Document Title:	**Optimizing Video Surveillance in Correctional Settings**
Author(s):	**Bryce E. Peterson, Rochisha Shukla, Daniel S. Lawrence, and Lily Robin**
Document Number:	**308634**
Date Received:	**February 2024**
Award Number:	**2015-R2-CX-K001**

Optimizing Video Surveillance in Correctional Settings

NIJ Grant Number: 2015-R2-CX-K001

Final Summary Overview

Bryce E. Peterson, Rochisha Shukla, Daniel S. Lawrence, Lily Robin

Inquiries should be directed to:
bpeterson@urban.org
(202) 261-5809
Bryce Peterson c/o Urban Institute
500 L'Enfant Plaza SW, Washington DC 20024

This project was supported by Award No. 2015-R2-CX-K001, awarded by the National Institute of Justice, Office of Justice Programs, U.S. Department of Justice. The opinions, findings, and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect those of the Department of Justice, or of the Urban Institute, its trustees, or its funders.

Abstract

This publication represents a technical summary report of the Urban Institute's evaluation of efforts with the Minnesota Department of Corrections (MnDOC) to improve the surveillance system in two state prisons: Stillwater Correctional Facility (STW) and Moose Lake Correctional Facility (ML). The goal of this study was to conduct a rigorous process and impact evaluation of the steps STW and ML took to optimize their surveillance systems, which included repositioning existing cameras, installing new cameras, and making other infrastructural upgrades. In addition, ML integrated an audio analytic technology in their system that would alert on-unit security staff through a visual and audio alert when it detected sounds associated with anger, fear, or verbal aggression.

The evaluation used a mixed-methods research design. Qualitative collection included stakeholder interviews and in-depth observations of the camera operations at ML and STW before, during, and after the upgrades. We interviewed wardens, supervisors and officers working in the intervention units, and numerous other individuals who oversaw operations, investigations, information technology, and camera installation and configuration in ML and STW. We also collected quantitative administrative data from ML and comparison facilities and employed comparative interrupted time-series (CITS) analyses to examine changes in two outcomes following the intervention: (1) total misconduct incidents and (2) guilty dispositions. To support the CITS, we identified another unit in ML that did not upgrade its surveillance system but was similar to the intervention housing unit in terms of population, architecture, and misconduct levels (internal comparison unit), and used the synthetic control method to create another comparison unit derived from the three other medium-security prisons operated by MnDOC (external comparison unit).

Findings from the CITS yielded limited evidence that the intervention reduced misconducts. However, we did find that the installation of cameras in new locations to reduce blind spots increased the number of guilty dispositions. These upgrades seem to support misconduct investigations by helping staff identify people who committed or witnessed these incidents. We also found challenges with the integration and use of the audio analytic technology in ML; all the alerts during the study period were either nuisance alerts (those triggered by people talking loudly to each other or other non-aggressive sounds) or false alerts (those without an obvious or perceptible audio trigger), with none of the alerts being triggered by fights or aggressive behavior as intended.

Table of Contents

Abstract i
Table of Contents ii
Acronyms ii
Introduction and Purpose 3
Study Sites 3
- Intervention Design and Planning 4
- Upgrades to surveillance system 5

Methods and Data 7
Findings 9
- Impact of Upgrades on Misconducts and Guilty Dispositions 9
- Challenges with Audio Analytics and Other Upgrades 10

Implications for Criminal Justice Policy and Practice 11
- Guidebook on Optimizing Public Surveillance Systems 12

Notes 13
Appendix A – CITS Modeling 14
Appendix B – CITS Tables and Figures 16
- Group Balance 16
- CITS Results 16

Acronyms

MnDOC	Minnesota Department of Corrections
STW	Stillwater Correctional Facility
ML	Moose Lake Correctional Facility
NIJ	National Institute of Justice
PTZ	Pan, Tilt, Zoom
Urban	Urban Institute
AA	Audio Analytics

Introduction and Purpose

In 2015, the National Institute of Justice (NIJ) funded the Urban Institute (Urban) to work with the Minnesota Department of Corrections (MnDOC) to develop and execute a rigorous plan to optimize the surveillance system in two state prisons: Stillwater Correctional Facility (STW) and Moose Lake Correctional Facility (ML). This included replacing existing cameras with better quality cameras, installing cameras in new locations to minimize blind spots, integrating audio analytics, and implementing other technological and infrastructural upgrades. Urban conducted a rigorous process and impact evaluation of the facilities' efforts using a mixed-methods research design to assess the impact of the interventions.

The purpose of this study was to: **(1) identify technical and operational weaknesses/gaps in the surveillance systems of two MnDOC prisons: STW and ML; (2) develop an enhanced surveillance intervention to help MnDOC overcome some of these weaknesses/gaps; (3) implement the enhanced surveillance intervention, documenting the challenges and successes the project team encountered during the process; and (4) evaluate the impact of the enhanced surveillance intervention on correctional misconduct and perceptions of safety within the prisons**. This summary provides an overview of the interventions, data, methodologies of and results from the process and impact evaluations, and implications for criminal justice policy and practice in the United States.

Study Sites

The MnDOC oversees ten state prisons, from which Urban and the MnDOC chose two in which to upgrade and optimize existing surveillance systems: Stillwater Correctional Facility (STW) and Moose Lake Correctional Facility (ML). STW is the state's largest close-security prison for adult males. Built in 1910, it has seven cell bock-style housing units within the main perimeter holding nearly 1,600 people, and a minimum-security housing unit outside the perimeter with approximately 100 people. Prior to their participation in the study, STW had a little more than 700 cameras installed throughout their facility that were nearly a decade old. ML differed from STW in many key aspects. ML was previously the Moose Lake Regional Treatment Center before it was converted to a medium-security prison for adult males in 1988. With a population of over 1,000, ML has nine dormitory style housing units and offers a variety of programming and treatment services. Like STW, ML's surveillance system relied on approximately 600 outdated cameras when we began the study. Further, because of its architectural history as a treatment center, ML's housing units and common areas had numerous blind spots that affected camera coverage.

Within both STW and ML, the Urban team worked closely with MnDOC to select a single housing unit that would receive surveillance system upgrades. This selection process involved an analysis of misconduct data by housing unit, conversations with leadership and key staff from each facility, and a walk-through and physical inspection of the facilities' housing units. Urban and MnDOC then selected the housing units that would benefit most from the upgraded surveillance intervention. In STW, the intervention housing unit had the highest rates of misconduct in the facility, as well as gaps in the existing surveillance system that, if addressed, would improve both camera coverage and the clarity of video feeds. In ML, we likewise selected the housing unit with the highest rate of infractions and obvious needs for surveillance system upgrades.

Intervention Design and Planning

Once we selected housing units in STW and ML, Urban and MnDOC worked together to design the site-specific interventions and plan for their implementation. This involved the following activities:

- **Inspect existing surveillance system**: Urban worked with the administrators, information technology specialists, electronic system specialists, and security staff from both STW and ML to determine what surveillance system upgrades would be most beneficial in the two intervention housing units. STW and ML personnel conducted physical inspections of the placement and location of all cameras in the housing units, as well as a visual assessment of the cameras' field of view from monitors in the viewing stations; created maps of the most important blinds spots and areas where camera clarity or coverage should be improved; and assessed the infrastructure supporting the units' surveillance systems, including available bandwidth and server capacity, as well as the software and hardware used in the staff viewing stations.

- **Conduct staff interviews**: Urban interviewed MnDOC leadership and key staff in ML and STW to inform the development of the site-specific interventions. Urban asked security staff from each unit where misconduct occurred in the units, whether these incidents were captured on camera, and the degree to which staff relied on video footage to detect or investigate incidents. Urban also asked unit staff, as well as staff who monitored camera feeds from the facilities' central control rooms, to describe any issues they had observed with the camera system or viewing stations.

- **Survey people in housing units:** Urban surveyed the residents of the intervention housing units to determine overall perceptions of safety and identify specific areas within the unit where assaults and other serious incidents where most likely to occur (e.g., cells, recreation rooms, day rooms/common areas, bathrooms and showers, closets, stairwells, etc.). To accomplish this, Urban offered surveys to all residents from both intervention housing units in small group settings (6-27 individuals per group) in a chapel (STW) and classroom (ML). Nearly half the residents were able and agreed to participate in the survey (47 percent overall response rate). The surveys yielded valuable information that both supported and added to what staff already knew about safety and security issues in the housing units.

Upgrades to surveillance system

Based on the activities describes above, Urban and MnDOC developed site-specific implementation plans that detailed recommendations for improving and optimizing the surveillance systems in STW and ML. Recommendations included (1) the installation of new high-definition Internet Protocol (IP) cameras, (2) infrastructural upgrades, and (3) the integration of audio analytic technology in ML.

Installation of New Cameras: Based on the assessment of the existing cameras' placement and field of view, both STW and ML determined that the most urgent need for improving their surveillance system would be replacing their outdated analog cameras with newer IP cameras and installing new cameras in additional locations to minimize blind spots. Being nearly a decade old, the feeds from the existing analog cameras in ML and STW had poor image quality. Often, staff could not even identify people from camera footage. The cameras also performed terribly in low-light settings, which hampered their ability to support the detection or investigation of critical incidents.

To that end, STW personnel purchased and installed 38 IP cameras in their intervention housing unit, replacing 32 existing analog cameras and installing and additional 6 in new locations. These upgrades occurred June through July 2018. The upgrades in ML's intervention housing unit occurred over two phases. First, they upgraded their existing 33 analog cameras to new IP cameras (September 2017). Second, they installed 22 new IP cameras in strategically placed locations, including dorm rooms, restrooms and showers (with a "black out" function to address PREA regulations), hallways, entry points, and the adjacent outside courtyard (May 2018). The upgrades across both facilities substantially improved camera coverage, minimized blind spots, and increased the clarity and image quality of camera views. This allowed staff to make better use of the cameras' live view and archived footage, enhancing investigations of misconduct and improving accurate identification of individuals involved.

Infrastructural Upgrades: To support and enhance the efficacy of the new cameras, STW and ML also upgraded their surveillance infrastructure. MnDOC re-wired both units to support the replacement of analog cameras with IP cameras. Both facilities also upgraded their viewing stations. In STW, the project supported the creation of a live viewing station in the unit's "secure bubble", the secure area inside the unit where staff could monitor incarcerated individuals in their cells, tiers, and exercise areas. Prior to the project, there was only a single-feed analog Pan, Tilt, Zoom (PTZ) camera that staff could use. All other camera feeds from the intervention unit were only viewed by staff in the central control room who were responsible for monitoring cameras across the whole facility. STW therefore installed a live viewing station within the secure bubble, which included two 24" high definition monitors that made it possible for the in-unit security staff to monitor live feeds from the unit's 38 new IP cameras. ML already had in-unit viewing stations in their housing units, but the project supported significant upgrades to accompany the other upgrades. For instance, ML replaced their single feed analog monitors with four high definition 32-inch TV monitors, making it easier for staff to view feeds from the unit's 55 new IP cameras. Both STW and ML worked with Urban to determine ideal positioning of monitors and identify efficient monitor layouts and view patterns to pre-load into the unit's system.

Accompanying the new viewing stations, both facilities upgraded the software they used to manage their surveillance system (from Genetec's *Omnicast* platform to *Security Center*). This upgrade, in conjunction with the installation of IP cameras and new viewing stations, made it easier for staff to view and organize camera feeds through the use of tile/grid layouts with pre-loaded video groupings (e.g. bathrooms/showers, day rooms, etc.). In ML, this upgrade was also critical for successfully integrating the audio analytic technology described below. Finally, because the new IP cameras required greater bandwidth to operate, both ML and STW upgraded their servers to maximize the efficiency of their surveillance systems.

Integration of Audio Analytic Technology: The intervention in ML further involved the installation and integration of audio analytic "aggression detection" technology. ML placed microphones in bathrooms and showers, which were identified through staff interviews and resident surveys as areas with high amounts of violent misconducts and limited video surveillance due to PREA regulations. ML personnel then integrated these microphones, the audio analytic software, and the unit's surveillance system so that security staff in the viewing station would receive an alert when the system detected sounds in the bathroom or shower associated with anger, fear, or verbal aggression (e.g., shouting or crashing noises). Once an alert was triggered, staff could view camera feeds from inside or outside the area, investigate the cause of the alert, and deploy officers to respond, as needed.

Methods and Data

The research team worked closely with the MnDOC to collect data associated with the surveillance system and upgrades. **Qualitative data** collection included stakeholder interviews and in-depth observations of the camera operations at ML and STW before, during, and after the upgrades. We interviewed wardens, supervisors and officers working in the intervention units, and numerous other individuals who oversaw operations, investigations, information technology, and camera installation and configuration in ML and STW. We then hand-coded and analyzed these data to identify high-level themes around whether the intervention was implemented as planned, issues that arose during the implementation and ongoing calibration of the system upgrades, and staff perceptions of success, challenges, and lessons learned from the project. We also received logs from ML on the audio analytic alerts integrated into their surveillance system. We descriptively analyzed these data to better understand the volume and types of alerts staff received.

Within a month of implementing the camera upgrades in STW, the facility experienced a very serious critical incident that resulted in a multi-month lock down, staff turnover, and changes to policy. This had two important implications for our project. First, the Urban research team did not communicate with staff in the facility for nearly a year while they dealt with the aftermath of the critical incident. Second, the resulting facility-wide lockdowns significantly impacted levels of misconduct (i.e., there were fewer misconducts in STW in the months following the incident). Although we explored ways to adjust for this in our analytic models, we ultimately determined it would be impossible to accurately determine whether the surveillance system upgrades contributed to the reductions in misconduct. We therefore opted to drop STW from our analyses of institutional safety and officer investigations and instead focused on ML.

We collected **quantitative data** from ML and its comparison facilities on misconducts and dispositions. We employed multiple intervention comparative interrupted time-series (CITS) analyses to observe how the count of 1) total misconduct incidents and 2) incidents resulting in guilty dispositions changed in the ML intervention unit after both phases of camera upgrades compared to an internal and an external comparison unit. As described above, improvements to the ML system were implemented in two phases. First, in September 2017, ML staff upgraded officer viewing stations and replaced the intervention unit's existing 33 analog cameras with new IP cameras. The second phase occurred in May 2018 and involved upgrading servers and installing 22 new cameras in strategic locations to reduce blind spots.

The CITS used 60 months of count data, from January 2015 to December 2019. This provided a pre-intervention time period of 32 months, followed by 8 months of post-intervention data after the first phase of ML's upgrades (September 2017) and 20 months after their second phase (May 2018). The CITS analyses allowed us to examine changes in relevant outcomes in the month immediately following the intervention, as well as the changes in post-intervention trends compared to pre-intervention trends.[1] Further, the analyses of guilty dispositions also controlled for the total number of misconduct incidents. Appendix A offers more information on our CITS models.

Changes in the ML intervention unit were compared to two equally matched units. First, we identified another unit in ML that did not upgrade their surveillance system but was similar to the intervention housing unit in terms of its population and misconduct levels. Importantly, this unit was an architectural mirror image of the intervention unit, allowing us to control for important physical features (i.e., the layout of the hallways, cells, dayrooms, bathrooms, showers, recreation areas, stairwells, and staff viewing stations). This internal comparison unit also had a similar number of and placement for their surveillance cameras. Second, we employed the synthetic control method to create an external comparison unit derived from the housing units in the two other medium-security prisons operated by MnDOC (Faribault and Lino Lakes). We created separate synthetic control models for the primary outcomes (i.e., the count of monthly misconduct infractions and the count of monthly guilty dispositions). The synthetic unit for the misconduct outcome included 4 housing units from Faribault and 3 from Lino Lakes, while the synthetic unit for guilty dispositions included 4 units from Faribault and 2 from Lino Lakes. Data from these units were combined and weighted appropriately to produce a unit with a similar population size and trend of the outcomes as the treatment unit during the pre-intervention period. As depicted in Table B1 in Appendix B, we found that the treatment unit and two comparison units were well balanced during the pre-intervention time period.

Findings

Impact of Upgrades on Misconducts and Guilty Dispositions

Appendix B presents the tables and figures associated with the CITS analyses on the misconduct and guilty disposition outcomes. We created four total models, two of which compared the intervention unit to the internal comparison unit (model 1) and to the external, synthetic comparison unit (model 2) on the number of misconduct incidents, while the other two compared the intervention unit to the internal comparison unit (model 3) and to the external comparison unit (model 4) on the number of incidents with guilty dispositions. There are four noteworthy findings from these models. First, across all four models, we found good balance during the pre-intervention period between the intervention and comparison units. The only exception was a significant difference in the starting value of guilty dispositions between the intervention unit and the external comparison unit (model 4). This suggests that we identified appropriate comparison units and increases the confidence in our findings. This is particularly noteworthy as we employed a novel application of the synthetic control method to create the external comparison group.[2]

Second, we found only limited evidence that the upgraded surveillance system had an impact on misconducts. We observed a significant reduction in the intervention unit's misconduct incidents in the month immediately following the second intervention period, but this finding was limited to model 2 (the model comparing the intervention unit to the external comparison unit) and there were no differences in model 1 or model 2 in the slopes of misconduct incidents. Likewise, there were no differences between the intervention and comparison units during the first intervention period.

Third, the intervention did have a significant impact on whether misconduct incidents resulted in a guilty disposition. We found a *decrease* in the slope of guilty dispositions during the first intervention period (model 4), but an *increase* in guilty dispositions in the month immediately following the second intervention period (model 4) and increased trends of guilty dispositions over the second intervention period (models 3 and 4). These findings suggest that the upgraded surveillance system may have improved misconduct investigations. That is, while the cameras did not deter or prevent new misconduct incidents from occurring, the footage from cameras may have helped staff identify people who committed or witnessed these incidents or generated other valuable evidence that increased how many resulted in guilty dispositions.

Finally, we found that the upgrades from the second phase of the intervention (installation of new cameras) resulted in more significant changes than those from the first phase (replacing older analog cameras with new IP cameras). Aside from one coefficient in Model 4, all other significant changes occurred during the second intervention period. Thus, the results of the CITS models indicate that installing new cameras in areas with high amounts of misconduct to minimize blind spots, rather than merely replacing older cameras with new ones, can be more effective at improving safety and securing guilty dispositions.

Challenges with Audio Analytics and Other Upgrades

Through our interviews with staff, we learned that staff in ML faced some challenges integrating audio analytics with their surveillance system. There were some problems with the calibration settings, which led some alarms being triggered by common sounds like individuals sneezing or the public announcement system. Even after adjusting the audio analytic technology's settings, an analysis of the alerts log data from late February 2019 through July 2019 found that over 97% of the 184 alerts were categorized as nuisance alerts (alerts triggered by people talking loudly to each other or other non-aggressive sounds), while the rest were categorized as false alerts (alerts without an obvious or perceptible audio trigger). None of alerts during this period were caused by fights or other aggressive behavior. Another issue was with how alerts were delivered to staff. Alerts were automatically displayed over a monitor in the staff viewing station, which obscured the camera feeds previously displayed on that monitor. Officers noted that this interfered with real-time response because they could not easily track individuals who may be involved in the incident across camera feeds until they responded to the alert.

Further, while staff in ML and STW perceived the surveillance upgrades to be beneficial overall, they reported that the application of the technologies was problematic. For instance, staff did not have access to archived footage, rendering them unable to retroactively investigate an incident without reaching out to a supervisor or watch commander who had permission to review stored footage. This often led to delayed responses to incidents. Additionally, staff reported that they were not offered many formal trainings on how to use the upgraded technology and mostly learned the features on the job. While they were able to use the basic functions, they were unaware of some of the more complex capabilities that the system offered.

Finally, confirming what we found in the CITS analyses, staff reported that the upgrades did not reduce overall misconducts in the intervention units. Staff noted that while some of the areas with historically high rates of violence saw a decrease in misconduct incidents, incarcerated individuals were able to identify new areas outside of camera coverage in which to engage in delinquent behavior. For example, staff in ML reported that fights moved out of the bathrooms and showers after implementation of the interventions and into janitorial closets. Relatedly, while most blind spots were addressed by the upgrades, some remained in dorm rooms and cells due to the arrangement of furniture. Staff reported that residents were aware of these issues and continued to engage in misbehavior in areas outside of the cameras' view. These challenges and lessons learned are described in more detail in a brief published by the Urban team under this project.[3]

Implications for Criminal Justice Policy and Practice

This study has yielded several important lessons for improving criminal justice policy and practices. First, upgrading and optimizing an existing surveillance system can help improve investigations. As the CITS analyses showed, some of the surveillance system upgrades were associated with an increase in the number of misconducts with a guilty disposition. During our interviews, staff also indicated that the intervention resulted in better system performance and improved clarity in recordings, making it easier for them to investigate misconduct incidents and identify individuals who may be involved.

Second, identifying strategic locations for cameras can be more beneficial than simply upgrading existing cameras for newer or better cameras. In our analysis of misconducts and guilty dispositions in ML, we found the second phase of the intervention (installation of cameras in new locations) was more effective than the first phase (replacing cameras in existing locations). Thus, departments might get more return on their investment if they first focus on reducing blind spots, rather than making more comprehensive upgrades to their surveillance systems.

Third, these types of upgrades require the support and collaboration of many individuals within a department: IT, electronic systems specialists, physical plant managers, investigative staff, and wardens/administration. It is also critical to have unit staff, as users of the system and as security experts on the unit, to weigh in on the placement of cameras and other systems upgrades. If possible, getting the input of incarcerated individuals about which areas in the facility are most unsafe can also be beneficial. Further, departments must have a close and collaborative relationship with the vendor(s) they select for the upgrades so that they can continuously work with them to identify and address issues. Vendors are also a good source for trainings on how best to use the technologies.

Finally, it is crucial to test new technologies before they are rolled out and integrated into a system. We had initially believed that the audio analytic aggression detection technology installed in ML would be a helpful tool for combatting violence in the intervention unit's bathrooms and showers. However, we did not find any conclusive evidence that this technology was effective, and staff remained skeptical about its utility throughout the study. It would have been wasteful and frustrating for staff if ML had rolled this technology out across the facility before taking the time to test it in the intervention unit. ML administrators and MnDOC leadership gained valuable information from the pilot test that informed their decision not to expand the technology into other units or facilities.

Guidebook on Optimizing Public Surveillance Systems

Drawing on the lessons and takeaways from this project, we developed a guidebook for correctional agencies on how to optimize surveillance systems to enhance institutional safety and security, which outlines nine chronological steps an agency should consider in order to enhance their existing system. [3] This guidebook will help agencies identify their surveillance goals, consider the limitations and constraints of their current system, and develop a strategy to make meaningful improvements. These nine steps include: (1) Identify a facility or unit for improvement; (2) Assess existing camera placement and field of view; (3) Assess existing infrastructure; (4) Understand and update departmental policies and procedures; (5) Expand camera coverage and minimize blind spots; (6) Make other hardware upgrades; (7) Integrate audio/video analytics; (8) Integrate training measures; and (9.) Continue monitoring the system and departmental needs.

Notes

[1] Linden, A. (2015). Conducting interrupted time-series analysis for single- and multiple-group comparisons. *The Stata Journal*, *15(2)*, 480-500. doi: 10.1177/1536867X1501500208.

[2] The synthetic control method is typically used to create comparison groups from specific geographic areas (e.g., states, counties, etc.). To our knowledge, there has been no research to date on how this method can be employed to evaluate interventions in correctional settings.

[3] Shukla, R., Bryce E. Peterson, Lily Robin, and Daniel S. Lawrence. 2021. *Audio Analytics and Other Upgrades in Correctional Surveillance Systems: Lessons Learned*. Washington, DC: Urban Institute.

[4] Shukla, R., Lily Robin, Bryce E. Peterson, and Daniel S. Lawrence. 2021. *Optimizing Surveillance Systems in Correctional Settings: A Guide for Enhancing Safety and Security*. Washington, DC: Urban Institute.

Appendix A – CITS Modeling

Figure A1 offers a hypothetical multiple intervention CITS model that is similar to the models we utilized for the analysis of misconducts and guilty dispositions, including the beta coefficients that are returned as part of the regression model.

Figure A1. Visual depiction of a multiple group, multiple intervention interrupted time-series design

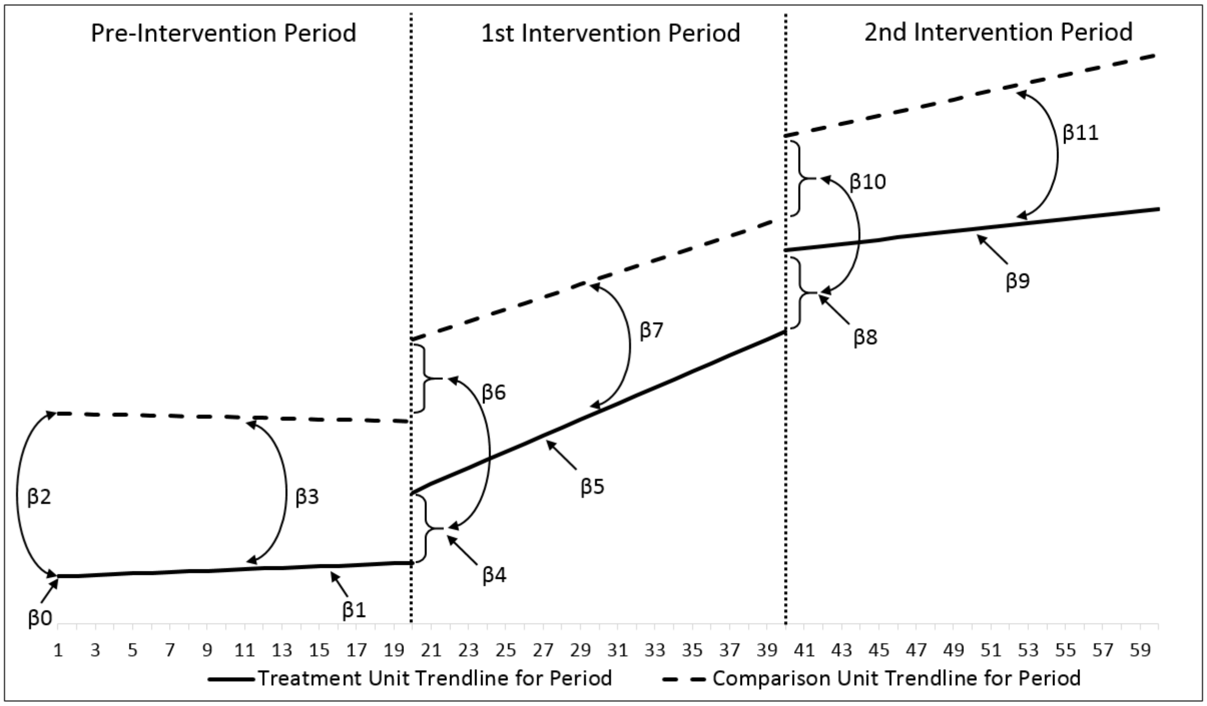


Figure adapted from:

Linden, A., & Adams, J. L. (2011). Applying a propensity-score based weighting model to interrupted time series data: Improving causal inference in program evaluation. *Journal of Evaluation in Clinical Practices*, 17(6), 1231-1238.

Linden, A. (2015). Conducting interrupted time-series analysis for single- and multiple-group comparisons. *The Stata Journal, 15(2)*, 480-500.

Where:

- β0: starting amount for treatment unit;
- β1: pre-period slope for treatment unit (periods 1 to 19);
- β2: difference in amount between treatment and control units at pre-period start (period 1);
- β3: difference in slopes between treatment and control units during pre-period (periods 1 to 19);
- β4: change in amount for treatment unit in the month immediately following first intervention on period 20;
- β5: difference in slopes between treatment unit's pre-period (periods 1 to 19) and first intervention period (periods 20 to 39);
- β6: difference in amount between treatment and control units in the month immediately following first intervention on period 20;
- β7: difference in slopes between the treatment and control units' first intervention period (period 20 to 39) compared to pre-period (period 1 to 19);

β8: change in amount for treatment unit in the month immediately following second intervention on period 40;

β9: difference in slopes between treatment unit's first intervention period (periods 20 to 39) and second intervention period (periods 40 to 60);

β10: difference in amount between treatment and control units in the month immediately following second intervention on period 40

β11: difference in slopes between the treatment and control units' second intervention period (periods 40 to 60) compared to first intervention period (periods 20 to 39)

We used the ITSA command in Stata 15.1 to run the CITS. All models included a control for the month of the year, and models examining guilty dispositions also included a control for the total amount of infractions. We used the results from the regression model to assess pre-intervention balance between the treatment group and comparison group by examining the difference at the first month of analysis between the two groups (β2) and the difference in slopes between the two groups during pre-period (β3). To claim that the groups are balanced in the pre-intervention period, β2 and β3 would be non-significant.

To assess whether the treatment unit's change in the outcome is significant in the immediate month following an intervention compared to the comparison unit's change, the model produces β6 for the first intervention cut point, and β10 for the second intervention cut point. Similarly, β7 and β11 are calculated to assess whether the treatment unit's pre- and post-intervention trend lines are different compared to the comparison unit's change as a result of the first and second intervention cut points, respectively.

Appendix B – CITS Tables and Figures

Group Balance

Table B1 presents the pre-intervention descriptive statistics for the intervention unit and two comparison units. Balance between the units was assessed using the Cohen's *d* effect-size and *t* statistics, where imbalance is exhibited with Cohen's d in excess of +/- 0.20 and a t in excess of +/- 1.96. While the internal comparison unit showed some signs of unbalance, results from the CITS analyses reported statistically identical pre-intervention trend lines with the treatment unit. The table also indicates that the synthetic control method yielded an external comparison unit that was statistically similar the intervention unit.

Table B1. Pre-Period Balance (n = 32 months)

	M	*SD*	Min - Max	*t*	*d*	Population as of Jan 2019
Total Infractions						
Intervention Unit	15.69	8.28	2.00 – 33.00	--	--	118
Internal Comparison	13.59	7.92	3.00 – 47.00	-1.03	- .26	118
Synthetic Comparison	15.62	3.41	8.48 – 22.01	-0.04	-.01	211.05
Guilty Dispositions						
Intervention Unit	14.53	7.59	2.00 – 32.00	--	--	118
Internal Comparison	11.81	5.38	3.00 – 25.00	-1.65	- .41	118
Synthetic Comparison	14.59	3.12	8.28 – 20.94	0.04	.01	230.52

CITS Results

Table B2. Total Infractions

	Model 1: Internal Comparison			Model 2: External Comparison		
	Coef. (SE)	95% Lower CI	95% Upper CI	Coef. (SE)	95% Lower CI	95% Upper CI
β0	11.99 (2.83) ***	6.38	17.59	13.06 (1.47) ***	10.14	15.97
β1	0.06 (0.10)	-0.13	0.26	0.07 (0.08)	-0.08	0.23
β2	3.24 (3.34)	-3.39	9.86	1.47 (2.48)	-3.44	6.39
β3	-0.07 (0.20)	-0.47	0.32	-0.09 (0.19)	-0.47	0.29
β4	-9.16 (3.95) *	-16.99	-1.33	-3.61 (2.49)	-8.54	1.32
β5	1.24 (0.90)	-0.54	3.03	0.94 (0.38) *	0.18	1.71
β6	2.04 (6.88)	-11.60	15.68	-4.07 (5.26)	-14.49	6.35
β7	-0.12 (1.02)	-2.13	1.90	0.36 (0.64)	-0.92	1.64
β8	-5.65 (4.85)	-15.26	3.96	2.32 (1.56)	-0.78	5.41
β9	-1.27 (0.93)	-3.11	0.57	-1.88 (0.40) ***	-2.67	-1.09
β10	-3.42 (6.11)	-15.53	8.68	-12.10 (3.19) ***	-18.42	-5.77
β11	0.35 (1.05)	-1.74	2.43	0.76 (0.65)	-0.52	2.04
Month of the year	0.10 (0.22)	-0.34	0.54	0.23 (0.17)	-0.11	0.58
Number of Months per unit	60			60		
Lag	0			2		
F	1.91 *			19.86 ***		

* *p* < .05; ** *p* < .01; *** *p* < .001

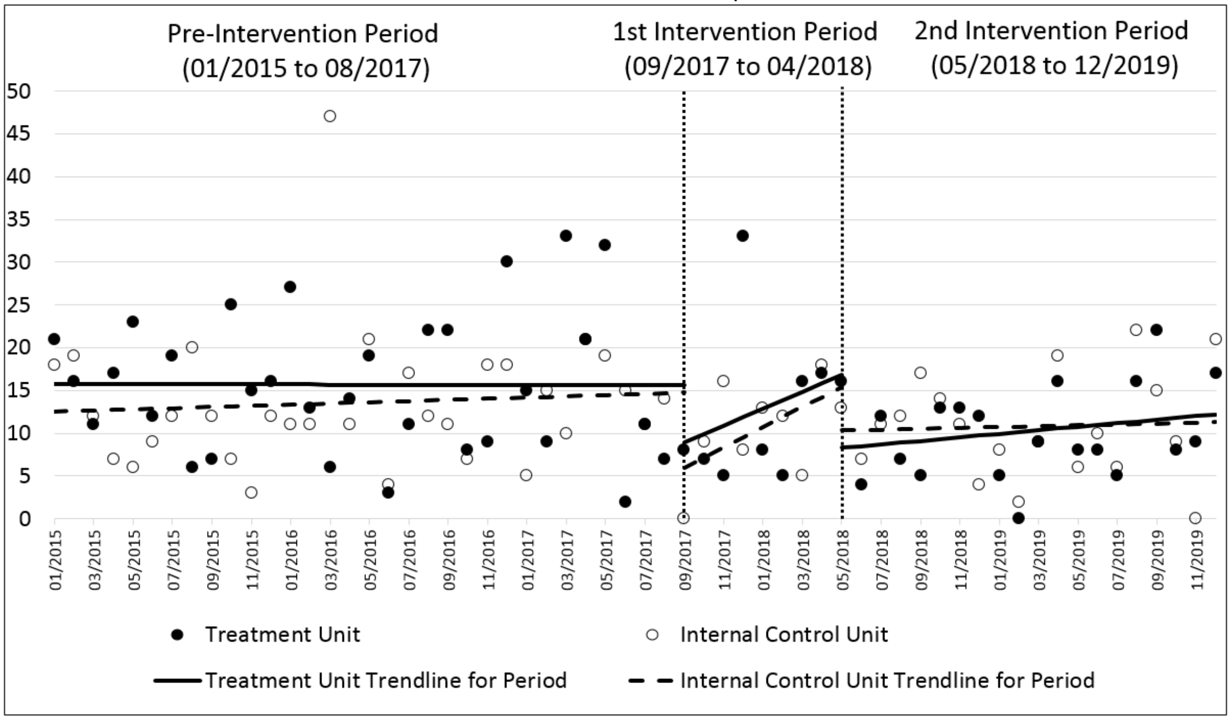
Table B3. Guilty Dispositions

	Model 3: Internal Comparison			Model 4: External Comparison		
	Coef. (SE)	95% Lower CI	95% Upper CI	Coef. (SE)	95% Lower CI	95% Upper CI
β0	0.07 (1.01)	-1.93	2.07	-1.36 (0.56) *	-2.46	-0.26
β1	0.04 (0.04)	-0.04	0.13	-0.02 (0.02)	-0.05	0.01
β2	1.67 (1.24)	-0.79	4.13	2.41 (0.37) ***	1.69	3.14
β3	-0.04 (0.05)	-0.14	0.06	0.03 (0.03)	-0.03	0.08
β4	-0.91 (1.10)	-3.08	1.26	1.14 (0.46) *	0.02	2.26
β5	0.05 (0.19)	-0.33	0.42	0.14 (0.10)	-0.05	0.33
β6	0.56 (1.21)	-1.84	2.96	-0.87 (1.01)	-2.86	1.13
β7	-0.37 (0.21)	-0.79	0.04	-0.60 (0.20) **	-1.00	-0.20
β8	-0.02 (0.92)	-1.85	1.81	-1.91 (0.60) **	-3.09	-0.72
β9	-0.05 (0.20)	-0.45	0.35	0.00 (0.12)	-0.23	0.23
β10	1.11 (0.97)	-0.82	3.04	3.80 (0.94) ***	1.93	5.66
β11	0.48 (0.22) *	0.06	0.91	0.55 (0.21) *	0.13	0.98
Total Infractions	0.82 (0.09) ***	0.64	0.99	0.88 (0.03) ***	0.82	0.93
Month of the year	-0.01 (0.06)	-0.13	0.12	-0.06 (0.03) *	-0.11	-0.00
Number of Months per unit	60			60		
Lag	5			3		
F	66.94 ***			285.49 ***		

* *p* < .05; ** *p* < .01; *** *p* < .001

Figure B1. Total Infractions

Intervention Unit and Internal Comparison Unit



Intervention Unit and External Comparison Unit

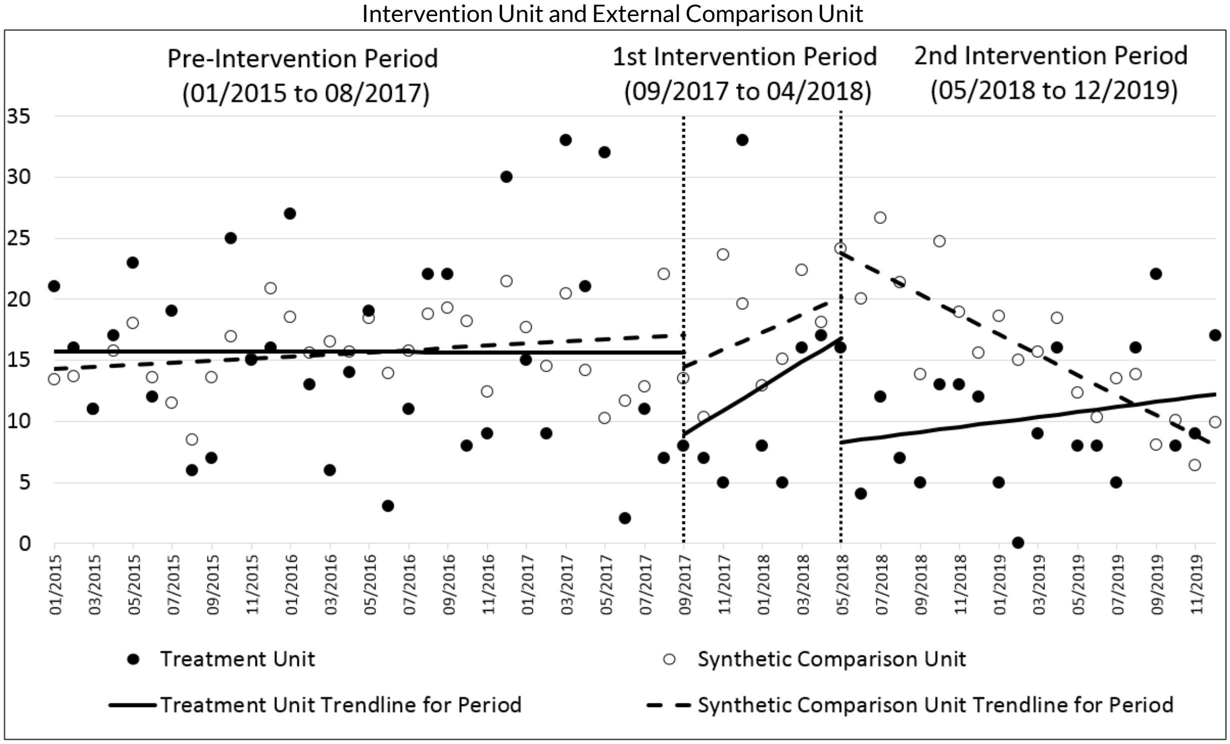
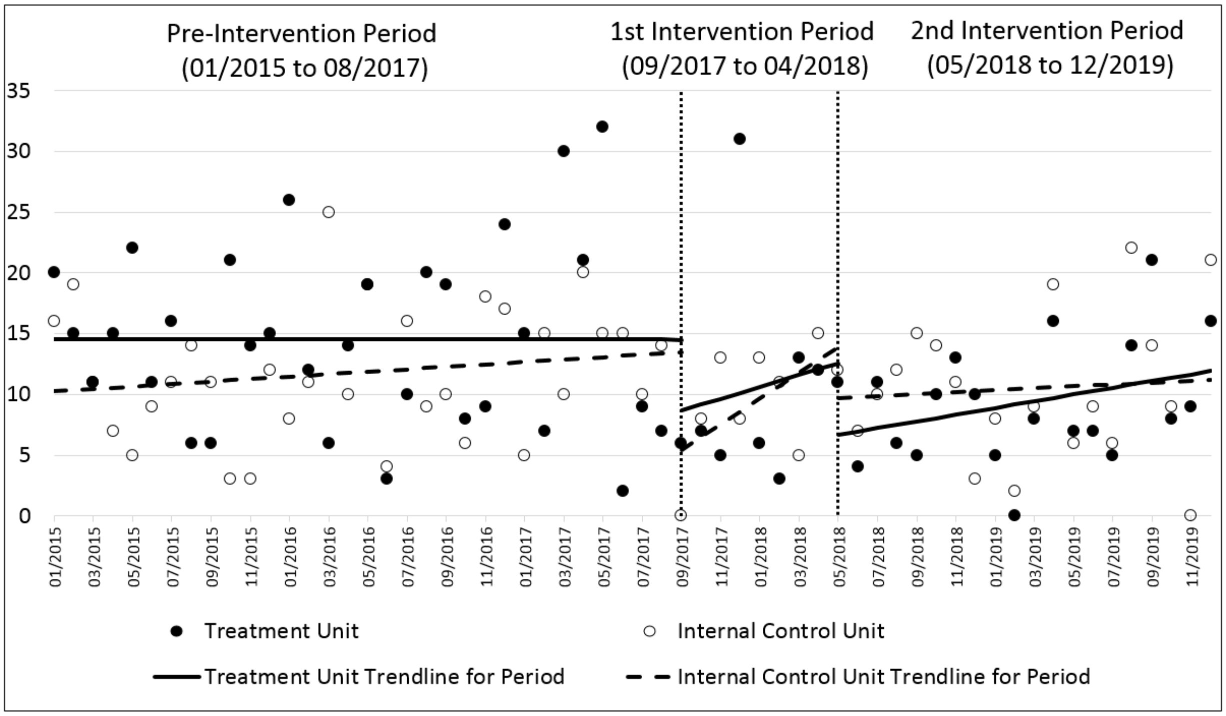


Figure B2. Guilty Dispositions

Intervention Unit and Internal Comparison Unit



Intervention Unit and External Comparison Unit