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# The effects of closed-circuit television on crime: meta-analysis of an English national quasi-experimental multi-site evaluation

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**Abstract** This article reports results obtained in an English national quasi-experimental multi-site evaluation of 14 closed-circuit television (CCTV) projects in residential areas, town and city centers, a city hospital, and car parks (parking lots). Both police and victimization data were collected before and after the installation of CCTV in target, control and buffer areas, and police Divisions. The results showed that CCTV was effective in reducing crimes in train station car parks but not in city centers or residential areas, seemed to be effective in reducing vehicle crimes (but not other types of crimes), and was most effective when the degree of coverage by CCTV was high and when CCTV was combined with other interventions such as improved lighting. Implications for situational crime prevention theory are drawn. There was no evidence of displacement or diffusion of benefits. It is concluded that CCTV needs to be implemented more effectively, based on an analysis of the crime problem and its causes, and needs to be evaluated using a randomized experimental design.

**Key words** CCTV · crime · evaluation · meta-analysis · quasi-experimental design · situational crime prevention · surveillance

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## Introduction

In the past 15 years there has been a tremendous growth in the use of closed-circuit television (CCTV) cameras in Great Britain. The number of surveillance cameras in England and Wales increased from 100 in 1990 to 400 in 1994, to 4,200 in 1997, and to 40,000 in 2002 (Armitage, 2002, p. 2). According to the *Sunday Times* (October 29, 2006, p. 13).

British people are now more spied upon by their political leaders than any other people in the free world, according to an official report. The report, compiled by surveillance experts and academics, points out that a typical Briton will be caught on camera up to 300 times a day. Britain now has 4.2 million public CCTV cameras, or one for every 14 people, more than any other country.

### Theory of CCTV

CCTV is a type of situational crime prevention measure. The theory underlying situational crime prevention suggests that whether crimes are committed depends on rational choices and situational factors such as the availability of criminal opportunities and the risks of detection. Clarke (1997) listed 16 opportunity reduction techniques under the headings of increasing perceived effort, increasing perceived risks, reducing anticipated rewards, and removing excuses. CCTV is listed as a surveillance technique that falls into the category of increasing perceived risks (of potential offenders).

Gill and Spriggs (2005) outlined a number of theories of how CCTV works. First, CCTV may reduce crime by deterring potential offenders because they think that they have an increased risk of being caught. Second, CCTV may encourage more people to use the area and, hence, may increase the perceived risk of being caught by increasing natural surveillance. Third, CCTV may facilitate the effective deployment of police and security staff to intervene to prevent crime and/or apprehend offenders. Fourth, CCTV may encourage the general public to take more precautions, and fifth, CCTV may encourage the general public and employees to intervene to prevent crime. However, CCTV may also reduce the vigilance of police, security staff, and the general public, to the extent that they begin to rely on it; and CCTV may reduce natural surveillance if fewer people use the area because they dislike being watched.

These theories have implications for the likely effectiveness of CCTV in reducing crime. First, CCTV will be most effective if potential offenders believe that they will be seen. It follows, therefore, that potential offenders will not be deterred if the coverage of CCTV cameras is low, since people can then choose to offend in places that are not covered by the cameras. Also, if places are poorly lit, or if the quality of images is poor, potential offenders may think that they will not be identified. Second, CCTV is unlikely to be effective if potential offenders do not rationally calculate the risks of offending, for example if they are impulsive, compulsive, or under the influence of drink or drugs. Third, CCTV will be most effective in preventing crimes in public view and least effective in preventing crimes that are difficult to observe or that occur in private places such as houses (e.g., domestic violence or child abuse).

The implication of these theories of CCTV is that, in the decision of whether to use it, the first step should be to analyze the crime problem in an area and its likely

causes. The second step should be to devise strategies to target these causes. In some cases (e.g., if potential offenders are likely to be deterred by an increase in the risk of detection, if crimes are committed in public view, if a large fraction of the area could be covered by CCTV cameras), CCTV may be chosen as a possibly effective crime reduction strategy. In other cases, CCTV is unlikely to be effective.

## CCTV effectiveness

It is claimed that CCTV is an effective measure in preventing crime, but this claim is often based on a handful of apparently successful projects that were poorly evaluated using simple before-and-after designs with no comparison conditions (Armitage et al., 1999. p. 226). This design is seriously flawed, because it fails to address many threats to internal validity (Farrington & Painter, 2003).

The first systematic review of the effects of CCTV in preventing crime was carried out by Welsh and Farrington (2002). Systematic reviews have explicit objectives, explicit criteria for including or excluding studies, extensive searches all over the world for eligible evaluations, careful extraction and coding of key features of studies, a structured and detailed report of the methods used for locating, appraising, and synthesizing evidence, and explicit conclusions about effect sizes (Farrington & Petrosino, 2000). In their systematic review, Welsh and Farrington (2002) only included evaluations with before-and-after measures of crime in experimental and comparable control areas. This was regarded as the minimum standard of methodological quality that was adequate for drawing conclusions about effectiveness in evaluation research (Cook & Campbell, 1979; Sherman et al., 2006).

In their most recent systematic review, Welsh and Farrington (2006) concluded that existing evaluation research showed that CCTV was effective in reducing crimes in car parks but not in city centers or public housing, was effective in reducing vehicle crimes but not violent crimes, and was most effective when combined with improved lighting. Welsh and Farrington (2004) compared the effectiveness of CCTV and improved street lighting and concluded that improved lighting was more effective in reducing crimes in city centers and residential areas. These reviews did not aim to address other possible effects of CCTV, such as helping to detect offenders, helping to deploy police, providing evidence for use in court, or reducing the fear of crime.

## The present research

In light of past research on CCTV, Welsh and Farrington (2002) made various recommendations about how to improve the methodological quality of future research. Since it is possible that CCTV might lead to an increase in reporting and recording of crimes, they recommended that victim-survey data should be collected as well as police data. They also pointed out the need for studies to have sufficient statistical power to detect the likely effects of CCTV and the need to collect information that would make it possible to disentangle the effects of CCTV from those of other interventions implemented at the same time (such as improved street lighting). They recommended that the intensity of the CCTV dose be measured and the relationship between the dose (e.g., the coverage of CCTV) and the response (e.g., the

reduction in crimes). They also suggested that effects on different types of crimes be measured and that displacement and diffusion of benefits (see Weisburd et al., 2006) be investigated by comparing crimes in experimental, adjacent (buffer) and non-adjacent control areas.

Overwhelmingly, past research on CCTV has measured police-recorded crimes. However, if CCTV causes an increase in the probability of a crime's being recorded, an increase in police-recorded crime in an area after CCTV has been installed is not necessarily evidence of the ineffectiveness of CCTV in reducing crime. Ideally, what is needed is some other measure of crime, such as that obtained in a victim-survey. If victim-survey crime in an area decreased after CCTV was installed, but police-recorded crime did not change or had increased, it might be suggested that CCTV was effective in reducing crime but that it also increased the probability of a crime's being reported or recorded. However, in the first evaluation to measure both police-recorded and victim-survey crimes before and after the installation of CCTV in experimental and control areas, Farrington, Bennett, and Welsh (2007) found that victim-survey crimes did not change but police-recorded crimes increased in the CCTV area compared with the control area. They concluded that CCTV may have had no effect on the commission of crimes but may have caused increased reporting and/or recording.

The main aim of the present article is to assess the effects of CCTV on crime in a large-scale English national quasi-experimental multi-site evaluation carried out by the University of Leicester and funded by the Home Office (Gill & Spriggs, 2005).[1] This is the most extensive evaluation of CCTV that has ever been conducted. In 2001 the Home Office funded 352 CCTV projects under the second round of the Crime Reduction Program. Seventeen of these projects, covering residential areas, town and city centers, car parks and a hospital, were selected by the Home Office for in-depth evaluation. Both process and impact evaluations were carried out, but this article summarizes only the results of the impact evaluation.

## Methods

Table 1 summarizes key features of 14 evaluated CCTV projects.[2] The first six projects (Deploy Estate, Dual Estate, Southcap Estate, Eastcap Estate, Northern Estate, Westcap Estate) were implemented in deprived housing estates mostly in the south of England. The seventh (City Outskirts) was implemented in a deprived area on the outskirts of a Midlands city, while the eighth (Borough) was implemented throughout a southern borough of mixed affluence. Four projects (Borough Town,

[1] Compared with the Home Office report, this article presents much more extensive meta-analyses, presents meta-analyses of survey data, compares target areas with buffer areas, presents more extensive analyses of displacement and diffusion of benefits, and deducts crimes in target, control and buffer areas from crimes in Divisions so that all numbers of crimes are mutually exclusive.

[2] There was some evaluation of a 15th project, in a northern city center, but police data could not be collected for this project, and survey data were collected only for the target area, not for any comparison area. This project is excluded from the present article, as were two other projects that failed to be implemented within the period of the research. The names of all projects (with the exception of Hawkeye, which is unique) have been changed to protect their identity.

**Table 1** Key features of 14 evaluated CCTV projects (*NK* not known)

| Project | Setting | New? | Other Interventions | Coverage (%) | Night viewing |
|---|---|---|---|---|---|
| Deploy Estate | Deprived estate | New | No | 34 | Good |
| Dual Estate | Deprived estate | New | No | 9 | Good |
| Southcap Estate | Deprived estate | New | Youth inclusion project | 73 | Poor |
| Eastcap Estate | Deprived estate | New | Lighting | 29 | Poor |
| Northern Estate | Deprived estate | New | No | 87 | Poor |
| Westcap Estate | Deprived estate | Extension | Youth inclusion project | 62 | Good |
| City Outskirts | Deprived outskirts | Extension | Lighting, anti-burglary | 68 | Good |
| Borough | Borough-wide | New | No | Low[a] | Poor |
| Borough Town | Town center | Extension | No | 70 | Good |
| Market Town | Town center | Extension | Community wardens, car park | 34 | Poor |
| Shire Town | Town center | New | Community wardens | 76 | Poor |
| South City | City center | Extension | Community wardens, police operations | 72 | Good |
| City Hospital | Hospital | Extension | Leaflets, posters, lighting, police operations | 76 | NK |
| Hawkeye | Car parks | New | Lighting, fencing, security | 95–100 | Good |

[a] In Borough, redeployable CCTV cameras were installed in small areas identified as crime "hot-spots", whereas there was a designated target area in all other cases. Since there were only eight cameras in Borough, coverage was low

Market Town, Shire Town, South City) were implemented in town or city centers, one (City Hospital) in a hospital, and the final one (Hawkeye) in 57 train station car parks (parking lots).

The target area was that specified within the original bid submitted by each project for Home Office funding. Where no target area was specified, it was taken to be the boundary of the area covered by the CCTV cameras. The buffer area was generally the area within one mile of the perimeter of the target area, but it was sometimes modified in light of physical boundaries (e.g., rivers, train lines) or police Division boundaries. Control areas were chosen because they had socio-demographic features and crime problems similar to those of the target areas. Target and control areas were similar in ethnicity, unemployment rates, and academic qualifications. The control area was usually within the same police Basic Command Unit as the target area. No new CCTV project was implemented, and no existing CCTV system was significantly changed, in the control area from 2 years prior to the installation of CCTV in the target area.

The CCTV projects implemented in residential areas were mostly new, while those implemented in town and city centers were mostly extensions of existing

**Table 2** Control room operations (*Y* yes, *N* no, *NK* not known)

| Project (24 hours?) | Effective room? | Cameras/ operator | Time spent watching (%) | Police communication | Police in room | Police respond | Police view CCTV |
|---|---|---|---|---|---|---|---|
| Deploy Estate(Y) | No | 49–66 | 78 | One-way | No | Yes | NK |
| Dual Estate(N) | No | 67 | 78 | Two-way | No | No | No |
| Southcap Estate(Y) | Yes | 148 | 71 | One-way | Yes | No | No |
| Eastcap Estate(Y) | No | 50 | 81 | Two-way | No | Yes | No |
| Northern Estate(Y) | No | 25–40 | 84 | One-way | No | Yes | No |
| City Outskirts(Y) | Yes | 48 | 78 | Direct line | No | No | Yes |
| Borough Town(N) | No | 173–520 | 63 | One-way | Yes | Yes | No |
| Market Town(N) | Yes | 27 | 93 | Direct line | No | No | Yes |
| Shire Town(N) | Yes | 27 | 93 | Retail radio | No | No | Yes |
| South City(Y) | Yes | 65–86 | 83 | Public house/ retail radio | Yes | Yes | Yes |
| Hawkeye(N) | Yes | 123–153 | NK | One-way | No | No | Yes |

projects. Some CCTV projects coincided with other interventions, such as improved lighting (Eastcap Estate, City Outskirts, Hawkeye, City Hospital), community wardens (Market Town, Shire Town, South City) new police operations (South City, City Hospital), and youth inclusion projects (Southcap Estate, Westcap Estate). The percentage of the area that was covered by CCTV cameras varied from only 9% in Dual Estate to 95–100% in the Hawkeye car parks. The quality of the image during night-time viewing was rated as good for seven projects but poor for six others.

Table 2 summarizes some key aspects of control room operations, based on extensive observational research (Gill et al., 2005). The control room was rated as effectively organized in six cases and not in five others. It was operational for 24 hours a day in six cases but not in five others. The number of cameras per operator varied from 25–40 to 173–520. The percentage of their time that operators spent watching the screens varied from 63% to 93%. Communication links with the police were only one-way in seven cases (operators could hear police radios but could not communicate directly with the police except by dialing 999), although in two of these there was a public house or retail radio system where operators could communicate with public houses or shops. Police were deployed in control rooms in only three cases; police responded effectively in five cases, and police regularly viewed CCTV evidence in five cases.

Table 3 shows the evaluation data that were collected. Ideally, the aim was to compare a target area where CCTV was installed with (a) a comparable non-adjacent control area, (b) an adjacent buffer area (in order to investigate displacement and diffusion of benefits), and (c) the rest of the police Division containing the target area. Ideally, police records of crimes in all areas would be obtained and also victimization data from surveys in the target and control areas. Ideally, crime data would be obtained for 12 months before the installation of CCTV cameras and for 12 months after the scheme went live.

For various reasons it was difficult to collect all of this data in all areas. There were problems of getting access to police data, and the Home Office funding was not adequate to conduct surveys in all areas. There was full police and survey data

**Table 3** Evaluation data [*(6)* available for 6 months only, *(T)* available for target area only, *(P)* available for prevalence only]

| Project | Target | Control | Buffer | Division | Survey |
|---|---|---|---|---|---|
| Deploy Estate | Yes | Yes | Yes | No | Yes |
| Dual Estate | Yes | Yes | Yes | No | Yes |
| Southcap Estate | Yes (6) | Yes (6) | No | No | Yes |
| Eastcap Estate | Yes | Yes | Yes | Yes | Yes |
| Northern Estate | Yes | Yes | Yes | No | Yes |
| Westcap Estate | No | No | No | No | Yes |
| City Outskirts | Yes | No | Yes | Yes | Yes (T) |
| Borough | Yes | No | Yes | Yes | No |
| Borough Town | Yes | Yes | Yes | No | No |
| Market Town | Yes | No | Yes | Yes | No |
| Shire Town | Yes | No | Yes | Yes | Yes (P) |
| South City | Yes | No | Yes | Yes | Yes (T) |
| City Hospital | Yes | No | Yes | Yes | No |
| Hawkeye | Yes | No | No | Country | No |

collection only in Eastcap Estate. However, police and survey data were also collected for target and control areas in Deploy Estate, Dual Estate, Northern Estate and Southcap Estate (the police data for only 6 months before and after). Surveys were carried out door-to-door on estates and in the street in town and city centers. The average sample sizes were over 400 respondents before and after in target areas and over 300 respondents before and after in control areas. It was difficult to identify comparable control areas for towns, city centers, the hospital and Hawkeye. For Hawkeye, the only comparison data were from the British Transport Police for crimes in train station car parks in the whole country.

Comparisons between a target area and the rest of the Division are unsatisfactory because Divisions are so much larger than target areas and hence not very comparable. Buffer areas are more comparable to target areas, and, in practice, changes in crimes in buffer areas were similar to changes in Divisions (see later). Hence, where there are no control areas, it is arguably at least as defensible to compare target areas with buffer areas as to compare target areas with Divisions, and both types of comparisons will be reported in later analyses. However, in comparing target areas with buffer areas, it is important to be aware of the possibilities of displacement and diffusion of benefits (Waples, S. J., Gill, M., & Fisher, P., unpublished paper, 2006), which can be investigated most satisfactorily in cases with target, control and buffer data (Deploy Estate, Dual Estate, Eastcap Estate, Northern Estate, Borough Town).

Although the full design could not be implemented at every site, this evaluation incorporated many of the methodological improvements suggested by Welsh and Farrington (2002). It included victim-survey crimes as well as police-recorded crimes. It had sufficient statistical power, bearing in mind that about 300–400 people in each of two areas are required for the detection of a 10% difference in the probability of victimization (Painter & Farrington, 1997, p. 216). It documented other interventions that were implemented at the same time as CCTV. It measured the intensity of the CCTV dose (the coverage). It also measured effects on different types of crimes and displacement and diffusion effects.

## Results

### Effect sizes in the national evaluation

Table 4 shows relative effect sizes (RESs) for total police-recorded crimes in the residential projects. The measure of effect size (which can be interpreted as an odds ratio) and its variance are described in the Appendix. Where there were control areas, target and control areas were compared. In other cases, both target and buffer areas, and target areas and Divisions, were compared. The statistical significance of each RES is shown, based on the z value obtained by comparing the natural logarithm of the relative effect size (LRES) with its standard error (SE). RES values greater than 1 indicate a crime-reducing effect of CCTV. For example, for comparing target and buffer areas in City Outskirts, RES=1.337, LRES=0.290, SE (LRES)=0.087, z=0.290/0.087=3.35, $P$=0.0008, two-tailed. Confidence intervals can easily be calculated from these figures. For example, the upper confidence interval of $LRES = 0.290 + 1.96 \times 0.087 = 0.460$, which is easily converted to RES=1.58. The lower confidence interval of this is RES=1.13. Since this interval does not include 1.00, the RES of 1.34 is statistically significant, as indicated by the z value; z values provide a more exact measure of statistical significance than confidence intervals do, and so z is shown in the tables.

The results in Table 4 show that the use of CCTV was followed by a reduced number of crimes only in City Outskirts. This was true whether the target area was compared with the buffer area or with the Division. For example, in the comparison of the target area with the Division, the RES of 1.45 indicated that crimes increased by 45% in the Division compared with the target area. The RES of 1.45 can also be interpreted as showing that crimes decreased by 31% in the experimental area compared with the control area (since 1/1.45=0.69). Actually, crimes decreased by 28% in the target area (from 1,526 to 1,098) and increased slightly in the Division (a 4% increase, from 19,616 to 20,434). However, it should be pointed out that crimes increased considerably in the target area just before the CCTV poles were erected (possibly due to the introduction of new Home Office counting rules) and then decreased back to the previous level by the time the system went fully live. Possibly, the erection of the poles caused

**Table 4** Effect sizes for total crimes in residential projects (*ns* not significant)

| Project | Comparison | RES | Significance | |
|---|---|---|---|---|
| | | | z | *P* |
| Deploy Estate | Target–control | 0.85 | −1.25 | ns |
| Dual Estate | Target–control | 0.78 | −2.02 | 0.044 |
| Southcap Estate | Target–control | 0.76 | −1.65 | ns |
| Eastcap Estate | Target–control | 1.03 | 0.15 | ns |
| Northern Estate | Target–control | 1.34 | 1.41 | ns |
| City Outskirts | Target–buffer | 1.34 | 3.35 | 0.0008 |
| City Outskirts | Target–Division | 1.45 | 3.99 | 0.0001 |
| Borough | Target–buffer | 0.80 | −1.74 | 0.082 |
| Borough | Target–Division | 0.63 | −5.10 | 0.0001 |

**Table 5** Effect sizes for total crimes in other projects (*ns* not significant)

| Project | Comparison | RES | Significance | |
|---|---|---|---|---|
| | | | z | *P* |
| Borough Town | Target–control | 1.12 | 0.85 | ns |
| Market Town | Target–buffer | 0.79 | −1.79 | 0.073 |
| Market Town | Target–Division | 0.87 | −1.26 | ns |
| Shire Town | Target–buffer | 1.22 | 1.37 | ns |
| Shire Town | Target–Division | 1.07 | 0.58 | ns |
| South City | Target–buffer | 0.99 | −0.15 | ns |
| South City | Target–Division | 0.98 | −0.27 | ns |
| City Hospital | Target–buffer | 1.38 | 0.95 | ns |
| City Hospital | Target–Division | 1.44 | 1.07 | ns |
| Hawkeye | Target–country | 3.34 | 6.21 | 0.0001 |

"anticipatory benefits" (Smith et al., 2002). However, the decrease in crime exactly coincided with improvements in lighting. Hence, the large effect size could not necessarily be attributed to the introduction of CCTV alone (Gill & Spriggs, 2005, pp. 26–29).

Table 4 also shows that police-recorded crimes significantly increased after the installation of CCTV in Dual Estate and Borough (in the Division comparison only). In Dual Estate, the RES of 0.78 indicated that crimes decreased by 22% in the control area compared with the target area. Actually, crimes increased by 4% in the target area (from 799 to 834) but decreased by 19% in the control area (from 464 to 378). In Borough, the RES of 0.63 indicated that crimes decreased by 37% in the Division compared with the target area, but it is more accurate to say that crimes increased by 59% (1/0.63) in the target area compared with the Division. Crimes increased by 73% in the target area (from 257 to 444) compared with only 8% in the Division (from 7,572 to 8,198). The buffer comparison may be more valid; crimes increased by 38% in the buffer area (from 421 to 583), giving a RES of 0.80, which was not quite significant.

Table 5 shows that none of the town or city center CCTV projects had significant effects on crime. The most desirable effect of CCTV was in Shire Town (RES= 1.22), comparing target and buffer areas. Crimes decreased by 4% in the target area, increased by 17% in the buffer area, and increased by 3% in the Division. This pattern of changes could suggest that some crimes may have been displaced from the target area to the buffer area (see later). However, the very small decrease in the target area (only 14 crimes, compared with an increase of 171 in the buffer area) suggests that very few crimes could have been displaced. There was a near-significant undesirable effect of CCTV in Market Town (RES=0.79), comparing target and buffer areas. Crimes increased by 18% in the target area, decreased by 7% in the buffer area, and increased by 3% in the Division. The increase in the target area (45 crimes) was similar to the decrease in the buffer area (41 crimes).

There was a desirable effect of CCTV in City Hospital, but numbers were small and the effect was not significant. The most significant and desirable effect of CCTV was for Hawkeye, in train station car parks. Crimes decreased by 73% in Hawkeye car parks (from 794 to 214), in comparison with a 10% decrease in

**Table 6** Effect sizes for total crimes in victim surveys (*ns* not significant)

| Project | Comparison | RES | Significance | |
|---|---|---|---|---|
| | | | z | *P* |
| Deploy Estate | Target–control | 0.93 | −0.60 | ns |
| Dual Estate | Target–control | 1.09 | 0.68 | ns |
| Southcap Estate | Target–control | 0.44 | −6.56 | 0.0001 |
| Eastcap State | Target–control | 0.75 | −1.88 | 0.060 |
| Northern Estate | Target–control | 1.03 | 0.17 | ns |
| Westcap Estate | Target–control | 1.85 | 4.18 | 0.0001 |

train station car parks in the whole country (from 12,590 to 11,335). The RES of 3.34 indicates that crimes decreased by 70% in Hawkeye car parks compared with all train station car parks (1/3.34=0.30).[3]

Table 6 shows the results obtained in victimization surveys in target and control areas before and after CCTV had been implemented. Information about numbers of crimes was only available from door-to-door surveys in residential areas, not from in-street surveys in town and city centers.[4] The results suggest that CCTV had a desirable reductive effect on crime in only Westcap Estate. Crimes decreased by 36% in the target area (from 649 to 418) but increased by 19% in the control area (from 266 to 317). The RES of 1.85 shows that crimes increased by 85% in the control area compared with the target area (1.192/0.644).

The most important comparison is between police-recorded and victim-survey data. Unfortunately, this was only available in five sites, and the victim-survey data did not show desirable effects of CCTV in any of these. In Deploy Estate, Dual Estate, and Northern Estate, the victim-survey data showed no significant effects of CCTV. The police-recorded data showed no significant effect in Deploy Estate, a non-significant but desirable effect in Northern Estate, and a significant undesirable effect in Dual Estate. Conceivably, this significant undesirable effect could have been caused by increased reporting and/or recording. In Southcap Estate, the victim-survey data showed a significant undesirable effect of CCTV, while the police-recorded data showed a non-significant undesirable effect. In Eastcap Estate, the victim-survey data showed a near-significant undesirable effect of CCTV, while the police-recorded data showed no significant effect.

The LRES values from police data correlated 0.40 with the LRES values from victimization data.[5] This correlation is substantial but not high, probably because the victimization data were dominated by harassment incidents that might not have been recorded by the police.

[3] Monthly data were available for all Hawkeye car parks but not for the whole country.

[4] Monthly crime data were not available in the surveys. However, as indicated in the Appendix, the average ratio of the monthly variance to the usual variance of LRES was about 2 in police data. Hence, the significance in Table 6 was tested by multiplying the usual variance of LRES by 2.

[5] Since RES is a ratio variable, natural logarithms of RES were correlated.

**Table 7** Percentage changes in total crimes

| Project | Target | Buffer | Control/Division |
|---|---|---|---|
| Deploy Estate | +21 | +3 | +3 |
| Dual Estate | +4 | +11 | −19 |
| Eastcap Estate | +2 | −17 | +5 |
| Northern Estate | −10 | +10 | +21 |
| City Outskirts | −28 | −4 | +4 |
| Borough | +73 | +38 | +8 |
| Borough Town | 0 | −5 | +13 |
| Market Town | +18 | −7 | +3 |
| Shire Town | −4 | +17 | +3 |
| South City | −10 | −11 | −12 |
| City Hospital | −37 | −12 | −9 |

## Displacement or diffusion of benefits?

If crimes are displaced from the target area to the buffer area, then crimes should decrease in the target area and increase in the buffer area relative to the control area or Division. Table 7 shows percentage changes in crimes in target areas, buffer areas, and control areas or Divisions. There was only one case out of 11 that fulfilled the above criteria for displacement, namely Shire Town. However, as mentioned previously, the decrease in the target area in Shire Town was small and not significantly different from the change in the Division (RES=1.07 in Table 5). Therefore, we do not find any evidence that CCTV caused any displacement of crimes.

If there is a diffusion of benefits from the target area to the buffer area, then crimes should decrease in both of these areas relative to the control area or Division. However, there is no evidence of this in Table 7. Crimes decreased in the target area relative to the control area or Division in four cases (Northern Estate, City Outskirts, Shire Town, City Hospital; there was a slightly lower increase than the control area in Eastcap Estate but an increase in the target area does not indicate any benefit of CCTV, and the changes were not significantly different). Only in City Outskirts was the decrease in the target area significantly different from the change in the control area/Division; and in City Outskirts there was a negligible decrease in the buffer area.

## Meta-analyses

In analyzing the victim-survey data, we could have used a multivariate multilevel modeling approach in which the number of crimes experienced by each person was predicted by characteristics of the person and characteristics of the area, as well as by whether the area had CCTV or not and features of the CCTV intervention. However, we could not carry out this kind of analysis with police-recorded crimes, because we only had aggregate data for areas, not individual-level data. Since we wanted to compare victim-survey and police-recorded results directly, we needed to use the same analytic method for both, and we therefore chose to use a meta-analytic approach. This has the advantage of showing results separately for each project. It might be objected that the CCTV interventions and

**Table 8** Results of meta-analyses [*RES* relative effect size (none significant), *T* target, *C* control, *B* buffer, *D* Division]

| Projects | Comparisons | Mean RES |
|---|---|---|
| 7 Residential | T–C/B | 0.95 |
| 7 Residential | T–C/D | 0.93 |
| 4 Town center | T–C/B | 1.02 |
| 4 Town center | T–C/D | 0.98 |
| 12 Projects | T–C/B | 1.00 |
| 12 Projects | T–C/D | 1.06 |
| 12+ Hawkeye | T–C/B | 1.10 |
| 12+ Hawkeye | T–C/D | 1.08 |
| 6 Surveys | T –C | 0.93 |
| 13 Theft of vehicle | T–C/D | 1.30 |
| 6 Projects | B–D | 1.00 |

sites were too heterogeneous for meta-analysis, but we did not find this empirically (see later).

The effect sizes suggest that CCTV might have had desirable effects in some areas and undesirable effects in other areas. Could it be that these findings reflect randomly chosen examples from an effect size distribution with a mean of zero, or do these effects (taken together) significantly differ from chance expectation? Meta-analyses can test these hypotheses. Table 8 reports meta-analyses of total crimes for (a) seven residential projects; (b) four town or city center projects; (c) 12 residential, town/city center or hospital projects; (d) the 12 projects plus Hawkeye; and (e) the six projects with survey data. The meta-analytic methods closely followed those of Lipsey and Wilson (2001), and random effects models were used. Briefly, we could not reject the null hypothesis that there were no significant effects of CCTV on numbers of crimes. None of the measures of heterogeneity was significant, showing that all effect sizes could have been drawn from a distribution with a mean of zero (even in analyses including Hawkeye).

Effects on different types of crimes were investigated, comparing target areas and control areas or Divisions. Most types of crimes had non-significant weighted mean RES values close to 1.0: burglary (1.03), theft from vehicles (1.09), shoplifting (0.87), other theft (1.01), violence (1.02), public order (0.85) and damage (0.97). The strongest effect was for theft of vehicles (RES=1.30), but this was still non-significant. This was largely driven by positive results in Hawkeye (RES=2.39) and City Outskirts (RES=2.31). Excluding Hawkeye, RES=1.20 [not significant (n.s.)]. While the results of the meta-analyses are compatible with no overall effect of CCTV on crimes, the very large effect size for Hawkeye (RES= 3.34; see Table 5) compellingly suggests that the introduction of CCTV in train station car parks (combined with lighting and other improvements) was effective in reducing vehicle crimes. Table 8 also shows the results of a meta-analysis for six projects comparing crimes in buffer areas and Divisions before and after the use of CCTV. The RES of 1.00 shows that, overall, changes in crimes in buffer areas were the same as changes in crimes in Divisions. This fact, together with the general absence of displacement or diffusion effects, makes it reasonable to compare target areas with buffer areas (adjacent control areas) in cases where there were not other control areas. As mentioned, target areas are more comparable to buffer areas than to Divisions.

### Effect sizes versus features of projects

What features of projects predicted larger or smaller effect sizes? When features in Tables 1 and 2 were compared with effect sizes in Tables 4, 5, and 6, it was clear that the most important predictor of effect size was the percentage coverage of the CCTV cameras.[6] LRES correlated 0.63 ($P$=0.021) with the percentage coverage. Five projects showing undesirable results (RES <1) had an average coverage of 44%, whereas eight projects showing desirable results (RES >1) had an average coverage of 71%. These percentages were almost significantly different ($P$=0.072). Even after the exclusion of Hawkeye, which had the largest RES and the greatest coverage, LRES correlated 0.52 ($P$=0.085) with the percentage coverage.

It was noteworthy that the two projects that showed the most significant desirable effects of CCTV on crime (City Outskirts and Hawkeye) also included improvements in lighting. There were also lighting improvements in the City Hospital scheme, which had desirable effects on crime (which were non-significant because of small numbers). However, there were lighting improvements in Eastcap Estate and no desirable effects of CCTV on crime. This may have been because the glare from the improved lighting in this estate actually impaired CCTV viewing. This was why the quality of the image in night-time viewing was rated as poor in Table 1. Also, the CCTV coverage in this project was low (29%).

A detailed process evaluation was conducted to assess how each CCTV system was implemented and the possible effects of differential implementation on effectiveness. This included considerable documentation of the CCTV projects, visits to areas, observation at meetings, and interviews with key personnel. However, Gill and Spriggs (2005, pp. 90–91) concluded that "No one characteristic consistently caused a system to fail or succeed... It is not possible to link the presence of any of the characteristics to overall crime outcomes". We believe that the most important feature of the projects that may have influenced their effectiveness was, as mentioned, the degree of coverage of the cameras.

## Discussion and conclusion

The results of this large-scale national multi-site evaluation of the effects of CCTV on crime are highly concordant with the conclusions of the previous meta-analyses by Welsh and Farrington (2002, 2006). CCTV was effective in reducing crimes in car parks but not in city centers or residential areas, seemed to be most effective in reducing vehicle crimes but not other types of crimes, and may have been most effective when combined with improved lighting. However, the conclusions about lighting must be tentative because the evaluations were not designed to test its importance and because it was improved in only four sites.

Importantly, the degree of coverage of an area by CCTV cameras predicted the success of the project in reducing crimes. Hawkeye may have been effective because of its high coverage, which may have deterred potential thefts of and from vehicles,

[6] Effect sizes were based on police data except for Westcap Estate.

possibly because these types of crimes are more likely to involve rational choices than, for example, violence. Alternatively, Hawkeye may have been effective because of the combination of CCTV with improved lighting, fencing, and security arrangements. This suggests that how CCTV is implemented and on what types of crimes it is targeted are very important.

The main implication of these results for situational crime prevention theory is that CCTV can be effective. However, CCTV was only effective in car parks, where crimes were committed in public view, where a large fraction of the area could be covered by the cameras, where there was controlled access, where the vehicle crimes probably involved rational decision making, where it seems likely that potential offenders were deterred by the risk of detection, and where CCTV was combined with other interventions. Other possible theories about the effects of CCTV were not supported by the national evaluation. For example, Gill and Spriggs (2005) found that CCTV did not encourage or discourage people from using the area, suggesting that there was no change in natural surveillance. Also, very few offenders were apprehended because of CCTV. However, it is clear from this research that the effectiveness of CCTV depends a great deal on how it is implemented, including the technical specification of cameras (e.g., the efficiency of their recording at night), the positioning of cameras, the operation of the control room, and communication with the police.

It seems likely that CCTV was sometimes ineffective in these evaluations because its implementation was not based on a careful analysis of the crime problem. Ideally, any crime reduction strategy should first begin by analyzing the crime problem in an area and its causes, and then devise strategies to target these causes. The areas studied here applied for Home Office money to implement CCTV projects because money was made available, not because an analysis of the crime problem suggested that CCTV would reduce it. Also, many projects did not have clear objectives; project managers often lacked relevant knowledge, and projects sometimes failed to engage adequately with the police. It seems likely that CCTV would prove to be more effective in reducing crimes if it were better implemented.

While the national evaluation addressed many of the methodological problems of previous CCTV evaluation research, further improvements could be made in future research (Farrington & Painter, 2003). Ideally, a large number of areas could be randomly allocated to have CCTV cameras or not, or to have alternative periods with or without CCTV coverage (e.g., using mobile cameras). In addition, future evaluations could include interviews with potential offenders to find out their motives (e.g., whether they make rational choices) and what they know about the CCTV project, and could test more hypotheses about moderators that influence the effects of CCTV (e.g., characteristics of areas) and mediators between CCTV and crime (e.g., the fear of being detected). Better measures of effect size (possibly based on time series analyses) are needed. Also, future research could systematically study the effect of CCTV in conjunction with or separately from other interventions such as improved lighting. Future research should learn from the positive results of this evaluation (the desirable effects on vehicle crimes in train station car parks) to suggest how CCTV could be implemented more effectively in residential areas and town centers, by maximizing the coverage,

combining it with other interventions, and targeting crimes that involve cost–benefit decisions.

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## Appendix

### Measuring effect sizes

In order to carry out a meta-analysis, there has to be a comparable measure of effect size in every evaluation. Welsh and Farrington (2002) found that the only comparable data that were reported in every CCTV evaluation was the number of crimes in time periods before and after the implementation of CCTV schemes. As far as possible, they analyzed the numbers of crimes in 12-month periods before and after:

| | Before | After |
|---|---|---|
| Experimental | a | b |
| Control | c | d |

They used the odds ratio (OR) as the measure of effect size:

$$OR = (a*d)/(b*c)$$

This measure is intuitively meaningful because it indicates the relative change in crimes in the control area compared with the experimental area. In this article, it is termed the "relative effect size" (RES).[7] RES=2 indicates that d/c (control after/control before) is twice as great as b/a (experimental after/experimental before). This value could be obtained, for example, if crimes doubled in the control area and stayed constant in the experimental area, or if crimes decreased by half in the experimental area and stayed constant in the control area, or in numerous other ways.

[7] The term "odds ratio" was used by Welsh and Farrington (2002) because they viewed b/a and d/c as measuring the odds of crimes occurring after or before. However, because this is a non-standard use of the term "odds ratio", the term "relative effect size" is used in this article.

The variance of the OR is usually calculated from its natural logarithm LOR:

$$VAR(LOR) = 1/a + 1/b + 1/c + 1/d$$

In this article, we use LRES, the natural logarithm of RES, and refer to VAR (LRES). This calculation of VAR (LRES) is based on the assumption that crimes occur at random, according to a Poisson process. This assumption is plausible because 30 years of mathematical models of criminal careers have been dominated by the assumption that the commission of crimes can be accurately modeled by a Poisson process (Blumstein et al., 1986; Piquero et al., 2003). In a Poisson process, the variance of the number of crimes is the same as the number of crimes. Unfortunately, the distribution from one year to the next of the number of crimes in small areas is not known.

The problem is how to distinguish year-to-year changes in crime that are caused by CCTV from changes caused by numerous other influencing factors. In comparisons of only one small experimental area with one small control area, it is likely that other interventions (e.g., new policing strategies) and other influencing factors (e.g., the release of a prolific offender from prison) will impinge differentially on the experimental and control areas. These other factors will increase the variance of the number of crimes in an area and will make it more difficult to detect any effect of CCTV.

Our estimate of VAR (LRES) was based on the variance of the monthly number of crimes. The yearly variance was estimated as 12-times the monthly variance. If the yearly variances are denoted by Va, Vb, Vc and Vd:

$$VAR(LRES) = \left[\frac{Va}{a^2} + \frac{Vb}{b^2} + \frac{Vc}{c^2} + \frac{Vd}{d^2}\right]$$

In a Poisson process, Va=a (etc.), and this equation reduces to the usual one above. This estimate of VAR (LRES) is too high, because, unlike yearly figures, monthly numbers of crimes are influenced by seasonal factors. Hence, using this estimate means that the significance tests are conservative.

Excluding Hawkeye (where the number of crimes is based on 57 car parks), 70 sets of monthly crime figures were available for before and after periods in target, control and buffer areas and Divisions.[8] For each area in each year, the total number of crimes N was compared with V/N, where V is the estimated variance of the number of crimes (based on monthly numbers). In a Poisson process, V/N=1.

[8] Table 3 shows 36 areas with police data before and after, but the Division was the same for Market Town and Shire Town, leaving 35 different areas.

It was clear that V/N increased with the total number of crimes. The correlation between V/N and N was 0.77 ($P<0.0001$). A linear regression analysis showed that $V/N = .0008*N + 1.2$

This equation suggests that Poisson (random) variation is more important at small values of N, but that influencing factors become more important as N increases. For values of N up to 1000, V/N was between 1 and 2. Given the median value of N of 760, it might be expected that the median value of V/N would be 1.8, but in fact it was 2.3. The average value of V/N was 1.45 for the lowest ten numbers of crimes (average 105 crimes), 1.58 for the next ten (average 297), 1.97 for the next ten (average 485), 2.86 for the next ten (average 769), 4.56 for the next ten (average 2,650), 5.76 for the next ten (average 7,295) and 19.20 for the highest ten (average 24,327). Therefore, the Poisson assumption is most applicable for comparisons of small areas (target vs control or buffer), not for comparisons of target areas with Divisions.

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