incident report for each of the 8,718 incidents not excluded for one of the aforementioned reasons was reviewed to ensure that they were reported either during or immediately following the crime incidents. "Discovery" incidents, where evidence of victimization surfaced an undetermined time after crime occurrence, were excluded.

[9] Furthermore, the Newark Police Department's Video Surveillance unit stopped reporting detections of motor vehicle violations after installation phase 1 due to concerns that core patrol officers were too-often being dispatched to low-level incidents that could be better addressed by other personnel, such as traffic control units.

Table 1. Breakdown of excluded cases.

	CCTV	Other	TOTAL
Total Incidents	**1,859**	**11,509**	**13,368**
Total Excluded	**474**	**4,779**	**5,253**
EXCLUSION BREAKDOWN			
Incident Type	19	1,812	1,831
Cancelled	260	1,245	1,505
Disposition	47	549	596
Officer Initiated	0	153	153
Property Crime	16	273	289
Motor Vehicle Violations	120	156	276
Not In-Progress	12	591	603
FINAL NUMBER OF INCIDENTS INCLUDED IN THE ANALYSIS	**1,385**	**6,730**	**8,115**

Table 2. Final count of incidents included in the analysis.

	CCTV	9-1-1	TOTAL
OVERALL CRIME	1,385	6,730	8,115
CRIME TYPE			
Violence	175	3,549	3,724
Disorder Offenses	631	1,383	2,014
Drug Offenses	389	691	1,080
Other Crime	190	1,107	1,297
PRIORITY LEVEL			
High Priority	303	2,082	2,385
Intermediate Priority	876	3,423	4,299
Low Priority	206	1,225	1,431

A total of 8,115 incidents remained for inclusion in the analysis: 1,385 CCTV detections and 6,730 calls-for-service (CFS). Analyses were conducted on the overall dataset as well as specific sub categories. Each incident was categorized as a violent crime, disorder offense, drug offense, or "other crime." "Disorder" offenses included incidents commonly referred to as "social disorder" in the literature (e.g. "disorderly persons" or "drinking in public"). No incidents

of "physical disorder," such as graffiti or litter, appeared in the VSU reports. "Other crime" is an official assignment code of the NPD. According to Newark police officials, incidents should be categorized as "other crime" only when no other code accurately reflects the incident in question. However, officials acknowledged that both CCTV and 9-1-1 operators often classify incidents as "other crime" when they have trouble deciding between numerous codes. For example, the NPD utilizes two separate codes for drug activity: a priority 5 code where visual confirmation of the offense exists and a priority 4 code in which the activity is "unverified." When an operator is unsure of how to classify the incident-at-hand, they may report it as "other crime" to not place the incident into the wrong narcotics category.

In addition to crime type, incidents were compared across priority level, according to NPD priority codes. As previously mentioned, the NPD upgrades the priority code of all CCTV incidents to expedite the process times of these incidents. For this reason, CCTV incidents may have a built-in "advantage" over similar calls-for-service since they may lead to a quicker police response. Therefore, in addition to crime type, each incident was categorized as being of one of the following priority levels: low-priority, intermediate-priority, or high-priority.[10]

Research Questions and Statistical Approach

[10] The Newark Police Department separates CAD assignment codes (generated by call takers and CCTV operators following the report/detection of an incident) into eight priority levels. Priority levels one, two, and three primarily include motor vehicle violations, previously occurring incidents of property crime (e.g. "theft report"), events necessitating police presence for the purpose of crowd control (e.g. "labor strike"), and low-level disorderly behavior (e.g. "urinating in public"). Incidents with such priority codes collectively encompass the "low-priority" category. Priority levels four and five include in-progress property crime (e.g. "stripping auto in progress"), violent crime (e.g. "robbery"), and more serious incidents of disorder (e.g. "drug activity"), and will be considered "intermediate-priority incidents." The "high-priority incidents" will include CAD levels six and seven, which mostly includes in-progress gun violence (e.g. "shooting in progress," "shots fired") and other incidents that have the potential to result in bodily injury (e.g. "assault in progress" or "burglary in-progress while resident is home.") Priority 8 is the highest priority level and includes severe incidents such as disasters (e.g. "building collapse," or "air crash"), violence towards public officials (e.g. "dignitary attack"), or officer assistance (e.g. "assist officer" or "mutual aid to outside agency."). Such incidents are rare and have little bearing on this study. Activity reports from November 2007 through December 2010 contained only 58 (0.2%) priority 8 incidents, all of which were either "assist officer" or "assist EMS" calls. These incidents were excluded based on the aforementioned "incident type" criteria, which does not compromise the validity of the analysis.

This study specifically analyzed the Newark surveillance unit's detection of criminal events and the subsequent response by patrol units. Four research questions guide the analysis. For each research question, different methodological and statistical approaches were incorporated, which are discussed below.

The first research question is *"Are case process times shorter with CCTV, as compared to calls-for-service?"* To answer this research question, CCTV detections and calls-for-service (CFS) were compared across the following process times: queue time, response time, and total process time (queue time + response time). A common approach to comparing the numeric distribution of two groups is the independent samples t test. However, queue time, response time, and total process time were found to be significantly non-normal in both skewness (skew.) and kurtosis (Kur.) across all crime categories (see Table 3). Since a normal distribution is a key assumption of t tests (Morgan, Leech, Gloeckner, & Barrett, 2007), Mann-Whitney U tests were instead conducted. The Mann-Whitney U test is a nonparametric version of the t test that does not assume normality. The dependent variable is treated as ordinal, with each case (from both the CCTV and CFS) being ordered within a single distribution from lowest value to highest value. The mean rank (rather than the mean value) of each category is reported and subjected to significance testing (Morgan et al., 2007: p. 147-148).

Table 3. Mean, standard deviation, and skew of queue time, response time, and total process time.

CRIME CATEGORY	QUEUE TIME				RESPONSE TIME				TOTAL PROCESS TIME			
	CCTV Mean	CFS Mean	Pr (skew.)	Pr (Kur.)	CCTV Mean	CFS Mean	Pr (skew.)	Pr (Kur.)	CCTV Mean	CFS Mean	Pr (skew.)	Pr (Kur.)
Overall Crime	28.58	31.20	0.00	0.00	9.40	6.84	0.00	0.00	37.99	38.05	0.00	0.00
Violence	8.51	11.24	0.00	0.00	4.30	5.12	0.00	0.00	12.81	16.37	0.00	0.00
Disorder Offenses	37.36	59.40	0.00	0.00	8.80	8.60	0.00	0.00	46.16	68.01	0.00	0.00
Drug Offenses	21.33	61.03	0.00	0.00	14.16	10.97	0.00	0.00	35.49	72.06	0.00	0.00
Other Crime	32.76	41.35	0.00	0.00	6.39	7.58	0.00	0.00	39.15	48.93	0.00	0.00
High Priority Incidents	8.92	3.08	0.00	0.00	11.76	4.78	0.00	0.00	20.68	7.87	0.00	0.00
Intermediate Priority Incidents	34.90	39.11	0.00	0.00	8.50	7.65	2.36	0.00	43.40	46.77	0.00	0.00
Low Priority Incidents	30.65	56.92	0.00	0.00	9.81	8.06	0.00	0.00	40.45	64.98	0.00	0.00

The second research question is *"Does CCTV produce a heightened level of enforcement than calls-for-service?"* The risk of offending is rarely (or never) completely absent. Offenders almost always face the possibility (however small) of being observed and reported to the police. For CCTV to represent a heightened level of "risk," CCTV detections should more often lead to police enforcement actions than calls for service. Fisher's exact tests were conducted to compare the case closure of CCTV incidents and CFS across three categories of enforcement actions: arrests, other enforcement, and any enforcement rate (arrests and "other").

The third research question is *"How often did surveillance activity occur over the study period?"* Case closure of incidents is only one determining factor of punishment certainty. It is also necessary for CCTV activity to occur on a fairly frequent basis for the increased certainty of punishment to be communicated to offenders. If CCTV activity rarely occurs, potential offenders will most likely not perceive CCTV's enhanced ability to deliver punishment. A series of ANOVA models compared the average weekly detections and enforcement actions for the overall study period, as well as across the five camera installation phases. The ANOVA tests

allowed for the assessment of the overall surveillance activity, as well as the linear trend of detections and enforcement actions.

The fourth and final research question is *"What effect did various surveillance barriers have on the linear trend of the surveillance activity?"* A series of negative binomial regression models[11] were conducted in order to identify factors that influenced the weekly occurrence of CCTV detections and enforcement actions. In the first model, the number of weekly detections served as the dependent variable. The number of weekly enforcement actions (arrests or "other") was the dependent variable in the second model. The units of analysis were the 165 weeks (spanning from Sunday through Saturday) from November 2007 through December 2010. The independent variables represented potential "surveillance barriers" operating in Newark: the installation phase of the camera program (an ordinal variable form 1 to 5); the four-week average of the footage requests made to the surveillance unit during the month;[12] a dichotomous variable identifying whether the gun-shot detection system was installed yet (1) or not (0); a dichotomous variable identifying if the week was after the November 2010 layoffs (1) or not (0); and a dichotomous variable identifying if the week was in the year 2010 (1) or not (0). Two additional covariates were included as controls for features of weather that may influence street-level activity and, consequently, the amount of surveillance activity. We would expect higher amounts of street-level activity to occur during warmer weather and when there is no precipitation (e.g.

[11] Chi-square goodness-of-fit tests conducted after exploratory Poisson regression models measured the distribution of the data. The findings revealed that the weekly count of detections and enforcement actions were both distributed as negative binomial processes. For detections: Pearson Chi-Square = 554.31 with d.f. = 157; p= 0.00. For enforcement actions: Pearson Chi-Square = 445.74 with d.f. = 157; p=0.00.

[12] Data on the number of footage requests were only available for monthly periods. In order to incorporate this data with weeks as units of analysis, the four-week average of each monthly count was taken. For example, if 20 footage requests occurred during a calendar month the weekly average was denoted as 5 (20/4=5). In respect to weeks spanning more than 1 month (e.g. a week that begins the last week of January and ends the first week of February) the requests for the two months was summed together and then divided by 8. For example, if 20 requests were received in January and 15 in February, the weekly average for the week spanning January and February would be 4.5 ([20+15]/8=4.5).

rain or snow). Therefore, the average daily high-temperature for each week ("Temperature") and the days with either rain or snow ("Precipitation") were calculated for each week.[13]

Findings

Research Question 1: Are case process times shorter with CCTV?

For research question 1, a series of Mann-Whitney U tests compared the process times of CCTV and CFS across the eight incident categories. Since multiple tests were conducted (e.g. one for each category) a Holm-Bonferroni correction was applied to the obtained *p* values in order to protect against Type I error (Holm, 1979).[14] While common in other disciplines (Belkap, 1992; Olejnik, Li, Supattathum, & Huberty, 1997; Rice, 1989) such procedures are rare in Criminology (see Ratcliffe, Groff & Fingerhut, 2011 for a noteworthy exception).

Table 4 displays the results of the Mann-Whitney U tests for queue minutes and response minutes. For overall incidents, CFS had significantly shorter time intervals than CCTV incidents. When measuring differences across crime types, CCTV incidents displayed significantly shorter queue times for both drug and disorder offenses. In respect to the response time for drug and disorder offenses, CFS displayed significantly shorter time intervals. In respect to priority levels, CFS had significantly shorter queue times for high priority incidents and response times for high

[13] This data was compiled from the Weather Underground website: www.wunderground.com/history

[14] The traditional procedure for controlling for multiple statistical comparisons is the Bonferroni method, where each obtained *p* value is multiplied by the number of tests performed and then compared to the target *p* value (e.g. 0.05) (Belkap, 1992). While this simple application is appealing, the Bonferroni method is considered an overly conservative estimate (Miller, 1981), and has the serious disadvantage of having low statistical power (Rice, 1989). While the Bonferroni method reduces the risk of committing a Type I error, it increases the risk of committing a Type II error (Olejnik et al., 1997). The Holm-Bonferroni method maintains statistical power by establishing different significance levels for rejecting individual hypotheses via the following formula: target *p* value/(n – *i* + 1) where n equals the number of tests conducted and *i* represents the rank number of the test in terms of degree of significance (Holm, 1979). The Holm procedure protects against Type I errors but maintains statistical power by sequentially increasing the criterion of statistical significance" (Olejnik et al., 1997: p. 391).

and intermediate priority incidents. CCTV had significantly shorter queue times for low priority incidents.

Table 4. Mann-Whitney U Test of differences of mean ranks of queue minutes and response minutes.

CATEGORY	QUEUE MINUTES				RESPONSE MINUTES			
	CCTV Mean Rank	9-1-1 Mean Rank	Z	p.	CCTV Mean Rank	9-1-1 Mean Rank	Z	p.
Overall Crime	4702.30	4263.63	-5.76	0.000**	4880.68	4225.73	-9.34	0.000**
Violence	1806.67	1865.25	0.70	0.482	1697.10	1870.66	2.09	0.037
Disorder Offenses	898.18	1057.38	5.70	0.000**	1040.30	992.53	-1.71	0.000**
Drug Offenses	394.92	622.45	11.51	0.000**	573.91	521.69	-2.65	0.008**
Other Crime	624.52	653.20	0.98	0.328	624.98	653.12	0.96	0.339
High Priority Incidents	1605.42	1223.28	-8.61	0.000**	1636.83	1218.95	-9.68	0.000**
Intermediate Priority Incidents	2296.57	2257.24	-1.00	0.318	2441.87	2221.50	-4.80	0.000**
Low Priority Incidents	707.81	831.55	3.76	0.000**	825.81	802.34	-0.14	0.888

***statistically significant after Holm-Bonferroni correction*

The findings regarding queue times were as expected. As previously discussed, NPD policy upgrades the priority level of CCTV incidents. It was thus not surprising to find that drug and disorder offenses observed on CCTV spent less time in the calls pending queue than their CFS counterparts. In fact, we were surprised that the differences between CCTV and CFS in respect to violence and the "other crime" categories did not achieve statistical significance. The findings regarding officer response times, however, were a bit surprising. Patrol officers do not determine which incidents in the "calls pending queue" they respond to. This is determined by the police dispatcher, who instructs patrol officers as to which incidents to address. Therefore, we did not expect the speed of officer responses to vary by reporting method (CCTV or CFS).

Table 5 presents the results of the Mann-Whitney U tests for total process minutes, a summation of the queue and response time intervals. Process times for overall cases were significantly lower in respect to CFS. This was also the case in respect to high-priority and intermediate-priory incidents. CCTV incidents exhibited significantly lower process times in respect to drug offenses, disorder offenses, and low-priority incidents.

Table 5. Mann-Whitney U Test of differences of mean ranks of total process minutes.

CATEGORY	TOTAL PROCESS MINUTES			
	CCTV Mean Rank	9-1-1 Mean Rank	Z	p.
Overall Crime	4864.08	4228.64	-8.46	0.000**
Violence	1756.24	1867.74	1.34	0.181
Disorder Offenses	916.24	1049.14	4.76	0.000**
Drug Offenses	415.35	610.27	9.87	0.000**
Other Crime	628.37	652.54	0.82	0.411
High Priority Incidents	1734.43	1205.52	-12.12	0.000**
Intermediate Priority Incidents	2355.28	2242.17	-2.54	0.020**
Low Priority Incidents	725.26	827.23	3.34	0.001**

***statistically significant after Holm-Bonferroni correction*

The cumulative findings of the series of Mann-Whitney U tests suggests the answer of research question 1 "*Are case process times shorter with CCTV?"* to be "no." Queue, response, and process times for overall incidents were significantly shorter for CFS incidents. While CCTV was associated with lower total process times for low priority and drug offenses and queue times for low priority, drug, and disorder offenses, CCTV did not consistently demonstrate quicker process times than CFS.

Research Question 2: Does CCTV produce a higher level of enforcement than 9-1-1?

Table 6 displays the results of a series of 2 X 2 Fisher's exact tests[15] comparing the arrest rate of CCTV and CFS. The table contains the actual and expected number of arrests, and also presents the numbers as percentages to represent the data as "clearance rates." Similar to the Mann-Whitney U tests, a Holm-Bonferroni correction was applied. Despite not being processed quicker than CFS, CCTV incidents consistently demonstrated higher arrests rates (see Table 6). Differences were statistically significant for all crime categories except violence. Across all the significant categories, CCTV's observed arrest rate was more than twice the expected rate. The highest CCTV arrest rates were observed in respect to drug offenses (20.6%) and high-priority incidents (21.5%). High-priority incidents were especially impacted by CCTV, with an observed arrest rate nearly three times the expected rate (7.7%). For all statistically significant categories, observed arrest rates for CFS were lower than the expected rates.

[15] Fisher's exact tests were performed instead of Chi-Squared since Chi-Squared is most appropriate when cases are relatively evenly split across categories (Morgan et al., 2007). However, Chi-Squared and Fisher's exact tests produced nearly identical results in this study.

Table 6. Fisher's Exact test for arrests

	ARREST				
	CCTV		9-1-1		p.
	Obs. (Exp.)	% Obs. (% Exp.)	Obs. (Exp.)	% Obs. (% Exp.)	
OVERALL CRIME					
Yes	152 (71.7)	11.0% (5.2%)	268 (348.3)	4.0% (5.2%)	0.000**
No	1233 (1313.3)	89.0% (94.8%)	6462 (6381.7)	96.0% (94.8%)	
VIOLENCE					
Yes	14 (9)	8.0% (5.1%)	177 (182)	5.0% (5.1%)	0.080
No	161 (166)	92.0% (94.9%)	3372 (3367)	95.0% (94.9%)	
DISORDER OFFENSES					
Yes	38 (16.9)	6.0% (2.7%)	16 (37.1)	1.2% (2.7%)	0.000**
No	593 (614.1)	94.0% (97.3%)	1367 (1345.9)	98.8% (97.3%)	
DRUG OFFENSES					
Yes	80 (41.1)	20.6% (10.6%)	34 (72.9)	4.9% (10.5%)	0.000**
No	309 (347.9)	79.4% (89.4%)	657 (618.1)	95.1% (89.5%)	
OTHER CRIME					
Yes	20 (8.9)	10.5% (4.7%)	41 (52.1)	3.7% (4.7%)	0.000**
No	170 (181.1)	89.5% (95.3%)	1066 (1054.9)	96.3% (95.3%)	
HIGH-PRIORITY INCIDENTS					
Yes	65 (23.4)	21.5% (7.7%)	119 (160.6)	5.7% (7.7%%)	0.000**
No	238 (279.6)	78.5% (92.3%)	1963 (1921.4)	94.3% (92.3%%)	
INTERMEDIATE-PRIORITY INCIDENTS					
Yes	75 (41.8)	8.6% (4.8%)	130 (163.2)	3.8% (4.8%)	0.000**
No	801 (834.2)	91.4% (95.2%)	3293 (3259.8)	96.2% (95.2%)	
LOW-PRIORITY INCIDENTS					
Yes	12 (4.5)	5.8% (2.2%)	19 (26.5)	1.6% (2.2%)	0.001**
No	194 (201.5)	94.2% (97.8%)	1206 (1198.5)	98.4% (97.8%)	

***statistically significant after Holm-Bonferroni correction*

Table 7 displays the findings for enforcement actions besides arrests. Differences between CCTV and CFS were statistically significant for overall crime, drug offenses, high priority crime, and intermediate priority crime—all in favor of CCTV. Overall CCTV incidents exhibited an observed closure rate of 22.2% compared to an expected rate of 14.5%. In respect to the individual crime categories, intermediate priority incidents had the highest closure rate of 28.4%, followed by drug offenses (23.9%) and high-priority incidents (20.8%).With an observed

closure rate more than four-times the expected rate (5.1%), high-priority incidents were particularly susceptible to CCTV effect.

Table 7. Fisher's Exact test for other enforcement

	OTHER ENFORCEMENT				
	CCTV		9-1-1		p.
	Obs. (Exp.)	% Obs. (% Exp.)	Obs. (Exp.)	% Obs. (% Exp.)	
OVERALL CRIME					
Yes	307 (201.4)	22.2% (14.5%)	873 (978.6)	13.0% (14.5%)	0.000**
No	1078 (1183.6)	77.8% (85.5%)	5857 (5751.4)	87.0% (85.5%)	
VIOLENCE					
Yes	18 (14.7)	10.3% (8.4%)	294 (297.3)	8.3% (8.4%)	0.329
No	157 (160.3)	89.7% (91.6%)	3255 (3251.7)	91.7% (91.6%)	
DISORDER OFFENSES					
Yes	166 (162.9)	26.3% (25.8%)	354 (357.1)	25.6% (25.8%)	0.742
No	465 (468.1)	73.7% (74.2%)	1029 (1025.9)	74.4% (74.2%)	
DRUG OFFENSES					
Yes	93 (72)	23.9% (18.5%)	107 (128)	15.5% (18.5%)	0.001**
No	296 (317)	76.1% (81.5%)	584 (563)	84.5% (81.5%)	
OTHER CRIME					
Yes	30 (21.7)	15.8% (11.4%)	118 (126.3)	10.7% (11.4%)	0.048
No	160 (168.3)	84.2% (88.6%)	989 (980.7)	88.6% (89.3%)	
HIGH-PRIORITY INCIDENTS					
Yes	63 (15.6)	20.8% (5.1%)	60 (107.4)	2.9% (5.2%)	0.000**
No	240 (287.4)	79.2% (94.9%)	2022 (1974.6)	97.1% (94.8%)	
INTERMEDIATE-PRIORITY INCIDENTS					
Yes	193 (138.6)	28.4% (20.4%)	683 (737.4)	18.9% (20.4%)	0.000**
No	487 (541.4)	71.6% (79.6%)	2936 (2881.6)	81.1% (79.6%)	
LOW-PRIORITY INCIDENTS					
Yes	51 (54.3)	24.8% (26.4%)	326 (322.7)	26.6% (26.3%)	0.609
No	155 (151.7)	75.2% (73.6%)	899 (902.3)	73.4% (73.7%)	

***statistically significant after Holm-Bonferroni correction*

Table 8 displays the results of Fisher's exact tests with case closure via any enforcement action (arrest or "other") as the dependent variable. CCTV incidents experienced significantly higher closure rates than CFS for six of the eight crime categories: overall crime, disorder offenses, drug offenses, other crime, high-priority incidents, and intermediate-priority incidents.

Drug offenses and high-priority incidents again displayed much larger than expected clearance rates. The observed rate for high-priority incidents was more than three times the expected rate (42.2% vs. 12.9%) while the observed rate for drug offenses was nearly twice the statistically expected rate (44.5% vs. 29.1%), as identified by the Fisher's Exact test.

Table 8. Fisher's Exact test for overall enforcement

	OVERALL ENFORCEMENT				
	CCTV		9-1-1		p.
	Obs. (Exp.)	% Obs. (% Exp.)	Obs. (Exp.)	% Obs. (% Exp.)	
OVERALL CRIME					
Yes	459 (273.1)	33.1% (19.7%)	1141 (1326.9)	17.0% (19.7%)	0.000**
No	926 (1111.9)	66.9% (80.3%)	5589 (5403.1)	83.0% (80.3%)	
VIOLENCE					
Yes	32 (23.6)	18.3% (13.5%)	471 (479.4)	13.3% (13.5%)	0.069
No	143 (151.4)	81.7% (86.7%)	3078 (3069.6)	86.7% (86.5%)	
DISORDER OFFENSES					
Yes	204 (179.8)	32.3% (28.5%)	370 (394.2)	26.8% (28.5%)	0.011**
No	427 (451.2)	67.7% (71.5%)	1013 (988.8)	73.2% (71.5%)	
DRUG OFFENSES					
Yes	173 (113.1)	44.5% (29.1%)	141 (200.9)	20.4% (29.1%)	0.000**
No	216 (275.9)	55.5% (70.9%)	550 (490.1)	79.6% (70.9%)	
OTHER CRIME					
Yes	50 (30.6)	26.3% (16.1%)	159 (178.4)	14.4% (16.1%)	0.000**
No	140 (159.4)	73.7% (83.9%)	948 (928.6)	85.6% (83.9%)	
HIGH-PRIORITY INCIDENTS					
Yes	128 (39)	42.2% (12.9%)	179 (268)	8.6% (12.9%)	0.000**
No	175 (264)	57.8% (87.1%)	1903 (1814)	91.4% (87.1%)	
INTERMEDIATE-PRIORITY INCIDENTS					
Yes	268 (180.3)	30.6% (20.6%)	617 (704.7)	18.0% (20.6%)	0.000**
No	608 (695.7)	69.4% (79.4%)	2806 (2718.3)	82.0% (79.4%)	
LOW-PRIORITY INCIDENTS					
Yes	63 (58.7)	30.6% (28.5%)	345 (349.3)	28.2% (28.5%)	0.505
No	143 (147.3)	69.4% (71.5%)	880 (875.7)	71.8% (71.5%)	

***statistically significant after Holm-Bonferroni correction*

The results of the Fisher's Exact tests suggest the answer to research question 2, "*Does CCTV produce a higher level of enforcement than 9-1-1?"* to be "yes." Across all enforcement types, most incident categories experienced significantly higher closure rates via CCTV than CFS. CFS did not exhibit higher closure rates than CCTV in a single instance. These findings support the assumption that CCTV leads to a higher certainty of punishment than CFS.

Research Question 3: "How often did surveillance activity occur over the study period?"

Table 9 displays the average levels of weekly surveillance activity for the overall study period as well as the five camera installation phases. Over the 165 week study period, an average of 10.19 detections and 3.41 enforcement actions occurred per week. However, weekly activity was not consistent. The highest levels of activity were evident at the beginning of the CCTV operation, with both detection and enforcement experiencing steady declines afterwards (see Figure 1 and Figure 2). An average of 26.84 CCTV detections occurred per week during camera phase 1. Each subsequent camera phase brought about a reduced amount of detections. Average weekly detections dropped to a low of 2.11 during phase 5, a number more than 92% lower than the phase 1 average. A similar pattern was observed for the enforcement actions. An average of 9.47 enforcement actions occurred per week during phase 1 and decreased during phase 2 (3.00) and phase 3 (2.93). While enforcement increased during phase 4 (3.68), weekly enforcement actions fell to a low of 1.22 during Phase 5. ANOVA tests confirmed that the observed differences for both detections and enforcement were statistically significant (p=0.00).

Research question 3 was *"How often did surveillance activity occur over the study period?"* ANOVA tests suggest that while detections and enforcement occurred frequently during the beginning of the CCTV operation, surveillance activity became somewhat rare.

Table 9. ANOVA results for the average number of weekly detections and enforcement actions across the camera installation phases.

Phase	WEEKLY ACTIVITY		
	Frequency	Mean Detections	Mean Enforcement
TOTAL	165	10.19	3.41
1 (11 Cameras)	19	26.84	9.47
2 (60 Cameras)	20	12.70	3.00
3 (111 Cameras)	71	9.83	2.93
4 (137 Cameras)	19	7.53	3.68
5 (147 Cameras)	36	2.11	1.22
F	-	51.05	17.01
p	-	0.00	0.00

Figure 1. Weekly surveillance detections

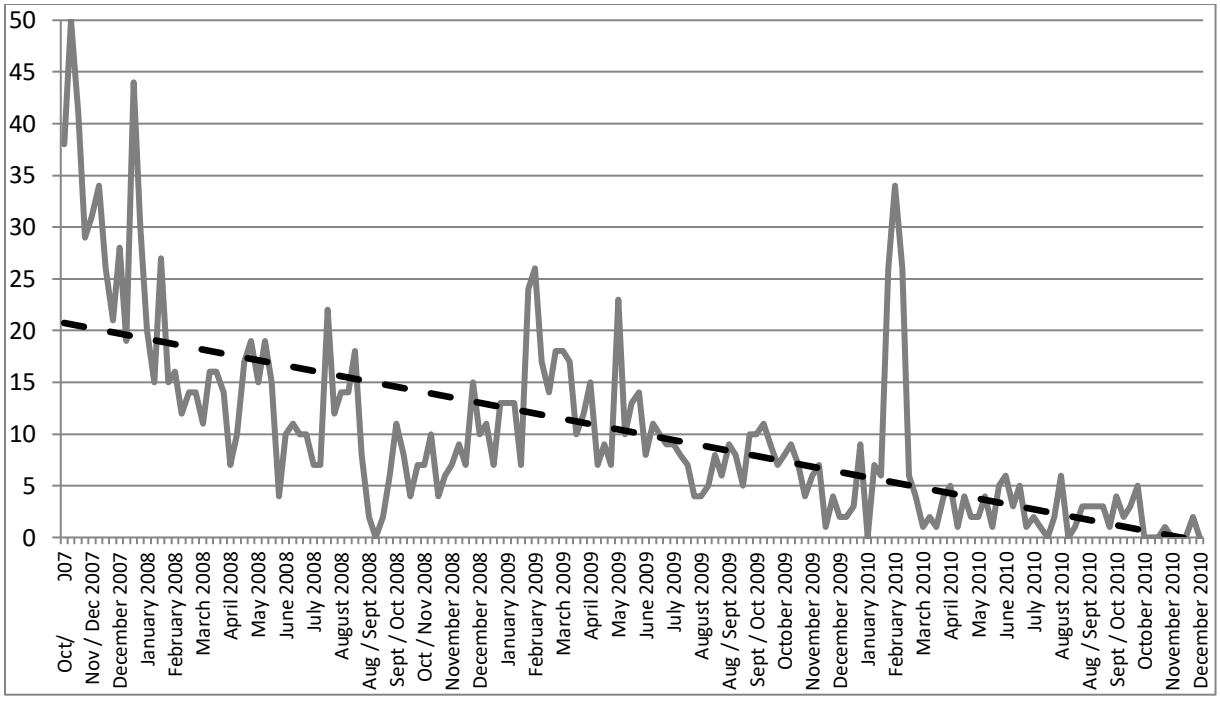
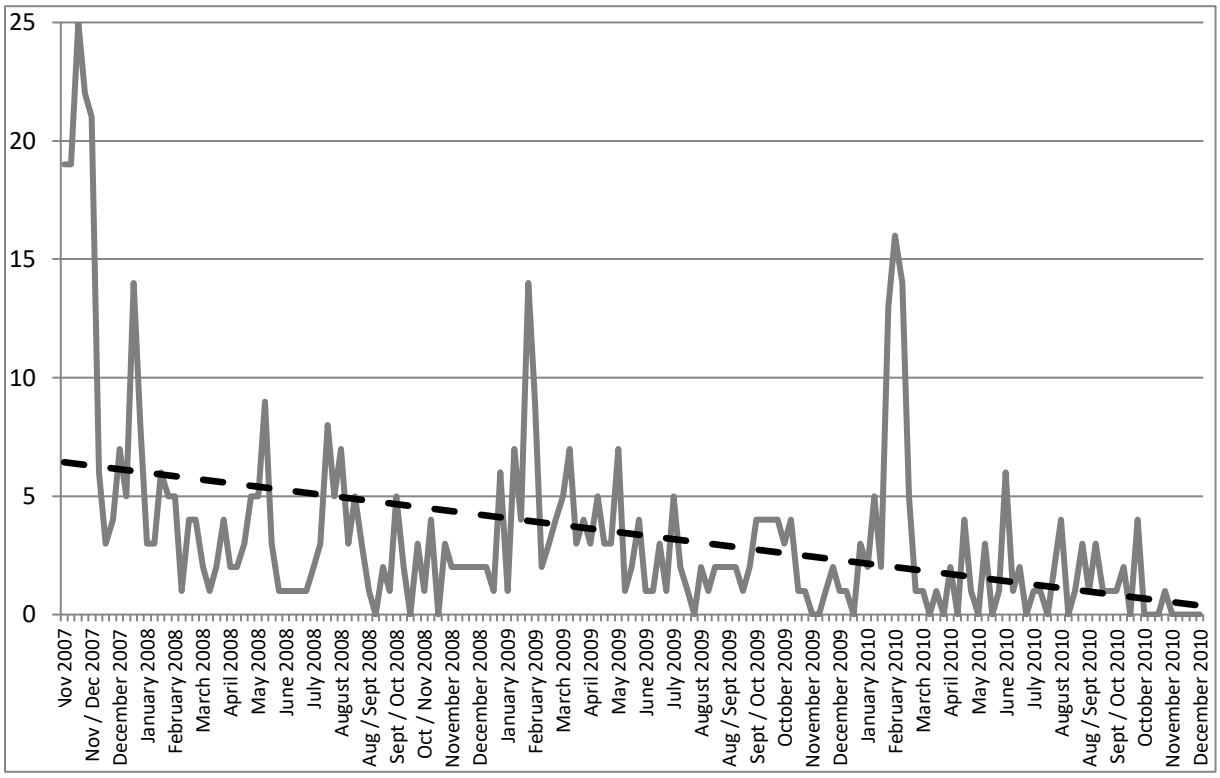


Figure 2. Weekly surveillance enforcement actions



Research Question 4: What effect did various surveillance barriers have on the linear trend of surveillance activity?

Table 10 displays the results of the negative binomial models testing the influence of several covariates on the weekly counts of detections and enforcement actions. The detections model found camera phase, footage requests, after layoffs, after gun-shot detection, and temperature to be statistically significant. "Footage requests" was the only significant variable with a positive β value (0.05). Four of the five variables exhibited negative β values. The coefficient for "camera phase" suggests that with each installation of a new wave of cameras weekly detections reduced by 64% (-0.64). Similarly, the introduction of the gun-shot detection system was associated with a 34% reduction in weekly detections (-0.34) while the period after

layoffs was associated with an over 200% reduction (-2.03). Temperature was statistically significant, but not in the expected direction. The results show that for every 1 degree increase in the temperature, weekly detections decreased by 1% (-0.01). While one may expect more detections to occur in warmer weather (e.g. when more people are outside) previous research has noted that ground-level obstructions such as leaves from trees and bushes (which are more prominent in warmer weather) often impede upon an operator's ability to monitor CCTV areas (Gill et al., 2006; Smith, 2004). Such a situation may have also presented hardships to CCTV operators in Newark. Furthermore, with fewer people outside during winter weather months (when leaves are absent), it may be easier for camera operators to focus on individuals engaged in criminal activity who are no longer "lost" in a sea of many people on the city streets.

Fewer variables achieved statistical significance in the enforcement model. Camera phase, year 2010, and temperature were all statistically significant. Camera phase (-0.63) and temperature (-0.01) were associated with enforcement decreases. The "year 2010" findings were somewhat surprising, with that variable being associated with an 88% increase in the weekly enforcement levels (0.88). The variable was insignificant in the detections models, meaning that year 2010 impacted the result of camera detections (e.g. "enforcement") without impacting the level of detections themselves. Furthermore, year 2010 was conceptualized as the period when the police department was shifting resources in preparation for the impending police layoffs; it was thus unexpected for the "year 2010" and "after layoffs" variables to be correlated with enforcement in opposite directions. Newark Police officials provided a potential explanation for this seemingly counterintuitive observation. A main concern of the Newark Police Department was maintaining adequate levels of officers on the street after the layoffs. Therefore, a number of officers in administrative posts were re-assigned to patrol duties throughout 2010 in order to

prepare them to take over for the street officers who were slated for termination. While this was done in anticipation of the layoffs, the immediate effect was an increased number of officers patrolling the streets of Newark; the "replacements" were on the street along with the officers currently assigned to patrol (who would later be terminated). Newark police officials suggested that this increase in street-level personnel may have enhanced the department's ability to respond to CCTV detections, leading to higher levels of enforcement actions.

Table 10. Negative binomial results for weekly surveillance detections and surveillance enforcement actions.

COVARIATES	DETECTIONS				ENFORCEMENT ACTIONS			
	β	S.E.	95% C.I.		β	S.E.	95% C.I.	
			Lower	Upper			Lower	Upper
Constant	4.44**	0.25	3.95	4.92	3.47**	0.37	2.75	4.19
Camera Phase	-0.64**	0.10	-0.83	-0.44	-0.63**	0.15	-0.91	-0.34
Footage Requests	0.05**	0.02	0.01	0.09	0.04	0.03	-0.02	0.10
After Gun-Shot Detection	-0.34**	0.17	-0.67	-0.02	-0.30	0.26	-0.81	0.22
After Layoffs	-2.00**	0.76	-3.49	-0.52	-20.27	8556.83	-16791.35	16750.81
Year 2010	0.31	0.21	-0.10	0.72	0.88**	0.32	0.26	1.50
Temperature	-0.01**	0.00	-0.02	-0.01	-0.01**	0.00	-0.02	0.00
Precipitation	0.01	0.03	-0.06	0.07	-0.03	0.05	-0.13	0.06

***p<0.01, *p<0.05**

The findings regarding footage requests being associated with higher levels of detections should be taken with a grain of salt. Since a disc of footage was created each time an enforcement action resulted from a CCTV detection, the correlation between footage requests and surveillance activity may be somewhat artificial. While excluding the discs burned for evidentiary purposes would have been beneficial, the data was not disaggregated in such a manner. This limited the model to incorporating the footage request category in its entirety.

In light of the ambiguity of "footage requests," two additional models were run excluding this variable (see table 11). This was done as an additional test of the covariate influence,

particularly by testing which covariates maintained significance absent the footage requests. In both the detections and enforcement models, camera phase, after layoffs, and temperature all maintained statistical significance with similar β values as the previous model. In the updated detections model, after gun-shot detections was no longer statistically significant.

The third research question was "*What effect did various surveillance barriers have on the steady reduction of surveillance activity?"* Results suggest that the expansion of the camera system (e.g. the "camera phase" variable) and the police layoffs significantly contributed to the downward trend in CCTV detections. In respect to enforcement, results suggest that while "year 2010" provided a temporary increase to the weekly number of enforcement actions, the ensuing police layoffs resulted in a significant decrease in the weekly enforcement actions.

Table 11. Negative binomial results for weekly surveillance detections and surveillance enforcement actions, without the footage requests covariate.

COVARIATES	DETECTIONS				ENFORCEMENT ACTIONS			
	β	S.E.	95% C.I.		β	S.E.	95% C.I.	
			Lower	Upper			Lower	Upper
Constant	4.27**	0.24	3.79	4.75	3.36**	0.36	2.66	4.06
Camera Phase	-0.45**	0.07	-0.59	-0.32	-0.49**	0.10	-0.69	-0.29
After Gun-Shot Detection	-0.29	0.17	-0.61	0.04	-0.25	0.26	-0.76	0.26
After Layoffs	-2.18**	0.76	-3.66	-0.69	-21.41	14218.83	-27889.82	27846.99
Year 2010	0.16	0.20	-0.24	0.56	0.77**	0.31	0.17	1.37
Temperature	-0.01**	0.00	-0.02	-0.01	-0.01**	0.00	-0.02	0.00
Precipitation	0.02	0.03	-0.05	0.08	-0.02	0.05	-0.12	0.07

p<0.01, *p<0.05

Discussion of Results

Findings of this study have significant policy implications for CCTV use by law enforcement. Despite having relatively similar process times, CCTV detections led to enforcement actions against suspects much more often that calls-for-service for five of the seven

incident categories included in the analysis. When enforcement is restricted to arrests, violence was the only category to not achieve statistical significance. This may be due to the fact that surveillance cameras may alert police to pertinent factors of street crime not typically captured by calls-for-service or officers on the street. Norris and Armstrong (1999a) discuss such advantages provided by CCTV: "Because the 'presence' of [CCTV] operatives is remote and unobtrusive, there is less likelihood that people will orient their behavior in the knowledge that they are being watched, and, by virtue of the elevated position and telescopic capacity of the camera, operators have a greater range of vision than the street-level police officer" (p. 159). For example, the primary author once heard the following radio-exchange between a Lieutenant of Newark's Narcotics Division (who was monitoring cameras) and undercover officers in the field: "The guys I saw selling on [street name] yesterday are now on [street name #2]. They just served [sold drugs to] a guy in a white Lexus. The kid who made the actual transaction is wearing a turquoise t-shirt. The other 2 dealers are on [street name #3]: [one is wearing a] red shirt, hat and a beard; the other one has a white t-shirt and thinner beard…they keep walking to the back of the building; I think that's where the stash [of drugs] is." As the quote illustrates, CCTV footage provided field officers with insight into a number of factors—such as drug stash location and additional suspects—which may have been difficult for the officers to observe on their own.

Unfortunately, the increased effectiveness of the cameras was negated by the fact that CCTV detections and, by extension, enforcement became rare occurrences as the system expanded. It is hard to argue that offender "risk perceptions" could have been affected in light of such rare enforcement. The "camera phase" and "after layoffs" variables were most associated with lower levels of detections and enforcement. These findings suggest that the Newark Police may have suffered from expanding the CCTV system absent a plan to maintain early levels of

surveillance activity. This may be symptomatic of "technological determinism," a term defined by Norris and Armstrong (1999a) as "an unquestioning belief in the power of technology" (p. 9). As argued by Pease (1999), "Crime reduction has been bedeviled by the tendency to polarize measures into those which will be helpful in all circumstances and those which will not be helpful in any … (CCTV) has sadly fallen into the first category" (p. 48). Such blind faith has led many agencies to deploy CCTV as a "stand-alone" tactic, overlooking important strategic considerations, such as operational focus and manpower (La Vigne et al., 2011).

These findings also dispute the commonly held notion of CCTV as a "force multiplier." A perceived benefit of CCTV cameras is that they provide additional "eyes on the street" that increase police presence. For example, Norris (2003) attributed the following statement to a public official who championed CCTV use against crime. "CCTV is a wonderful technological supplement to the police…One police officer likened the 20-camera system as having 20 officers on duty, 24-hours a day constantly taking notes" (p. 254). Such statements fail to realize that the human component of CCTV is what makes observation possible. While the cameras record footage of the target areas, a human operator is needed to review said footage for investigatory purposes (e.g. "taking notes"), or to discover infractions in real-time.

A seemingly obvious solution would be for police departments to provide maximum staffing for their surveillance units to keep the camera-to-operator ratio as low as possible. Despite the likely benefits this would generate—in respect to increased detections and enforcement—the current fiscal situation of many police agencies likely precludes the possibility of dedicating additional resources to surveillance. A more realistic option may be for police to incorporate CCTV cameras into current proactive operations of their agency. In Baltimore, for example, surveillance operators routinely worked in conjunction with officers from the narcotics

and bicycle patrol units, specifically by monitoring cameras in areas patrolled by these units and directly alerting the officers via two-way radio when an incident was observed (La Vigne et al., 2011). Such a policy can maximize CCTV functionality by avoiding certain surveillance barriers outlined in this paper. Specifically, it enables operators to detect incidents of concern that may have gone unobserved had they been tasked with monitoring all of the system's cameras for the entirety of their shift. Focusing on the cameras in specific target areas essentially lowers the camera to operator ratio, allowing operators to focus their attention on specific criminogenic environments. Such a strategy is consistent with evidence-based policing practices, namely hot spots policing, which have demonstrated that the concentration of police resources amongst a few problematic targets more sufficiently addresses crime than the even distribution of resources across a jurisdiction (Braga & Weisburd, 2010). Furthermore, by having proactive units at their disposal, operators can immediately dispatch officers when they observe a crime incident, which can help increase the certainty of punishment in CCTV areas.

Such policy recommendations directly relate to cities that have already invested in large CCTV systems. However, the findings also suggest that cities should design their CCTV systems in a manner that allows for maximum proactive activity. Police should ensure that they have the capacity to actively monitor cameras and swiftly respond to any incidents observed by the operators, an approach advocated elsewhere (see Ratcliffe, 2006: p. 20). Officials should also be mindful of this fact when deciding to expand their existing systems. While positive effects may be experienced in the initial stages of a CCTV system (e.g. when there are fewer cameras), these effects may not be sustainable as the system expands. This is especially true if additional personnel are not able to be allocated to either the monitoring or response functions of the CCTV operation. While financial and organization commitment are considered necessary factors in the

sustainability of technological approaches to crime prevention (Cameron et al., 2008), this study presented a paradoxical situation where fiscal commitment may have compromised sustainability. By investing in the expansion of the CCTV system, the Newark Police Department created a situation where operators were unable to efficiently monitor the system in its entirety. While CCTV may also provide police investigatory benefits (La Vigne et al., 2011; Ratcliffe, 2006) and reduce fear of crime (Cordner, 2010: p. 51) the explicit goal of police agencies is often the detection and prevention of street-level crime. The expansion of existing systems may require agencies to re-consider their CCTV strategy and mission over time.

Conclusion

While previous studies have predominately focused on the effect of CCTV (e.g. deterrence) this current study focused on relevant process-related factors of surveillance, which likely relate to CCTV's ability to deter crime. However, this study, like most others, has specific limitations that should be mentioned. For one, the control group was limited to calls-for-service occurring within CCTV areas. On the one hand, exclusively including calls-for-service from CCTV areas controls for the environment; since the geography is identical for both the treatment and control group, differences cannot be attributed to the disproportionate influence of criminogenic features (e.g. crime attractors or generators) on either group. However, calls-for-service occurring outside of CCTV areas are completely unrelated to CCTV, and thus may have been a more appropriate comparison and something to consider for future research.

Additional limitations relate to the covariates utilized in the negative binomial regression models. In addition to the previously-discussed issue of our inability to disaggregate the "footage requests" variable, the data did not allow for identification of the precise days that the

surveillance unit was below full strength. The dichotomous “after layoffs” and “year 2010” variables were included as proxy measures for when CCTV operators were most likely to be temporarily assigned to other assignments. The models may have improved had the data included precise dates that less than two operators were on duty. Furthermore, there may have been other potential surveillance barriers not accounted for in our model, such as inadequate training (Gill et al., 2005) and low motivation (Norris & McCahill, 2006) of surveillance personnel. While this would likely be relatively consistent across all data for this study, since CCTV operators in Newark have similar levels of training, it is something to consider in future research.

Despite these limitations, this study makes significant contributions to the literature. The findings confirm that CCTV cameras, on a case-by-case basis, increase the certainty of punishment over, an assumption that has previously been left implicit. The findings also caution against expanding CCTV systems to the point where police are unable to adequately monitor the totality of cameras. While CCTV-reported incidents more often led to enforcement than calls-for-service, their infrequent occurrence likely minimized the effect of the enforcement. In light of these findings, it is prudent for police to carefully consider agency resources, such as personnel levels, before substantially investing in CCTV systems.

References

Apel, R. (in press). Sanctions, perceptions, and crime: Implications for criminal deterrence. *Journal of Quantitative Criminology.* Published online before print: 18 February 2012.

Apospori, E. and Alpert, A. (1993). The role of differential experience with the criminal justice system in changes in perceptions of severity of legal sanctions over time. *Journal of Research in Crime and Delinquency, 39:* 184-194.

Armitage, R., Smythe, G., Pease, K. (1999). Burnley CCTV evaluation. In Tilley, N. and Painter, K. (eds.) *Surveillance of Public Space: CCTV, Street Lighting and Crime Prevention.* Crime Prevention Studies Vol. 10. Criminal Justice Press: Monsey, NY.

Belkap, J. (1992). Empirical estimates of Bonferroni corrections for use in chromosome mapping studies with the BXD recombinant inbred strains. *Behavior Genetics, 22 (6):* 677-684.

Bittner, E. (1990). *Aspects of police work.* Northeastern Press: Boston, MA.

Braga, A. and Weisburd, D. (2010). *Policing problem places: Crime hot spots and effective prevention.* New York, NY: Oxford University Press.

Butler, G. (1994). Shoplifters' views on security: Lessons for crime prevention. In Gill, M. (ed.) *Crime at Work: Studies in Security and Crime Prevention.* London: Perpetuity Press.

Cameron, A., Kolodinski, E., May, H., and Williams, N. (2008). *Measuring the effects of video surveillance on crime in Los Angeles.* Report prepared for the California Research Bureau. USC School of Policy, Planning, and Development.

Caplan, J., Kennedy, L., and Petrossian, G. (2011). Police-monitored cameras in Newark, NJ: A quasi-experimental test of crime deterrence. *Journal of Experimental Criminology, 7(3)*: 255-274.

Clarke, R. (1997). Introduction. In Clarke, R. (ed.) *Situational Crime Prevention, successful case studies, second edition.* Criminal Justice Press: Monsey NY.

Clarke, R. and Cornish, D. (1985). Modeling offenders' decisions: A framework for research and policy. In Tonry, M. and Norris, M. (ends). *Crime and Justice: An Annual Review of Research, Vol. 6.* Chicago: University of Chicago Press

Cook, P. (1980). Research in criminal deterrence: Laying the groundwork for the second decade. In Tonry, M. (ed.) *Crime and Justice: An annual review of research, Vol. 2.* University of Chicago Press: Chicago: 211-268.

Cordner, G. (2010). *Reducing fear of crime: Strategies for police.* U.S. Department of Justice. Office of Community Oriented Policing Services.

Cornish, D. and Clarke, R. (1987). Understanding crime displacement: An application of rational choice theory. *Criminology, 25(4):* 933-947.

Cornish, D. and Clarke, R. (1986). *The reasoning criminal: Rational choice perspectives on offending.* New York: Springer-Verlag.

Cusson, M. (1993). Situational deterrence: Fear during the criminal event. In Clarke, R. (ed.), *Crime Prevention Studies, Vol. 1:* 55-68. Criminal Justice Press: Monsey, NY.

Ditton, J. and Short, E. (1999). Yes it works. No it doesn't: Comparing the effects of open-street CCTV in two adjacent Scottish town centres. In Tilley, N. and Painter, K. (eds.) *Surveillance of Public Space: CCTV, Street Lighting and Crime Prevention. Crime Prevention Studies, 10.* Criminal Justice Press: Monsey, NY.

Ditton, J. and Short, E. (1998). When open street CCTV appears to reduce crime: Does it just get displaced elsewhere? *CCTV Today, 5(2)*: 13-16.

Durlauf, S. and Nagin, D. (2011). Imprisonment and crime: Can both be reduced? *Criminology and Public Policy, 10 (1)*: 13-54.

Eck, J. and Spelman, W. (1987). *Problem solving: Problem-oriented policing in Newport News.* National Institute of Justice.

Farrington, D., Gill, M., Waples, S. and Argomaniz, J. (2007). The effects of closed-circuit television on crime: meta-analysis of an English national quasi-experimental multi-site evaluation. *Journal of Experimental Criminology, 3:* 21-28.

Gill, M., Rose, A., Collins, K., and Hemming, M. (2006). Redeployable CCTV and drug-related crime: A case of implementation failure. *Drugs: education, prevention and policy,* 13(5): 451-460.

Gill, M. and Hemming, M. (2004) *Evaluation of CCTV in the London borough of Lewisham* Perpetuity Research & Consultancy International (PRCI) Leicester, United Kingdom

Gill, M. and Spriggs, A (2005). *Assessing the impact of CCTV.* London: Home Office Research Study No. 292.

Gill, M., Spriggs, A., Allen, J., Hemming, M., Jessiman, P., and Kara, D. (2005). *Control room operation: Findings form control room observations.* London: Home Office

Gill, M., and Loveday, K (2003). What do offenders think about CCTV? *Crime Prevention and Community Safety: An International Journal, 5(3):*17-25.

Gill, M. and Turbin, V. (1998). CCTV and shop theft: Towards a realistic evaluation. In. Norris, C., Moran, J. and Armstrong, G. (eds.) *Surveillance, Closed Circuit Television, and Social Control.* Ashgate

Hawken, A. and Kleiman, M. (2009). *Managing drug-involved probationers with swift and certain sanctions: Evaluating Hawaii's HOPE.* NC 229023. Washington, DC: National Institute of Justice.

Holm, S. (1979). A simple sequentially rejective multiple test procedure. *Scandinavian Journal of Statistics, 6:* 65-70.

King, J., Mulligan, D, and Raphael, S. (2008). *CITRIS Report: The San Francisco community safety camera program. An evaluation of the effectiveness of San Francisco's community safety cameras. Research in the Interest of Society*. Center for Information Technology Research in the Interest of Society, University of California, Berkeley.

La Vigne, N., Lowry, S., Markman, J., Dwyer, A. (2011). *Evaluating the use of public surveillance cameras for crime control and prevention.* US Department of Justice, Office of Community Oriented Policing Services. Urban Institute, Justice Policy Center: Washington, DC.

La Vigne, N., and Lowry, S. (2011). *Evaluation of camera use to prevent crime in commuter parking lots: A randomized controlled trial.* Urban Institute, Justice Policy Center: Washington, DC.

Law Enforcement Information Technology Standards Council [LEITSC]. (2008). *Standard functional specifications for law enforcement computer aided dispatch (CAD) systems.* U.S. Department of Justice, Office of Justice Programs, Bureau of Justice Assistance, and the National Institute of Justice.

Leman-Langlois, S. (2002). The myopic panopticon: The social consequences of policing through the lens. *Policing and Society, 13 (1):* 43-58.

Lomell, H. (2004). Targeting the unwanted: Video surveillance and categorical exclusion in Oslo, Norway. *Surveillance& Society, 2:* p. 346-360.

Miller, R., Jr. (1981). *Simultaneous statistical inference,* McGraw-Hill: New York.

Morgan, G., Leech, N., Gloeckner, G., and Barrett, C. (2007) SPSS for introductory statistics: Use and interpretation. Taylor & Francis: London

Nagin, D. (1998). Criminal deterrence research at the outset of the twenty-first century. In Tonry, M. (ed.) *Crime and Justice: A review of research, Vol. 23.* University of Chicago Press: Chicago. P. 1-42.

Norris, C. (2003). From personal to digital: CCTV, the panopticon, and the technological mediation of suspicion and social control. In Lyon, D. *(ed.) Surveillance as Social Sorting: Privacy, Risk and Digital Discrimination.* Routledge: London and New York.

Norris, C. and Armstrong, G. (1999a). CCTV and the social structuring of surveillance. In Tilley, N. and K. Painter (1999) *Surveillance of Public Space: CCTV, Street Lighting and Crime Prevention.* Crime Prevention Studies Vol. 10. Criminal Justice Press: Monsey, NY.

Norris, C. and Armstrong, G. (1999b). *The maximum surveillance society. The rise of CCTV.* Berg: Oxford.

Norris, C. and McCahill, M. (2006). CCTV: Beyond penal modernism? *British Journal of Criminology, 46*: 97-118.

Olejnik, S., Li, J., Supattathum, S. and Huberty, C. (1997). Multiple testing and statistical power with modified Bonferroni procedures, *Journal of Educations and Behavioral Statistics, 22:* 389-406.

Painter, K. and Tilley, N. (1999). Seeing and being seen to prevent crime. In. Tilley, N. and Painter, K. (eds.) *Surveillance of Public Space: CCTV, Street Lighting and Crime Prevention. Crime Prevention Studies Vol. 10.* Criminal Justice Press: Monsey, NY.

Paternoster, R. (1987). The deterrent effect of the perceived certainty and severity of punishment: A review of the evidence and issues. *Justice Quarterly, 4 (2)*: 173-217.

Paternoster, R. and Piquero, A. (1995). Reconceptualizing deterrence: An empirical rest of personal and vicarious experiences. *Journal of Research in Crime and Delinquency, 32:* 251-286.

Paternoster, R., Saltzman, L., Chiricos, T., and Veldo, G. (1982). Perceived risk and deterrence: Methodological artifacts in perceptual deterrence research. *Journal of Criminal Law and Criminology, 73*: 1238-1258.

Pawson, R. and Tilley, N. (1994). What works in evaluation research? *British Journal of Criminology, 34(3):* 291-306.

Pease, K. (1999). A review of street lighting evaluations: Crime reduction effects. In. Tilley, N. and Painter, K. (eds.) *Surveillance of Public Space: CCTV, Street Lighting and Crime Prevention. Crime Prevention Studies Vol. 10.* Criminal Justice Press: Monsey, NY.

Piquero, A. and Pogarsky, G. (2002). Beyond Stafford and Warr's reconceptualizing of deterrence: Personal and vicarious experiences, impulsivity, and offending behavior. *Journal of Research in Crime and Delinquency, 39:* 153-186.

Piza, E. (2012). *Identifying the ideal context for CCTV camera placement: An analysis of micro-level features.* Doctoral Dissertation submitted to the Graduate School-Newark, Rutgers, The State University of New Jersey.

Piza, E. and O'Hara, B. (in press). Saturation foot-patrol in a high-violence area: A quasi-experimental evaluation. *Justice Quarterly.* Published online before print 12 March 2012.

Pogarsky, G. (2002). Identifying "deterrable" offenders: Implications for research on deterrence. *Justice Quarterly, 19:* 431-452.

Pogarsky, G. and Piquero, A. (2003). Can punishment encourage offending? Investigating the "resetting" effect. *Journal of Research in Crime and Delinquency, 40:* 95-120.

Ratcliffe, J. (2006). *Video Surveillance of Public Places.* Problem-Oriented Guides for Police. Response Guide Series. Guide No. 4. U.S. Department of Justice Office of Community Oriented Policing Services. Center for Problem-Oriented Policing.

Ratcliffe, J., Groff, E., Fingerhut, A. (2011). *The impact of Philadelphia's public CCTV cameras: Preliminary findings from a time series analysis.* Temple University Center for Security and Crime Science: Philadelphia.

Ratcliffe, J., Taniguchi, T., and Taylor, R. (2009). The crime reduction effects of public CCTV cameras: A multi-method spatial approach. *Justice Quarterly, 26 (4)*:746-770.

Rice, W. (1989). Analyzing tables of statistical tests. *Evolution, 43 (1):* 223-225.

Sarno, C., M. Hough, and M. Bulos. (1999). *Developing a picture of cctv in Southwark Towne Centres: Final Report.* London: Criminal Policy Research Unit, South Bank University.

Sherman, L. (1990). Police crackdowns: Initial and residual deterrence. In Tonry, M. and Morris, N. (eds.), *Crime and Justice: A Review of Research, Vol. 12:* 1-48. University of Chicago Press: Chicago.

Smith, G. (2004). Behind the scenes: examining constructions of deviance and informal practices among CCTV control room operators in the UK. *Surveillance & Society,* 2 (2/3): 376-395.

Weisburd, D., Einat, T., and Kowalski, M. (2008). The miracle of the cells: An experimental study of interventions to increase payment of court-ordered financial obligations. *Criminology and Public Policy,* 7: 9-36.

Welsh, B. and Farrington, D. (2007). *Closed-circuit television surveillance and crime prevention: A systematic review.* Stockholm, Sweden: National Council for Crime Prevention.