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Eric L. Piza
CUNY John Jay College

Joel M. Caplan
Rutgers University

Leslie W. Kennedy
Rutgers University

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

Eric L. Piza, Joel M. Caplan and Leslie W. Kennedy

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 component of the deterrence doctrine. This study analyzes CCTV's relation to punishment certainty in Newark, NJ. Across eight crime categories, CCTV and 9-1-1 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

Eric L. Piza is a member of the research faculty at the Rutgers University School of Criminal Justice and the research director for Crime Analytics of the Rutgers Center on Public Security, Newark, NJ, USA. He previously served as the GIS Specialist for the Newark, NJ Police Department, responsible for the day-to-day crime analysis and evaluation efforts of the agency. His recent research articles have appeared, or are forthcoming, in journals including *Crime & Delinquency*, *Justice Quarterly*, and *Journal of Quantitative Criminology*. Joel M. Caplan is an Assistant Professor at the Rutgers University School of Criminal Justice and Associate Director of the Rutgers Center on Public Security. Joel has been pursuing cutting-edge research on crime control, crime forecasting, and police deployments. Recent products of this research have been disseminated at professional conferences; in refereed journals, including *Justice Quarterly*, *Journal of Quantitative Criminology*, *Cityscape*, *Crime and Delinquency*, and *Journal of Experimental Criminology*; and in books edited, respectively, by McGloin, Sullivan and Kennedy (2011; Taylor & Francis), Kennedy and McGarrel (2011; Routledge), Lum and Kennedy (2012; Springer), and Bruinsma and Weisburd (forthcoming; Springer-Verlag). Leslie W. Kennedy is a university professor at the Rutgers University School of Criminal Justice, director of the Rutgers Center on Public Security, and core faculty member in the Division of Global Affair at Rutgers University. His interests relate to different applications of the risk approach to local and global security across different sectors. Recently, he has authored *The Risk in Crime* (with Van Brunschot, Rowman and Littlefield) and *Risk Balance and Security* (with Van Brunschot, Sage) and edited books on crime emergence and evidence based counter-terrorism. In addition, he has published in *Justice Quarterly*, *Journal of Quantitative Criminology*, *Journal of Experimental Criminology*, *Punishment and Society*, *and the American Journal of Public Health*.
Correspondence to: E. Piza, School of Criminal Justice, Rutgers University, 123 Washington St., 5th Fl., Newark, NJ 07102, USA. E-mail: elp@rutgers.edu

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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

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). 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 & Spriggs, 2005; 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, 2012; Piquero & Pogarsky, 2002). 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 & Lowry, 2011; La Vigne et al., 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 (CFS) 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 its (downward) linear trend. 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 CFS. 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. Specifically, the infrequent occurrence of CCTV activity likely prevented the "certainty of punishment" 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, pp. 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 achieved. 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 (Butler, 1994; Ditton & Short 1998; 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 (p. 19), "offenders appear to believe that the notification of an incident [via CCTV] carries no guarantee that the police are able to respond quickly." 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 that 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 (2012, p. 6),

> 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.

Clarke and Cornish (1985) similarly note that 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" (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, police can utilize enforcement actions to strategically 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. For example, 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, 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, respectively.

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 US 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 most documented cases of police-operated CCTV systems reporting that operators are given the primary responsibility of proactively monitoring cameras for the purpose of detecting incidents of concern (Armitage, Smythe, & Pease, 1999; Caplan, Kennedy, & Petrossian, 2011; Ditton & Short, 1999; Farrington et al., 2007; Gill et al., 2005; Keval & Sasse, 2010; Norris & Armstrong, 1999a, 1999b; Norris & McCahill, 2006; Ratcliffe, Taniguchi, & Taylor, 2009; Smith, 2004), the detection of criminal events by CCTV operators is rare (Norris & Armstrong, 1999a, 1999b). Ditton and Short (1999) found that operator activity led to only one arrest per 967 h 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 eight times over a 12-month period. General monitoring activity of surveillance operators (as opposed to enforcement activity) is similarly low. Over 592 h, Norris and Armstrong (1999a) 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" (p. 161); this translates to a rate of 1.5 targeted surveillances per hour of proactive monitoring. Norris and McCahill (2006) found similarly low levels of operator activity, with operator-generated surveillances occurring only once every 4 h across four CCTV systems in Britain (p. 108).

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 20 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). A high camera-to-operator ratio has the predictable result of

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.

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 disk, can impede upon active camera monitoring. King et al. (2008) reported that burning 1 h of footage onto disks took about 2 h in San Francisco, CA. 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 CFS are reported to police (Law Enforcement Information Technology Standards Council [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 "calls 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 CFS. 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, 1999b; 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 CFS? (2) Does CCTV produce a heightened level of enforcement compared to CFS? (3) How often did surveillance activity occur over the study period? and (4) What effect did various surveillance barriers have on the steady reduction of surveillance activity?

Research Setting

The City of 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 (VSU). Two video surveillance operators under the supervision of a police sergeant monitor the cameras during all shifts. As per the departmental order establishing the VSU, 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), the camera-to-operator ratio is 73:1. 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 disks of footage and monitoring the department's gunshot 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. Operators manually identify footage of concern in the CCTV software application, export said footage to the computer hard drive, and then burn the footage on disk. 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 gunshot detection technology, monitoring the system

2. Phase 1: 8 June 2007 (11 cameras installed), Phase 2: 15 March 2008 (49 cameras installed and system size increased to 60), Phase 3: 31 July 2008 (51 cameras installed and system size increased to 111), Phase 4: 10 December 2009 (25 cameras installed and system size increased to 136), and Phase 5: 23 April 2010 (10 cameras installed and system size increased to 146).

may take operators away from their active monitoring functions. When a gunshot detection occurs, operators manually review acoustic recordings of the gunshots to determine their validity (e.g. whether the sound was a gunshot 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 gunshots.

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 were compiled from the Newark Police Department's weekly VSU activity reports, which list all incidents that occurred in CCTV areas of the city (both CCTV detections and 9-1-1 CFS).[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), response time (minutes between dispatch time and arrival time), 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

3. Similar measures were taken in respect to patrol, with officers detailed to specialized footpatrol posts being reassigned to motorized patrol, which have city-mandated minimum levels, in order to avoid overtime expenditures (Piza & O'Hara, 2012).

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 .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.

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.[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 canceled 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 the complaint. For example, while a caller may state that a large fight is occurring 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. 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 CFS. Property crimes only accounted for 16 of the 1,859 CCTV detections, which does not lend itself to reliable statistical analysis. Motor vehicle violations (e.g. illegal parking), on the other hand, were rarely reported to police via CFS.[9] Lastly, all incidents not falling within one of the aforemen-

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.

9. Furthermore, the VSU stopped reporting motor vehicle violations after phase 1 due to concerns that core patrol officers were too often being dispatched to low-level incidents that could be better addressed by traffic control units.

Table 1 Final count of incidents included in the analysis

	CCTV	CFS	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

tioned 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 hindered 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 in which evidence of victimization surfaced an undetermined time after crime occurrence were excluded.[10]

A total of 8,115 incidents remained for inclusion in the analysis: 1,385 CCTV detections and 6,730 CFS (See Table 1). 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 Newark Police Department (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.

10. Due to space constraints, a numerical breakdown of the excluded incident categories is not presented but is available from the primary author upon request.

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 CFS 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.[11]

Research Questions and Statistical Approach

The first research question is "Are case process times shorter with CCTV, as compared to CFS?" To answer this research question, CCTV detections and 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 nonnormal in both skewness and kurtosis across all crime categories.[12] 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).

11. 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 are 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" and "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.

12. Due to space constraints, the results of the normality tests are not presented, but are available from the lead author upon request.

The second research question is "Does CCTV produce a heightened level of enforcement than CFS?" 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 to offenders, 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[13] 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 from 1 to 5); the four-week average of the footage requests made to the surveillance unit during the month;[14] a dichotomous variable identifying whether the gunshot 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

13. χ^2 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 $\chi^2 = 554.31$ with df = 157; $p = 0.00$. For enforcement actions: Pearson $\chi^2 = 445.74$ with df = 157; $p = 0.00$.

14. Data on 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). For 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 would be 4.5 ([20 + 15]/8 = 4.5).

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. 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.[15]

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).[16] While common in other disciplines (Belkap, 1992; Olejnik et al., 1997; Rice, 1989) such procedures are rare in criminology (see Ratcliffe, Groff, & Fingerhut, 2011 for a noteworthy exception).

Table 2 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- and intermediate-priority incidents. CCTV had significantly shorter queue times for low-priority incidents.

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

15. This data were compiled from the Weather Underground website: www.wunderground.com/history

16. 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. .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, Li, Supattathum, & Huberty, 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).

Table 2 Mann-Whitney *U* test of differences of mean ranks of queue minutes and response minutes

	Queue minutes				Response minutes			
	CCTV	CFS			CCTV	CFS		
Category	Mean rank	Mean rank	*Z*	*p*	Mean rank	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.

Table 3 Mann-Whitney *U* test of differences of mean ranks of total process minutes

	Total process minutes			
Category	CCTV Mean rank	CFS 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.

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 3 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.

The cumulative findings of the 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 CFS?

Table 4 displays the results of a series of 2×2 Fisher's exact tests[17] 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

17. 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 4 Fisher's exact tests for arrests

	Arrest				
	CCTV		CFS		
	Obs. (Exp.)	% Obs. (% Exp.)	Obs. (Exp.)	% Obs. (% Exp.)	*p*
Overall crime					
Yes	152 (71.7)	11.0 (5.2)	268 (348.3)	4.0 (5.2)	0.000*
No	1,233 (1313.3)	89.0 (94.8)	6,462 (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)	3,372 (3,367)	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)	1,367 (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)	1,066 (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)	3,293 (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)	1,206 (1198.5)	98.4 (97.8)	

*statistically significant after Holm-Bonferroni correction.

Holm-Bonferroni correction was applied. Despite not being processed quicker than CFS, CCTV incidents consistently demonstrated higher arrests rates. 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.

Table 5 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

Table 5 Fisher's exact tests for other enforcement

	Other enforcement				
	CCTV		CFS		
	Obs. (Exp.)	% Obs. (% Exp.)	Obs. (Exp.)	% Obs. (% Exp.)	*p*
Overall crime					
Yes	307 (201.4)	22.2 (14.5)	873 (978.6)	13.0 (14.5)	0.000*
No	1,078 (1183.6)	77.8 (85.5)	5,857 (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)	3,255 (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)	1,029 (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)	2,936 (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.

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 6 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 6 Fisher's exact tests for overall enforcement

	Overall enforcement				
	CCTV		CFS		
	Obs. (Exp.)	% Obs. (% Exp.)	Obs. (Exp.)	% Obs. (% Exp.)	*p*
Overall crime					
Yes	459 (273.1)	33.1 (19.7)	1,141 (1326.9)	17.0 (19.7)	0.000*
No	926 (1111.9)	66.9 (80.3)	5,589 (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)	3,078 (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)	1,013 (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)	2,806 (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 CFS?" 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 7 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. Figure 1 shows that CCTV detections and enforcement actions both experienced a sharp and steady decline after the initial phases of the program. 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 by less than 1 incident per week during phase 4 (3.68), weekly enforcement actions fell to a low of 1.22 during Phase

Table 7 ANOVA results for the average number of weekly detections and enforcement actions across the camera installation phases

Camera installation phase	Weekly activity		
	Frequency	Mean detections	Mean enforcement
Overall Study Period	165	10.19	3.41
Phase 1 (11 cameras)	19	26.84	9.47
Phase 2 (60 cameras)	20	12.70	3.00
Phase 3 (111 cameras)	71	9.83	2.93
Phase 4 (136 Cameras)	19	7.53	3.68
Phase 5 (146 cameras)	36	2.11	1.22
F	—	51.05	17.01
p	—	0.00	0.00

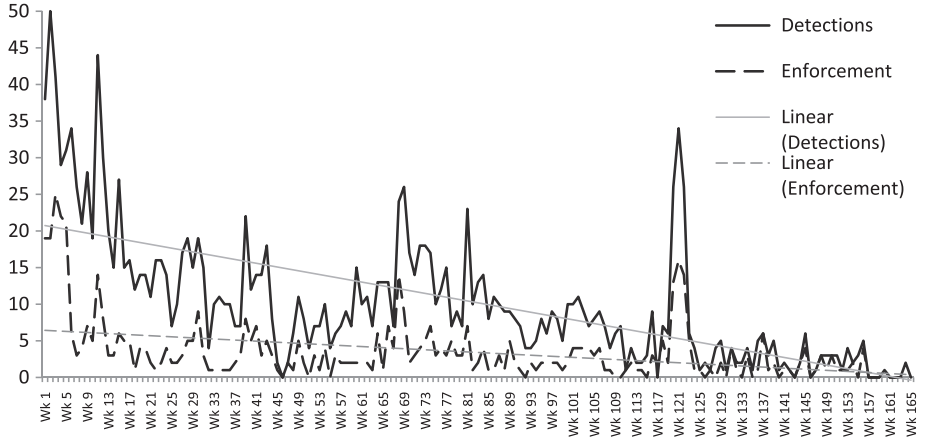

Figure 1 Weekly surveillance detections and enforcement actions.

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.

Research Question 4: What Effect did Various Surveillance Barriers have on the Linear Trend of Surveillance Activity?

Table 8 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 gunshot detection, and temperature to be statistically significant. "Footage requests" was the only significant variable with a positive incidence rate ratio (IRR) (1.05). Four of the five variables exhibited negative IRR values. The IRR for "camera phase" suggests that with each installation of a new wave of cameras weekly detections reduced by approximately 47%. Similarly, the introduction of the gunshot detection system was associated with a 29% reduction in weekly detections while the period after layoffs was associated with an over 86% reduction. 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 approximately 1%. 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

Table 8 Negative binomial results for weekly surveillance detections and surveillance enforcement actions: IRRs

Covariates	Detections				Enforcement actions			
			95% CI				95% CI	
	IRR	SE	Lower	Upper	IRR	SE	Lower	Upper
Camera phase	0.53**	0.52	0.44	0.64	0.53**	0.08	0.40	0.71
Footage requests	1.05**	0.02	1.01	1.09	1.04	0.03	0.98	1.10
After gunshot detection	0.71*	0.12	0.51	0.98	0.74	0.19	0.44	1.24
After layoffs	0.13**	0.10	0.03	0.60	0.00	0.00	0.00	0.00
Year 2010	1.36	0.29	0.904	2.05	2.42**	0.76	1.30	4.48
Temperature	0.99**	0.00	0.98	0.99	0.99**	0.04	0.98	0.10
Precipitation	1.01	0.03	0.95	1.07	0.97	0.05	0.88	1.07

*$p<0.05$; **$p<0.01$.

CCTV areas (Gill, Rose, Collins, & Hemming, 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 (IRR = 0.53) and temperature (IRR = 0.98) were associated with enforcement decreases. The "year 2010" findings were somewhat surprising, with that variable being associated with a doubling of weekly enforcement levels. 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 reassigned 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.

The findings regarding footage requests being associated with higher levels of detections should be taken with a grain of salt. Since a disk 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 disks burned for evidentiary purposes would have been beneficial, the data were 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 9). 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 IRR values as the previous model. In the updated detections model, after gunshot detections was no longer statistically significant.

Table 9 Negative binomial results for weekly surveillance detections and surveillance enforcement actions, without the footage requests covariate: IRRs

	Detections				Enforcement actions			
			95% CI				95% CI	
Covariates	IRR	SE	Lower	Upper	IRR	SE	Lower	Upper
Camera phase	0.64**	0.44	0.55	0.73	0.61**	0.06	0.50	0.75
After gunshot detection	0.75	0.12	0.54	1.04	0.78	0.20	0.47	1.30
After layoffs	0.11**	0.09	0.03	0.50	0.00	0.00	0.00	0.00
Year 2010	1.18	0.24	0.79	1.75	2.16*	0.66	1.19	3.93
Temperature	0.99**	0.00	0.98	0.99	0.99**	0.00	0.98	0.10
Precipitation	1.02	0.03	0.95	1.08	0.98	0.05	0.89	1.08

*$p<0.05$; **$p<0.01$

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.

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 CFS 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 CFS 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-h 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. Therefore, increased resources towards "human aspects" of surveillance may be necessary to ensure maximum efficiency of CCTV. Unfortunately, little consideration has typically been given to the human factors of CCTV, with aspects such as the camera-to-operator ratio, lack of criminal intelligence afforded to operators, and methods of communi-

cation between operators and field officers being overlooked by practitioners (Keval & Sasse, 2010).

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 enabling 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 strategies are consistent with evidence-based practices, such as 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 space (Braga, Papachristos, & Hureau, 2012). Furthermore, by having proactive units at their disposal, operators can immediately dispatch officers when they observe a crime, which can help increase the perceived certainty of punishment.

The introduction of technologies like gunshot-flash recognition and video analytics are increasingly becoming integrated with CCTV in an attempt to "ensure a more efficient and effective crime-fighting tool" (La Vigne et al., 2011, p. 23). Since operators cannot simultaneously monitor all cameras in a system, such technology may better focus operator attention by identifying precisely when an operator should monitor a specific camera. However, the issue of cost effectiveness should be considered before implementing such technologies. For example, research has shown that the cost-saving benefits of CCTV (in respect to crime occurrence and merchandise shrinkage) is slim, with certain studies suggesting that CCTV needs to be in place upwards of a decade before recouping the capital cost (Beck & Willis, 1999; Sasse, 2010). Since complimentary technology adds additional expenses to CCTV systems, practitioners should consider whether funds may be better allocated towards on-the-ground police tactics with established records of success (e.g. Braga et al., 2012; Braga & Weisburd, 2012; Weisburd, Telep, Hinkle, & Eck, 2010), in lieu of such technology. Furthermore, there is no guarantee that such technology will indeed increase CCTV effectiveness, as illustrated in the current study. Findings of the initial negative binomial regression models (see Table 8) suggest that the introduction of the gunshot detection system led to a *decreased*

level of CCTV detections, and while the variable lost statistical significance in the updated model (see Table 9), it was not associated with increased CCTV activity in any of the models.

Findings of this study 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 commitments 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. 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 research has predominately measured 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 CFS occurring within CCTV areas. On the one hand, exclusively including CFS 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, CFS 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 CFS, 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 CFS, 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.

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