

ANDREW R. MORRAL, TERRY L. SCHELL, BRANDON CROSBY, ROSANNA SMART, ROSE KERBER,
JUSTIN LEE

Preliminary Findings from the Aerial Investigation Research Pilot Program

In this report, we provide a preliminary description of the clearance rates achieved by the Baltimore Police Department (BPD) during the six-month pilot test of the Aerial Investigation Research (AIR) program. We do not provide an effectiveness analysis for citywide crime and policing outcomes because the data necessary to perform that analysis are not yet available. To evaluate the citywide effect of the AIR pilot program on crime and clearance rates, we would need to examine the program's effect on all crimes and their investigation. This is because the AIR program might affect when crimes are committed (e.g., shifting them to nighttime hours when the AIR program was not operational), or it could improve the efficiency of police investigations, increasing the policing resources available for cases that did not receive AIR evidence.

Instead, we examine the more limited question of whether cases are more likely to be cleared or solved by police when AIR evidence is available for them. We also offer statistical information about targeted crimes during the pilot, how many cases involved AIR evidence, and clearance rates for cases with and without AIR evidence.

The results in this report are provisional and reflect case outcomes as of November 5, 2020. Some cases that received evidence from the AIR pilot are still under investigation and might yet result in arrests. We treat as *provisionally cleared* those cases determined by detectives themselves to have been successfully cleared as defined by the Federal Bureau of Investigation (2019a): The case has been closed by arrest or by exception (e.g., the suspect had died, the victim refused to press charges). Some of these cases might be reopened after the routine oversight reviews that are required before cases can be officially counted as cleared, a process that can lag months behind detectives' reports. The statuses of several cases in our review are uncertain because BPD records contain inconsistent information about whether cases involve crimes that were authorized for investigation through the AIR pilot. We will produce a final report by spring 2022 that resolves many of these uncertainties and that estimates the effectiveness of the AIR pilot.

The AIR Pilot Program

Baltimore has experienced low crime clearance rates in recent years. U.S. cities of comparable size to Baltimore have an average murder clearance rate of 55 percent, but Baltimore's 2019 murder rate was

only 32 percent, one of the lowest clearance rates that Baltimore has recorded in recent decades (Federal Bureau of Investigation, 2019b). As suggested by Cook and Ludwig (2018), low clearance rates might cause more crime. Victims could seek out street justice because they do not believe going to the police will produce results. In addition, low clearance rates could undermine community support and cooperation with police if citizens believe that the police have little interest in solving crimes or if witnesses feel that the risk of cooperation with the police outweighs the probability that their assistance will pay off with an arrest. To help reverse the downward trend in clearance rates, at the end of 2019, the police commissioner of Baltimore announced that Baltimore Police Department would conduct a six-month pilot test of AIR.

The AIR pilot program was designed to facilitate police investigations of four types of crime, as set out in a memorandum of understanding (MOU) between the BPD and Persistent Surveillance Systems (PSS), the private firm providing the AIR pilot capabilities. *MOU crimes* are homicides, nonfatal shootings, armed robberies, and carjackings. In the original plans, three manned aircraft equipped with powerful cameras would fly above the city during daylight hours, capturing a second-by-second record of outdoor events. Imagery from the aircraft could then be used to support crime investigations. Suspects and witnesses could be tracked forward and backward in time from any crime scenes captured by the aircraft. When aerial imagery showed suspects passing Citiwatch closed-circuit television cameras or BPD license plate readers, AIR analysts working for PSS could access those BPD systems to identify license plate numbers, facial imagery, and other information that could be useful for solving crimes.

Abbreviations

AIR	Aerial Investigation Research
BPD	Baltimore Police Department
MOU	memorandum of understanding
PSS	Persistent Surveillance Systems
RMS	records management system
UCR	Uniform Crime Reporting

The six-month AIR pilot began on May 1, 2020, and continued until October 31, 2020. Planes flew during daylight hours only. Planes were grounded when rain, low clouds, or other weather conditions impeded visibility or presented safety hazards. Planes were supposed to fly at 9,500 feet above sea level, but clouds often forced them to fly at a lower altitude. In the first weeks of the pilot program, planes were permitted to fly at 3,500 feet, but noise complaints from city residents led the BPD to raise the minimum altitude for operations to 4,500 feet on May 18. This reduced the number of days that planes could fly because they were more likely to be affected by clouds at this higher altitude. In addition, when two aircraft were in the same AIR coverage zone, collision avoidance rules required that they maintain 1,000 feet of vertical separation; this meant that sometimes one plane was pushed above the cloud ceiling and could not record footage.

The original plan was for three aircraft to work together to collect imagery for more than 90 percent of Baltimore. However, during most of the first two months of the pilot, only a single plane was operational, limiting coverage to either the western and central parts or the eastern and central parts of the city. In late June, a second plane began to be used, and it was declared fully operational by PSS staff on July 6, 2020. The AIR pilot program collected an average of 5.7 hours of imagery per day in May, 7.7 hours of imagery per day in early June, and 9.1 hours of imagery per day for the remainder of the pilot program (during which there were two operational planes). PSS did acquire a third plane, but it was not readied for AIR operations in time to be used during the pilot. The slow start and the reliance on two planes, rather than three, contributed to the AIR pilot program logging less than 40 percent of its originally planned 4,300 flight hours.

Other challenges in May and June contributed to lower numbers of cases investigated with AIR evidence. Initially, AIR evidence was not analyzed unless a detective specifically requested it. Few detectives did so, possibly because they were unfamiliar with the pilot or the request process. Beginning in early July, BPD leadership changed the request protocol so that a request for AIR evidence was automatically generated for all MOU crimes. In addition,

some technical problems with the AIR evidence request process led to the AIR pilot not receiving some requests made by detectives during the pilot's first months. Finally, although PSS proposed that information from the BPD's Computer Aided Dispatch, Shot Spotter, and License Plate Reader systems be provided to the AIR pilot, ultimately, the BPD did not provide these resources to it.

For these reasons, the AIR pilot program was never fully operational as originally proposed, although it approached its maximum operational capabilities around the first week of July, when PSS leadership indicated its second plane was fully operational and the BPD request process was changed. Our data and analyses cover the entire pilot period; in the appendix, we provide additional analyses that examine pilot data only from July to October 2020, when the pilot was at its maximum operational capabilities.

Crimes and Investigations During the AIR Pilot

During the six-month AIR pilot, 1,532 MOU crimes were reported across the city of Baltimore. Table 1 describes the types of MOU crimes that were reported, along with case outcomes classified by whether police investigators received AIR evidence. Of the MOU crimes reported, 211 (14 percent) occurred at a place and time when an AIR aircraft

was overhead. The AIR pilot received a request for evidence and provided evidence for 75 percent of these crimes (158 crimes).

Table 1 also includes data for two types of case outcomes: provisionally cleared and provisionally solved. Provisionally cleared, as noted earlier, means that at least one of the crimes associated with a case has been cleared by arrest or by exception, according to either the database used by the investigating detective or the BPD records management system. Case status updates in the record management system sometimes lag by many months pending an official Uniform Crime Reporting (UCR) review, so we cannot rely on this system for recent outcomes. *Provisionally solved* is a broader category of outcomes that includes all provisionally cleared cases as well as cases that were closed because they were unfounded (i.e., police determined that no crime actually occurred), those that were originally reported as an MOU crime but were subsequently determined to be something else (e.g., a carjacking that was reclassified as a robbery), and cases that remain open but for which an arrest warrant has been issued by a court.

Across MOU crime types, 24 percent of cases with AIR evidence have been cleared by arrest or exception to date, compared with 16 percent of cases for which no AIR evidence was available. Similarly, 30 percent of cases with AIR evidence have been pro-

TABLE 1
Summary of All Memorandum-of-Understanding Cases in Baltimore City During the Aerial Investigation Research Pilot

	Homicides	Shootings	Armed Robberies	Carjackings	Total
All MOU crimes	168	332	777	255	1,532
Crimes with AIR evidence	36 (21%)	30 (9%)	66 (8%)	26 (10%)	158 (10%)
<i>Provisionally cleared</i>	10 (28%)	7 (23%)	12 (18%)	9 (35%)	38 (24%)
<i>Provisionally solved</i>	11 (31%)	7 (23%)	20 (30%)	10 (38%)	48 (30%)
Crimes with no AIR evidence	132 (79%)	302 (91%)	711 (92%)	229 (90%)	1,374 (90%)
<i>Provisionally cleared</i>	23 (17%)	38 (13%)	116 (16%)	42 (18%)	219 (16%)
<i>Provisionally solved</i>	26 (20%)	42 (14%)	175 (25%)	53 (23%)	297 (22%)

NOTES: Provisionally cleared and provisionally solved rates describe the percentage of the next higher-level total represented by the corresponding count. For instance, 158 MOU crimes with AIR evidence is 10 percent of all MOU crimes, and 38 provisionally cleared cases with AIR evidence is 14 percent of all crimes with AIR evidence.

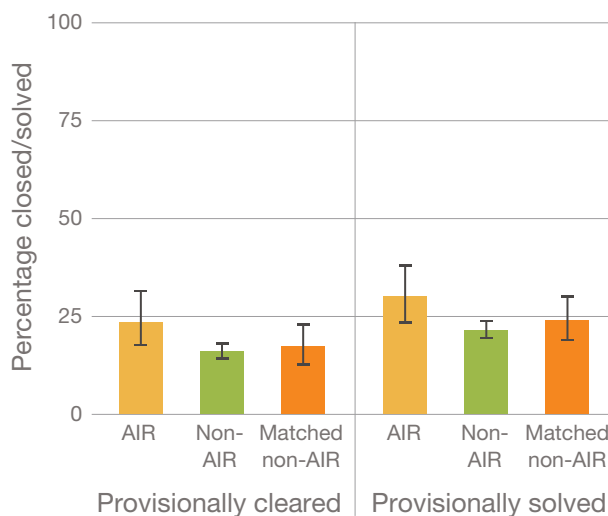
visionally solved to date, compared with 22 percent of cases for which no AIR evidence was available. For individual crime types, cases have been provisionally cleared or solved at rates 2 to 16 percent higher when AIR evidence was provided compared with when it was not.

Despite the higher proportion of positive outcomes for AIR cases, this crude comparison of rates is misleading because there are systematic differences between the types of cases for which AIR evidence is available and those for which it is not. For instance, AIR evidence is typically only available for cases that occur during daylight hours. Historically, cases that occur during daylight hours in Baltimore are cleared at higher rates than those occurring at night. Cases with AIR evidence occur primarily in a few police districts, and clearance rates vary across districts. Similarly, AIR cases consist of a higher percentage of homicides than non-AIR cases, and homicides are cleared at a higher rate than other MOU crimes. Therefore, we would expect cases with AIR evidence to have a higher clearance rate, even if AIR had no effect on clearance rates. Other factors, too—such as weather, day of the week, and whether the crime is a domestic violence incident—could differ between AIR and non-AIR cases and affect clearance rates in ways unrelated to the AIR program.

Because there are systematic differences that could affect clearance and solve rates between cases with and without AIR evidence, simple comparisons of rates between these two groups are difficult to interpret. A more interpretable comparison would be between AIR cases and a matched subset of other cases that are similar to the AIR cases in terms of when and where they occurred and in terms of other characteristics that could affect clearance rates. We constructed such a comparison group from the 1,374 non-AIR cases that occurred during the pilot using propensity score weighting (see the methodological appendix).

Figure 1 illustrates provisionally cleared and solved rates for all cases with AIR evidence, all cases without AIR evidence, and the subset of cases without AIR evidence that are weighted to more closely match the characteristics of the cases with AIR evidence. As is evident from this figure, identifying the subgroup of non-AIR cases that are most similar to

FIGURE 1
Rates at Which Crimes Were Provisionally Cleared and Solved



NOTES: Sample sizes for AIR and non-AIR cases are 158 and 1,374, respectively. Effective sample size for the matched non-AIR cases is 254.

AIR cases has only a modest effect on the comparison groups' clearance and solve rates, but we nevertheless have more confidence that the comparison is being made between comparable cases.

When we compare the provisional clearance rates for AIR cases and our matched comparison cases, the difference is not significant (difference = 7 percentage points, $t = 1.61$, $p = 0.11$). Similarly, there is no statistically significant difference between provisionally solved rates between AIR cases and our matched comparison cases (difference = 6 percentage points, $t = 1.39$, $p = 0.16$). This lack of statistical significance does not necessarily mean that the AIR program is ineffective, but it does mean that, with the evidence that has accumulated to date, we cannot rule out the possibility that AIR evidence packages are not associated with the rate at which cases are cleared or solved.

The matching procedure we used for these analyses does not account for the fact that some cases close quickly, such as when the suspect is arrested at the crime scene (Cook et al., 2019). These cases close before AIR evidence would ever need to be used. The primary benefit of the AIR pilot might be expected to be found among the more-difficult cases that are not resolved at the crime scene or shortly afterward. If we

think of AIR as helpful for more-difficult cases, we can better estimate the effects of AIR evidence packages on this subset of cases by excluding from the analysis all cases that close on the day of the crime or the next day.^A Therefore, using just the cases that did not close within one day, we compared clearance rates for those with AIR evidence packages to a matched comparison group without AIR evidence packages (see Figure 2). Restricting the analysis to more-difficult cases reduced the sample sizes of each group to 142, 1,275, and 256 for the AIR, non-AIR, and matched non-AIR groups, respectively. Removing the easier cases also reduced provisional clearance rates for the AIR cases to 15 percent, for non-AIR cases to 9 percent, and for matched non-AIR cases to 9 percent. For these more-difficult cases, this 7-percentage point difference in provisional clearance rates for AIR cases and matched comparison cases was statistically significant ($t = 2.09, p = 0.04$).^B Similarly, AIR evidence packages were associated with a 7-percentage point difference in rates at which cases were provisionally solved, but this difference did not quite reach statistical significance ($t = 1.77, p = 0.08$).

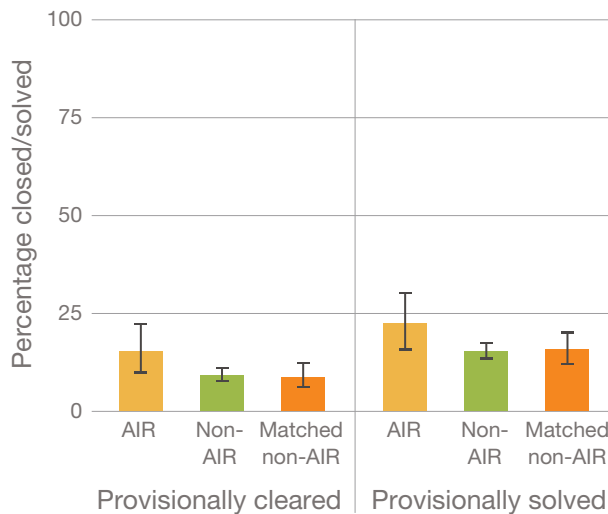
Discussion

Although our analyses suggest that the AIR pilot was associated with increased clearance rates for more-difficult cases, relatively few cases received AIR evidence, limiting the overall effect that the pilot could have on BPD clearance rates citywide. The AIR pilot program produced evidence packages on just 158 of the 1,532 MOU crimes that occurred during the pilot. If those evidence packages are associated with a

^A Excluding all cases that are closed on the day of the crime or the following day may result in the exclusion of some cases for which the AIR program did, in fact, aid in the clearance of the case. In some cases, detectives contacted the AIR program and received information by phone or through briefings shortly after visiting the crime scene. However, excluding cases closed within one day of the crime probably disproportionately excludes cases that were solved at the crime scene or shortly thereafter—i.e., it disproportionately excludes the less difficult cases for which the AIR program would not be required.

^B The 7-percentage point difference seems inconsistent with the provided rates because of rounding. The AIR (15.49 percent) and matched non-AIR (8.90 percent) values round to 15 percent and 9 percent, but their difference rounds to 7 percent.

FIGURE 2
Rates at Which Crimes Were Provisionally Cleared and Solved Among All Cases That Were Not Cleared on the Day of the Crime or the Next Day



NOTES: Sample sizes for AIR and non-AIR cases are 142 and 1,275, respectively. Effective sample size for the weighted non-AIR cases is 256.

7-percentage point improvement in provisional cleared cases, this would imply that approximately 11 additional MOU crimes might have been cleared with the AIR packets relative to what would have been cleared without them. Even if one assumes that the program increased rates of provisionally cleared cases by 17 percentage points (the maximum benefit that is consistent with the available data), this would imply that about 27 more MOU crimes would have been cleared with the program than without it. Under these optimistic assumptions, the overall rate of cleared MOU crimes across Baltimore would increase by approximately 1.8 percent. Had the program been fully implemented throughout the pilot period, we would expect that a larger number of cases would have received AIR evidence and that a larger number of crimes for which AIR evidence was available would have been cleared or solved.

It is possible that the AIR program is more effective for specific MOU crimes, such as shootings or carjackings, for which rates of cases provisionally cleared appear to be higher when AIR evidence is available. However, the numbers of cases available to assess these differences is quite small, meaning that

all such comparisons are unreliable, and we are not able to construct matched comparison cases for these specific crimes.

These are preliminary findings and should not be interpreted as a conclusion about the overall effectiveness of the AIR program for several reasons. The data on which these analyses are based are not final and might change once sufficient time has passed to investigate all crimes that occurred during the pilot. Case statuses might also change after UCR review. Moreover, the analyses presented here do not account for many possible effects of the program on the wider set of crimes and investigation outcomes that could substantially influence our conclusions about the effects of the AIR program on crime and police investigations. For instance, the AIR program could cause decreases in crime rates because of a deterrent effect. The AIR program could also increase clearance rates for all MOU crimes by making BPD detectives more efficient. If that were true, the current preliminary analysis would underestimate the benefits of the program. Alternatively, if AIR evidence causes a reallocation of effort from other cases, examining only the effect of AIR evidence on the cases for which it was available would overstate the benefits of the program.

The matching strategy we used to identify non-AIR cases to AIR cases also has limitations. Although the matched cases do, on average, occur at times and places comparable to AIR cases, they might still differ from AIR cases in important and systematic ways that make them a misleading comparison group. For example, some AIR evidence packages

were produced because BPD detectives actively investigating specific crimes requested them. Therefore, some of the crimes with AIR evidence packets might have been more actively investigated than the crimes in our matching set—a difference that might result in a spurious difference in clearance rates between cases with and without AIR evidence.

These and other hypothetical effects of the AIR program cannot be evaluated with the analyses that we have presented in this report. Therefore, in this report, we provide no conclusions on the effectiveness of the AIR program; we only provide preliminary information on differences in clearance rates for AIR and non-AIR cases shortly after the pilot had ended, which might prove useful for BPD policymakers. We will release a final report that estimates the effectiveness of the AIR pilot on crime and clearance rates in Baltimore in spring 2022.

Finally, there are other possible benefits and harms of the AIR program that we have not examined in this report. For example, the program might provide evidence that improves prosecutor's conviction rates in court; it might facilitate BPD internal investigations; it might be used by defense counsel to support the cases of innocent defendants; and it might affect police-community relations (for better or worse). Although these and other possible effects of the program are important, improving the rate of arrests for serious crimes was one of the BPD's primary motivations for piloting the AIR program, so we considered this as the primary outcome in this report.

Methodological Appendix

In this appendix, we describe in greater technical detail how we identified cases described in this report, and how we conducted the propensity score analysis to derive case weights to construct a comparison set of cases that better match the characteristics of AIR cases. At the same time, we present analyses for the portion of the AIR pilot during which the program had achieved its maximum operational capabilities, the period from July to October 2020.

Identification of Cases

Cases were counted as MOU crimes during the pilot period if they were classified as a homicide, a non-fatal shooting, an armed robbery, or a carjacking in the BPD’s Lotus Notes data system. This data system is used to record findings from BPD investigations, and it sometimes includes more-accurate crime type information than is initially entered in BPD’s records management system (RMS). The RMS is initially populated with information from the call for service, and this information can be inaccurate. Once a detective investigates the crime, they enter a more accurate crime description in Lotus Notes. Information in the Lotus Notes–based data system and RMS is later reconciled through a formal UCR review, although this review sometimes occurs months after the crime is first investigated. Cases

with no Lotus Notes crime type information are assumed to be the crime type listed in the RMS.

For our secondary analysis of more-difficult cases, we excluded cases that cleared within one day of the crime. In some cases, there were discrepancies between the Lotus Notes system and the RMS for incident dates or dates that the case cleared. In these cases, we treated the earlier incident date or the earlier clearance date as the correct one.

Table A.1 summarizes cases and case outcomes from July 1 through October 31—when AIR pilot activity was highest.

Constructing a Matched Comparison Group of Cases

As discussed in the report, AIR crimes and other MOU crimes can have systematically different characteristics, such as whether they occurred during the day or at night; such characteristics are known to affect clearance rates. Table A.2 describes differences between AIR and non-AIR cases across the characteristics we used to construct a weighted set of comparison cases. In addition to crime type, time, day, and month indicators, other case characteristics we considered in identifying well-matched comparison cases from the non-AIR cases included whether the crime involved domestic violence, occurred indoors or outdoors, or occurred during bad weather. For the latter variable, we linked to Meteorological

TABLE A.1
Memorandum-of-Understanding Crimes from July 1 to October 31, 2020

	Homicides	Shootings	Armed Robberies	Carjackings	Total
All MOU crimes	105	229	518	187	1,039
Crimes with AIR evidence	26 (25%)	15 (7%)	48 (9%)	22 (12%)	111 (11%)
<i>Provisionally cleared</i>	6 (23%)	1 (7%)	9 (19%)	7 (32%)	23 (21%)
<i>Provisionally solved</i>	7 (27%)	1 (7%)	15 (31%)	7 (32%)	30 (27%)
Crimes with no AIR evidence	79 (75%)	214 (93%)	470 (91%)	165 (88%)	928 (89%)
<i>Provisionally cleared</i>	12 (15%)	21 (10%)	66 (14%)	31 (19%)	130 (14%)
<i>Provisionally solved</i>	15 (19%)	25 (12%)	105 (22%)	38 (23%)	183 (20%)

NOTES: Provisionally cleared and provisionally solved rates describe the percentage of the next higher-level total represented by the corresponding count. For instance, 111 MOU crimes with AIR evidence is 11 percent of all MOU crimes, and 23 provisionally cleared cases with AIR evidence is 21 percent of all crimes with AIR evidence.

TABLE A.2

Proportion of AIR Cases, Non-AIR cases, and Weighted Comparison Cases with Characteristics Used for Identifying Cases Similar to AIR Cases

	All Pilot Cases			Cases from July to October			All More-Difficult Cases		
	AIR	Non-AIR	Non-AIR Weighted	AIR	Non-AIR	Non-AIR Weighted	AIR	Non-AIR	Non-AIR Weighted
n/ESS:	158	1,374	254	111	928	266	142	1,275	256
day:Monday	0.16	0.16	0.15	0.15	0.16	0.13	0.16	0.16	0.16
day:Tuesday	0.18	0.11	0.17	0.14	0.11	0.13	0.18	0.11	0.14
day:Wednesday	0.13	0.14	0.11	0.14	0.14	0.13	0.12	0.14	0.11
day:Thursday	0.1	0.14	0.1	0.12	0.14	0.14	0.09	0.14	0.1
day:Friday	0.13	0.15	0.16	0.14	0.16	0.18	0.14	0.15	0.17
day:Saturday	0.18	0.15	0.18	0.15	0.15	0.16	0.18	0.15	0.18
day:Sunday	0.13	0.15	0.14	0.15	0.13	0.14	0.13	0.15	0.14
month:5	0.15	0.16	0.15	0	0	0	0.16	0.16	0.16
month:6	0.15	0.16	0.14	0	0	0	0.14	0.16	0.15
month:7	0.18	0.15	0.17	0.26	0.22	0.24	0.2	0.15	0.18
month:8	0.19	0.18	0.2	0.27	0.26	0.27	0.19	0.18	0.19
month:9	0.14	0.17	0.14	0.2	0.25	0.23	0.13	0.17	0.12
month:10	0.19	0.18	0.19	0.27	0.27	0.26	0.18	0.18	0.19
time:12am_2am	0.02	0.13	0.03	0.03	0.12	0.04	0.03	0.13	0.03
time:2am_4am	0	0.09	0.01	0	0.08	0.02	0	0.09	0.01
time:4am_6am	0.01	0.06	0.01	0.02	0.06	0.02	0.01	0.05	0.01
time:6am_8am	0.01	0.03	0.01	0.01	0.03	0.01	0.01	0.03	0.01
time:8am_10am	0.04	0.04	0.04	0.04	0.04	0.05	0.04	0.04	0.04
time:10am_12pm	0.13	0.05	0.12	0.14	0.05	0.13	0.14	0.04	0.12
time:12pm_2pm	0.18	0.06	0.17	0.16	0.06	0.15	0.16	0.06	0.17
time:2pm_4pm	0.11	0.07	0.11	0.14	0.07	0.14	0.11	0.07	0.11
time:4pm_6pm	0.26	0.06	0.24	0.27	0.06	0.22	0.25	0.06	0.21
time:6pm_8pm	0.13	0.1	0.15	0.13	0.1	0.14	0.13	0.1	0.15
time:8pm_10pm	0.07	0.15	0.08	0.05	0.15	0.06	0.08	0.15	0.09
time:10pm_12am	0.02	0.16	0.03	0.01	0.18	0.04	0.03	0.17	0.04
crimecat: armed robbery	0.42	0.52	0.46	0.43	0.51	0.5	0.41	0.51	0.46
crimecat:carjacking	0.16	0.17	0.18	0.2	0.18	0.19	0.16	0.16	0.16
crimecat:homicide	0.23	0.1	0.18	0.23	0.08	0.14	0.22	0.1	0.18
crimecat:shooting	0.19	0.22	0.18	0.14	0.23	0.18	0.21	0.23	0.2
district:CENTRAL	0.08	0.1	0.1	0.06	0.09	0.08	0.07	0.1	0.08

	All Pilot Cases			Cases from July to October			All More-Difficult Cases		
	AIR	Non-AIR	Non-AIR Weighted	AIR	Non-AIR	Non-AIR Weighted	AIR	Non-AIR	Non-AIR Weighted
district:EASTERN	0.13	0.1	0.14	0.13	0.08	0.1	0.14	0.1	0.15
district:Multiple	0.02	0.02	0.02	0.02	0.03	0.02	0.03	0.03	0.03
district: NORTHEAST	0.15	0.12	0.14	0.14	0.11	0.14	0.14	0.12	0.12
district: NORTHERN	0.05	0.1	0.05	0.04	0.1	0.07	0.05	0.09	0.06
district: NORTHWEST	0.08	0.11	0.07	0.08	0.12	0.07	0.08	0.11	0.08
district: SOUTHEAST	0.13	0.13	0.13	0.13	0.14	0.13	0.13	0.12	0.14
district: SOUTHERN	0.08	0.09	0.08	0.1	0.09	0.1	0.07	0.09	0.06
district: SOUTHWEST	0.12	0.11	0.1	0.14	0.11	0.12	0.11	0.12	0.1
district: WESTERN	0.13	0.08	0.13	0.14	0.08	0.13	0.14	0.08	0.14
Domestic	0.01	0.02	0.01	0	0.02	0.02	0.01	0.02	0.01
Badweather	0.06	0.13	0.06	0.06	0.14	0.07	0.07	0.13	0.07
Indoors	0.17	0.18	0.15	0.14	0.18	0.16	0.18	0.17	0.16
in_pss_zone_north	0.34	0.34	0.3	0.35	0.35	0.3	0.35	0.34	0.33
in_pss_zone_east	0.59	0.46	0.59	0.55	0.46	0.48	0.58	0.46	0.56
in_pss_zone_west	0.63	0.5	0.57	0.64	0.5	0.56	0.63	0.5	0.57
in_pss_zone_southwest	0.41	0.4	0.43	0.42	0.39	0.45	0.41	0.4	0.42

NOTES: n = the sample size in the AIR and non-AIR groups. ESS = the effective sample size of the matched non-AIR group. More-difficult cases = all MOU cases that did not close on the day of the crime or the next day.

Aerodrome Report data from Baltimore/Washington International Thurgood Marshall Airport describing cloud coverage information based on incident time. “Badweather” was assigned if a code of BKN (broken), OVC (overcast, i.e., full cloud coverage) or VV (vertical visibility; i.e., clouds cannot be seen because of fog or heavy precipitation) was indicated at an altitude less than 3,000 feet. Finally, we considered which of PSS’s four flight areas a crime occurred in (downtown and east, downtown and west, north, and southwest). Because these areas overlap, crimes can be coded as being in more than one flight area. As can be seen in Table A.2, prior to weighting, AIR and non-AIR cases differed substantially on many of these case characteristics.

Propensity scores and corresponding weights were constructed using the twang package in the R Statistical Programming language (twang version 1.6, Ridgeway et al., 2020). For our analyses, propensity scores (p) are the probabilities that each case in the dataset is an AIR case, based on a statistical model that predicts whether cases had AIR evidence based on the covariates listed in Table A.1. Cases that share characteristics with AIR cases are estimated to have higher propensity scores; those that share fewer characteristics with AIR cases have lower scores. Cases that did have AIR data all receive a weight of one, whereas comparison cases are weighted by the odds associated with their propensity scores: $p/(1-p)$. Weighted means and comparisons between

means were calculated using the survey package in R (Lumley, 2020).

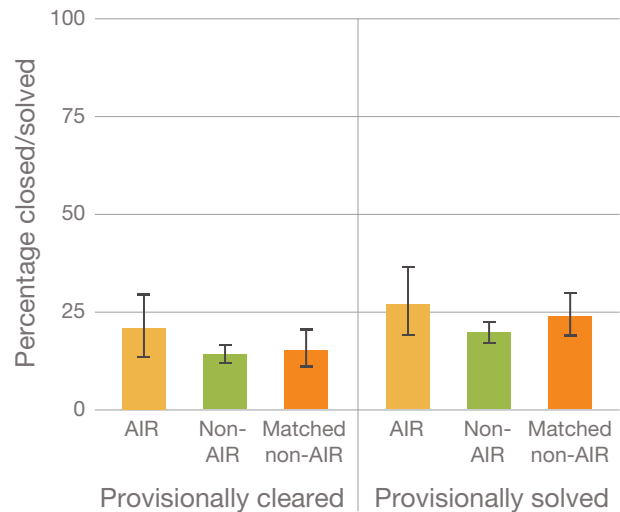
We constructed three sets of weights designed to match non-AIR cases to AIR cases occurring any time during the pilot for our main analyses

1. match non-AIR cases to AIR cases occurring from July 1 to October 31, 2020, the period of maximum AIR program capacity.
2. match AIR cases to non-AIR cases among the subset of MOU crimes that occurred during the pilot and were not closed on the day of the crime or the next day for our analysis of more difficult cases.

As seen in Table A.1, each sets of weights effectively reduced the differences between the AIR and non-AIR case characteristics we considered. Although several characteristics were statistically significantly different before weighting (not shown), none remained so after weighting. Using these weights, we then calculated the rates of provisional clearances and solved cases for the weighted non-AIR cases shown in Figure 1, Figure 2 and Figure A.1, which displays the analyses for the last four months of the pilot.

For cases during the period of maximum AIR operational capacity there is no statistically significant difference between provisionally cleared rates for AIR cases and rates for non-AIR cases (difference = 6 percentage points, $t = 1.27$, $p = 0.2$). (Recall that this was also true for the analysis with the full sample of MOU cases.)

FIGURE A.1
Rates at Which Crimes Were Provisionally Cleared and Solved, July 1 to October 31 Subset



NOTES: Sample sizes for AIR and non-AIR cases are 111 and 928, respectively. Effective sample size for the weighted non-AIR cases is 266.

Similarly, there is no statistically significant difference between provisionally solved rates (difference = 3 percentage points, $t = 0.61$, $p = 0.54$). Again, the lack of a statistically significant difference in case outcomes should not be interpreted as evidence that AIR had no effect. This report provides preliminary data on outcomes that are still changing because open cases remain under investigation. Moreover, our analyses may not have sufficient statistical power to detect small differences in case outcomes.

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About This Report

Baltimore has reported murder clearance rates as low as 32 percent in recent years. At the end of 2019, the police commissioner of Baltimore announced that the Baltimore Police Department (BPD) would conduct a six-month pilot test of Aerial Investigations Research (AIR), during which manned aircraft equipped with powerful cameras would facilitate investigations of four types of crime: homicides, nonfatal shootings, armed robberies, and carjackings. The pilot began on May 1, 2020, and continued until October 31, 2020. In this preliminary report, we provide an initial description of the clearance rates achieved by the BPD during the six-month pilot test, which might prove useful for BPD policy-makers. We do not draw conclusions about the effectiveness of the AIR pilot. An outcome evaluation of the AIR pilot will be included in the final report. This report was sponsored through a grant from Arnold Ventures.

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