Colonel Eliot K. Isaac, Police Chief

Expanding the Analytical Toolbox for Evidence Based Law Enforcement: A Comprehensive Metric for Violence at Micro-Places

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Increasingly, law enforcement agencies (LEAs) are expected to reduce crime within their respective jurisdictions. Therefore, law enforcement executives are encouraged to adopt strategies based upon the best available evidence (see: The Center for Evidence-Based Crime Policy's "Evidence-Based Policing Matrix") and operationalize new strategies from emerging criminological theories. This has shifted law enforcement from a process-driven model (e.g., critical incident management, tactical response) to a results-driven model. Within this shift, constant, timely feedback is required in order to inform leadership of progress and the on-going impact of strategies implemented by the organization.

Traditional crime analysis techniques have primarily measured general crime trends over long periods of time (e.g., year-to-date crime counts). Measuring reductions in *singular* crime categories (e.g., gunshot victims) over *short* time periods is often difficult (if not impossible) considering the relative infrequency of serious crimes and the level of focus required for effective crime reduction strategies. Instead, it is often necessary for LEAs to identify groups of outcomes describing the problems that police are attempting to address (e.g., gun violence, street crime). In accordance with these challenges, a gun violence metric was developed in order to inform the Cincinnati Police Department's Place-based Investigations of Violent Offender Territories (PIVOT) strategy. Specifically, this measure was developed based upon the following needs and principles:

1. Source data needs to be sufficiently large to provide meaningful figures
2. More serious events have a greater impact on the violence level of an area than less serious events;
3. Events occurring closer to the present date have a greater impact on perceptions of violence than events occurring longer ago;
4. Events occurring near a location have more impact at that location than events occurring far from the location.

These principles were used to analyze crime data and create violence scores for every location within Cincinnati.

First, four datasets were used to measure gun violence in Cincinnati: 1) shooting incidents, 2) robberies, 3) all crimes committed with guns, and 4) weapons-related calls-for-service (shootings, shots fired, gun, weapon, and robbery calls-for-service). These four datasets provide a sufficiently large number of incidents to identify a gun violence score for all 225,000 geographically-based cells (described in full detail below). Notably, these datasets overlap (e.g., the various calls-for-service categories can overlap with the incident measures and create duplicates). However, very few calls-for-service are entered into officially reported offenses.

Even on the highest priority calls, callers may erroneously report circumstances or call takers may misinterpret call information resulting in call-for-service misclassification. As detailed below, these duplication and misclassification problems can be mitigated by weighting these events across three dimensions. In total, 7,500+ total data points are available for analysis at any point in time when using these four datasets over all time periods analyzed (described in further detail below).

Second, events were weighted according to their seriousness. Seriousness was measured using the following weighting scheme:

1. Shooting Incidents = 20 points;
2. Robberies = 10 points;
3. Gun Offenses = 5 points;
4. Weapons-Related Calls-for-Service = 1 point;

These weights were determined based on the approximate portion of the total data each event type accounted for (e.g., at any given point in time, there were about 20 weapons-related calls-for-service for every shooting incident). Notably, the most reliable data (i.e., shooting incidents) accounted for the greatest portion of the score and the least reliable data (i.e., calls-for-service) accounted for the smallest portion. This minimizes potential errors associated with reporting issues and unverified data, including calls-for-service records. Additionally, post-hoc assessments of face validity show areas with the highest violence scores also are areas of interest related to gun violence. Therefore, this appears to be a useful method of weighting data in order to identify areas with the most serious incidents of gun violence.

Third, this measure introduces a recency bias. Traditionally, LEAs engaging in site- and/or area-specific crime prevention strategies (e.g., problem-solving) have relied largely upon measuring pre-post outcomes after lengthy "treatment" phases. This leaves strategies devoid of informative feedback; timely feedback is vital to monitor strategy successes and failures so that necessary alterations can be made to optimize successful outcomes. Time-weighting allows scores to change across short time periods, despite the infrequency of violent events. This provides the on-going feedback necessary to adjust proactive strategy activities. Additionally, greater influence is given to more recent events and the measure weights each event less as time passes after the date of the incident. This helps to account for the fading impact of an event on a community's collective memory and experience over time. Specifically, this metric scores events according to the following schedule:

1. Events occurring in the past 28 days are given the full value of their respective seriousness weight (i.e., 1.0 x weight)
2. Events occurring between 28 and 56 days ago are given 80% value of their respective seriousness weights (i.e., 0.8 x weight)
3. Events occurring between 56 and 112 days ago are given 60% value of their respective seriousness weights (i.e., 0.6 x weight)
4. Events occurring between 112 and 168 days ago are given 40% value of their respective seriousness weights (i.e., 0.4 x weight)

5. Events occurring between 168 and 224 days ago are given 20% value of their respective seriousness weights (i.e., 0.2 x weight)
6. Events occurring prior to previous 224 days do not contribute to violence scoring.

For example, a shooting that has occurred between 56 days and 112 days ago will be given a score of 12 points (i.e., 20 x 0.6 = 12). As constructed according to this schedule, data lose 40% of their value within the first 56 days and lose an additional 20% of their initial value for each subsequent 56-day period thereafter. This gives the most weight to offenses and calls-for-service occurring within the first 28 days of reference.

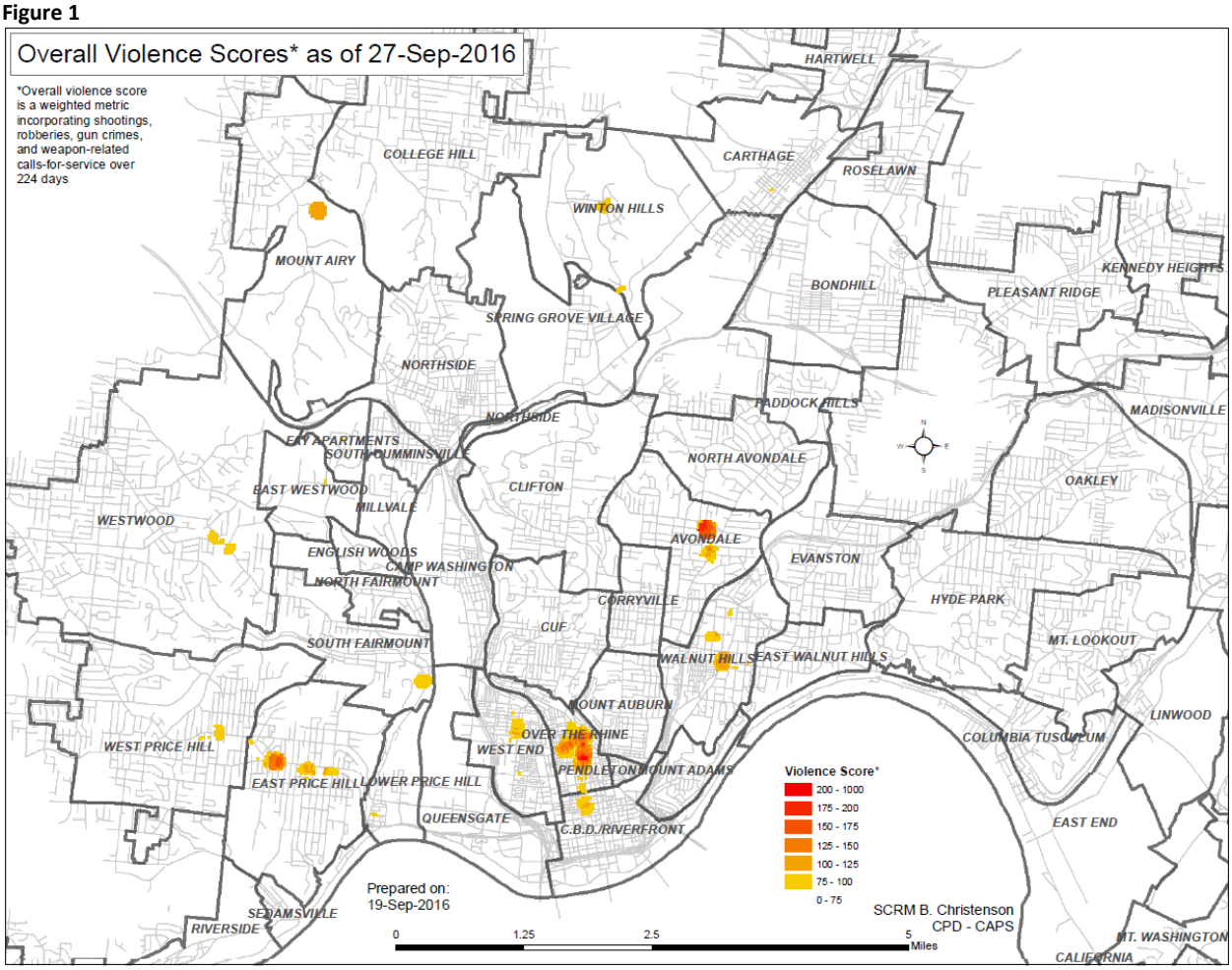
Fourth, in order to calculate the violence metric, Cincinnati was divided into 100-foot by 100-foot grid. Each cell was then given a score based upon all events (shooting incidents, robberies, gun crimes, and weapon-related calls-for-service) weighted by their seriousness and according to their time schedule occurring within 400 feet (approximately 1 block) of each cell. This is similar to the methodology commonly used for raster datasets, such as kernel density estimates. The 400-foot buffer distance was chosen based upon past research that suggests a 1 block influence of criminogenic places. This methodology can generate a violence score for every city location at any specific point in time.

Practical Uses

1. Raw score (citywide)

This metric can be used to identify and rank-order concentrated violence across a jurisdiction. Used in this way, violence scores resemble traditional hot spot mapping, transposed from raster to vector graphics, with one critical difference: a time-dimension is added to traditional location and seriousness weighting. Figure 1 provides one visual example of these data on September 27, 2016. Based upon previous exploratory analysis of these scores, a lower threshold score of 75 and 25-point violence category increments were used to identify and rank-order violent locations. Scores above 200 points were given the reddest color on a yellow-red color ramp.

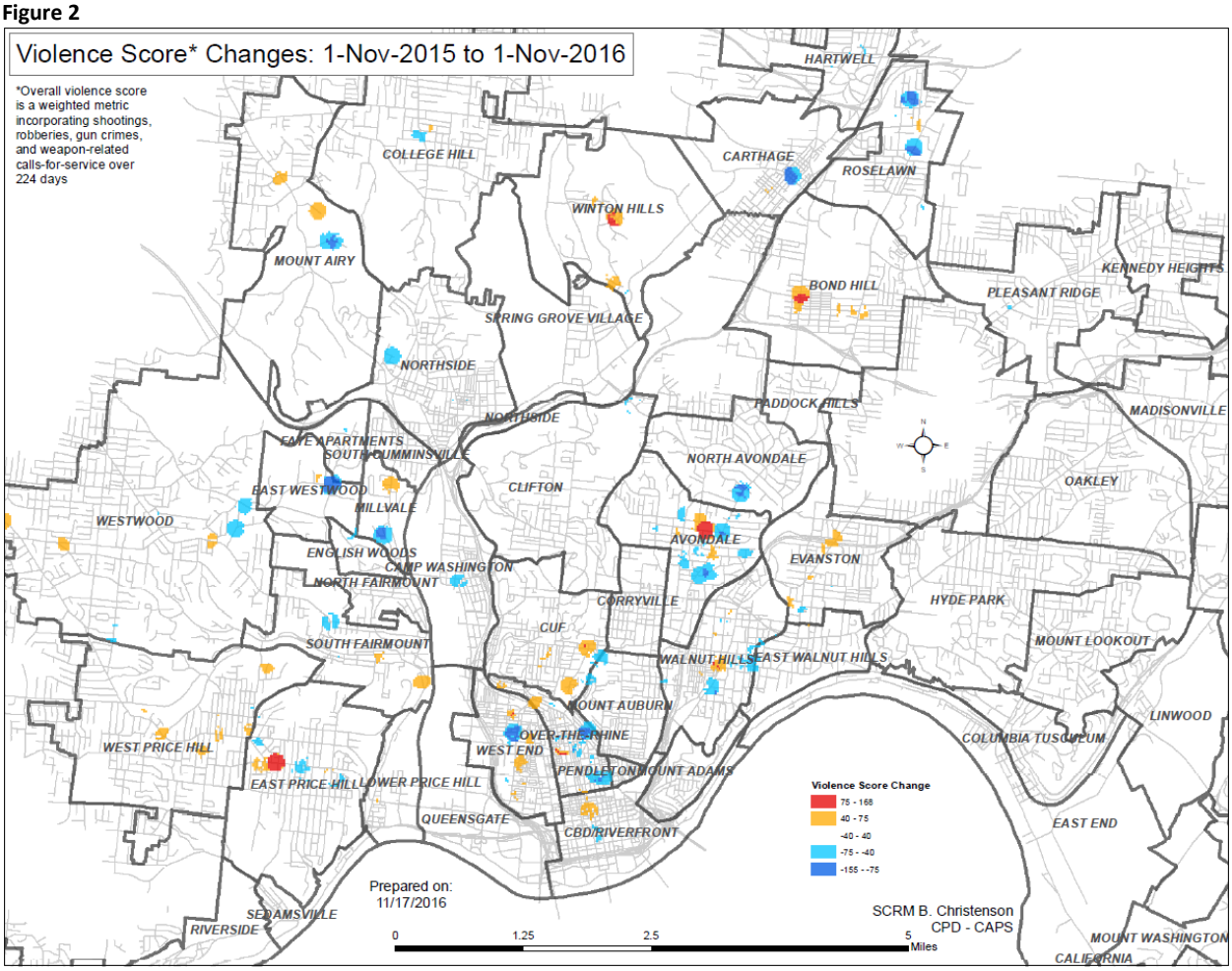
Figure 1



2. Change Score

Second, cell scores from two different time periods (or some identified "average" [e.g., 3-year average] reference period to the time period of interest) can be compared to identify areas of increasing and decreasing gun violence. Emerging hot spots can be difficult to identify when assessing crime data over a large area. By pairing the change score with the overall violence level, both the most violent areas as well as areas showing substantially increasing violence can be identified. Notably, analyzing violence scores in this manner is useful at a citywide level (see Figure 2) as well as neighborhood and project-site levels (not shown).

Figure 2



3. Project Site Scoring

Complex crime prevention projects typically involve many varied responses. The Cincinnati Police Department's new Place-based Investigations of Violent Offender Territories (PIVOT) strategy, which focuses on areas of about two square blocks (for a general description of the PIVOT strategy, see the Research In Brief in Police Chief Magazine, April 2017 [forthcoming]), regularly tracks this metric at project sites in order to initially direct resources to locations within sites driving the violence. It also allows for the shifting of resources as initial efforts take effect and new issues emerge. Click the links for a summary describing the various responses enacted under the PIVOT framework at site 1 and at site 2 (forthcoming). Constant re-assessment of project site scores has allowed for the nuanced responses necessary for high-level problem-solving under the PIVOT strategy to optimize violence reduction.

4. Project Site Longitudinal Score Tracking

Fourth, scores can be tracked longitudinally in order to identify trends. Different from the 1-year change scores, this method measures violence score changes over a small area across many time periods, rather than a single cell's score change between two time periods. This has been used as an important performance tracker within the PIVOT strategy. All 100' x 100' cells comprising an area of interest (here, PIVOT sites) are pooled together. From this pool, the cell with the highest score represents the violence level at that point in time for the area of interest (here, the PIVOT site). As part of the PIVOT strategy, these violence scores are reported at bi-weekly meetings to update partners on progress related to the project's core objective of reducing gun violence. Figures 3 and 4 depict the visual representation of these data. In these charts an approximated trend line is added to further visualize project progress. Notably, according to this metric, both projects have shown substantial sustained reductions in overall violence levels compared to pre-response levels. See here for a more thorough description of responses at each PIVOT site.

Figure 3

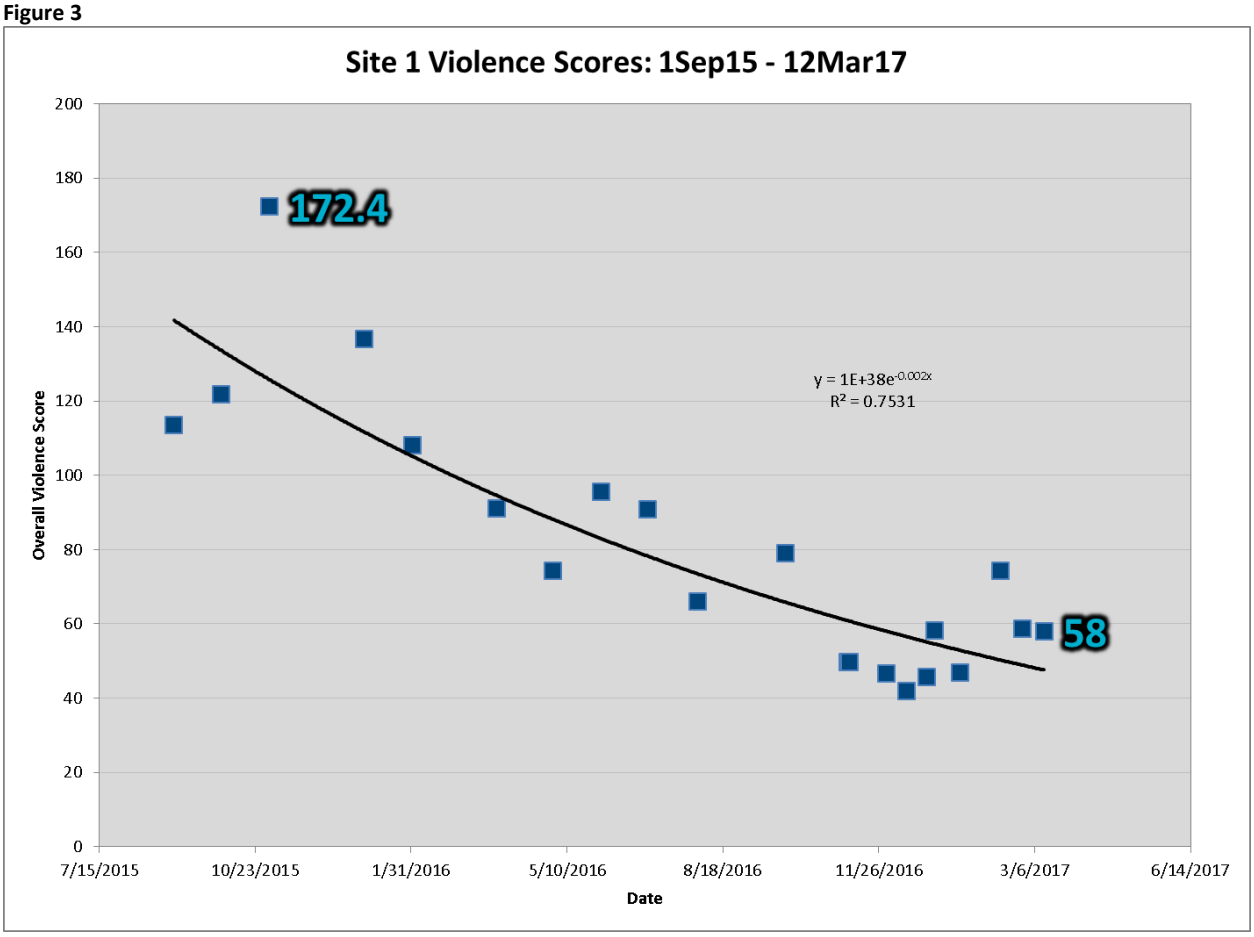
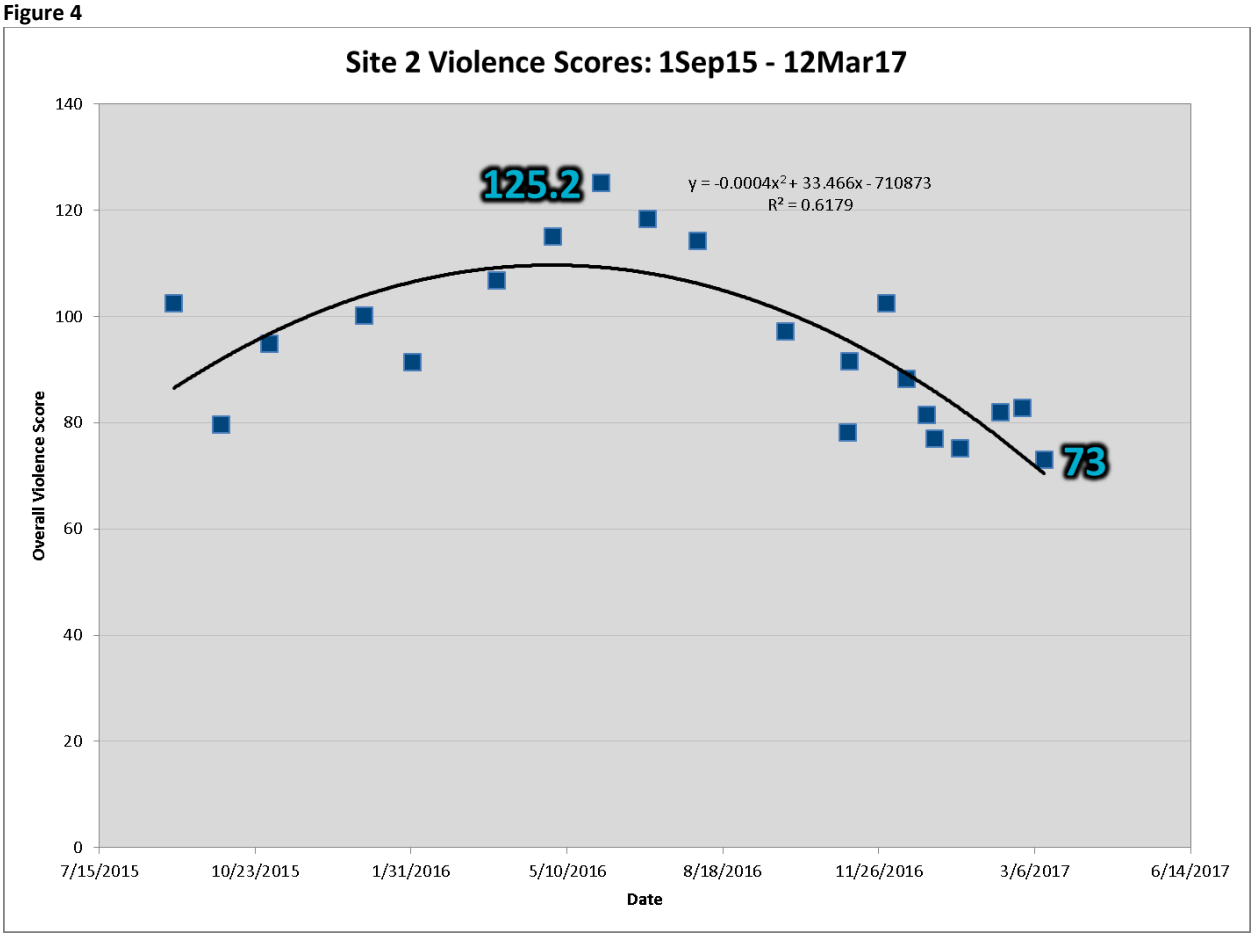


Figure 4


Site 2 Violence Scores: 1Sep15 - 12Mar17
y = -0.0004x² + 33.466x - 710873
R² = 0.6179
125.2
73
Overall Violence Score
140
120
100
80
60
40
20
0
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016
3/6/2017
6/14/2017
Date