Harm-focused offender triage and prioritization: a Philadelphia case study

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Received 19 August 2018
Revised 25 November 2018
Accepted 26 November 2018

Abstract

Purpose – The purpose of this paper is to describe and test a quantitative harm-focused approach to offender selection for investigation and surveillance. The approach incorporates a measure of crime harm as well as a time-decay function that adjusts the score downward for offenders who desist from crime.

Design/methodology/approach – Across 10 of 21 high-crime police districts in the city of Philadelphia, the authors compare the mean harm scores of 60 prolific offenders selected by district analysts, 60 prolific offenders selected citywide by detectives assigned to the Gun Violence Reduction Task Force and the top 60 prolific offenders chosen from a harm-score generated list of known offenders in the ten high-crime districts.

Findings – The offenders on the harm-focused list have significantly greater mean harm scores than the offenders identified by the crime analysts or task force personnel. They have a significantly greater mean number of gun crime episodes in their offending history as well.

Research limitations/implications – The harm-focused approach uses arrest data that may not accurately reflect convictions and which miss undetected criminal activity. A leader of a criminal organization who orchestrates criminal activities but does not engage directly may have a low harm score. Arrest data may also suffer from some inherent bias. The approach also requires the creation of a crime harm index. Determining the operational impact on overall crime reduction by focusing on offenders with higher harm scores will require further research.

Practical implications – Clinical methods of target selection based on officer intuition, opinion and experience may have limitations in terms of effectiveness and accuracy. They also lack transparency and may incorporate bias, a critical consideration given the current crisis in police-community trust and legitimacy. The actuarial method of weighing the harm of past offending with a crime harm score may be more acceptable and defendable to the community. It also identifies offenders with a higher frequency of involvement in gun crimes. Until methodological limitations are better understood, a compromise may be to start with the harm-score method (data-driven) and supplement this initial list through intelligence and investigative information.

Originality/value – The paper expands crime harm indices to quantify offender triage lists. The authors also empirically demonstrate through a case study that the approach is more effective at identifying harmful offenders than methods that solely rely on the experience or intuition of either crime analysts or detectives.

Keywords Policing, Intelligence-led policing, Intelligence, Police technology, Crime analysis, Harm-focused

Paper type Research paper

1. Policing in the age of fiscal austerity

Fiscal austerity in police departments has been a topic of discussion for at least 30 years (Stewart, 1989). In the 1980s and early 1990s, austerity combined with increasing crime rates to motivate innovation in policing as administrators looked for ways to improve efficiency from their limited available resources. The growth of community policing (Cordner, 1995), problem-oriented policing (Goldstein, 1990) and intelligence-led policing (ILP) (Ratcliffe, 2016) can all be tied to this search for efficiency and effectiveness in the face of constrained budgets.

Policing: An International Journal

1363-951X
DOI 10.1108/PIJPSM-08-2018-0118

Improvements in data management and information technology since the 1990s have provided an opportunity to focus police energies where they can be most effective. Hot spots policing is one example of a direct result of these innovations (Braga, Papachristos and Hureau, 2014; Weisburd and Telep, 2014). Efforts to focus police on high crime areas have received more attention than attempts to target investigative resources to the most deserving offenders. This is surprising given that about 6 percent of the population commit about 60 percent of the crime (Ratcliffe, 2016), a generalized rule garnered from multiple large longitudinal research projects (Wikström, 2009; Sellin and Wolfgang, 1964; Wolfgang *et al.*, 1972; Farrington, 1992; Farrington *et al.*, 2006a, b).

While a small percentage of people are responsible for a majority of the crime, and there is evidence of crime reduction potential from focusing on serious, repeat offenders (Sherman *et al.*, 1998), the fiscal constraints in which police departments find themselves means they cannot focus on every problematic offender in a community. The need to support accurate target selection seems paramount. Yet to date, there has been little effort to quantify and evaluate methods by which police agencies can triage their offender lists and focus investigative resources.

This paper proposes and tests a method to quantify the most harmful offenders in a jurisdiction, and compares the results of this harm-based metric against two traditional approaches. The harm-focused approach detailed here represents a rare actuarial methodology to triage offenders for police attention and is compared to two clinical mechanisms that draw on police experience and intuition; a list drawn up by crime analysts, and a list drawn up by detectives in a gun violence reduction task force (GVRTF).

The next section outlines some of the theoretical underpinnings to offender-focused and harm-focused policing. We then outline the history of crime and intelligence analysis organization in the case study location, Philadelphia, PA, before describing the method and results. A discussion section completes the paper.

2. The development of offender and harm-focused approaches

2.1 Offender-focused approaches

While the lineage of ILP in reference to other policing paradigms such as community policing and problem-oriented policing may be disputed (Sheptycki, 2004; McGarrell *et al.*, 2007; Carter and Carter, 2009; Ratcliffe and Guidetti, 2008), a number of operational themes permeate the academic and practitioner literature. Alongside the targeting of resources to crime hot spots and repeat victims, ILP also prioritizes organized crime and serious repeat offenders (Carter, 2009; Ratcliffe, 2016; Sheptycki, 2000). Flood and Gaspar refer to a desire to combat "criminal specialists," those individuals who are "good at what they do […]. [and] exercise a measure of influence over the volume criminals and serve as role models for the up and coming young villain" (Flood and Gaspar, 2009, p. 58). They also stress the need to address "criminal leaders" who "exercise a high degree of control and direction over others" (Flood and Gaspar, 2009, p. 59).

Existing quantitative evaluations tend to be case studies of individual police operations rather than overall targeting approaches, such as one UK police force's disruption efforts (Kirby and Snow, 2016) or the evaluation of an FBI-led gang interdiction in South Central Los Angeles (Ratcliffe *et al.*, 2017). In these cases, the targeting decision was not evaluated. The current paper seeks to explore the process of selecting subjects with a more upstream contribution. This would appear to be valuable, given the already documented limitations of humans in ranking decisions (Macbeth and Ariel, 2017), especially for "practitioners under all the pressures that confront crime analysts and police on a day-to-day basis" (Mohler *et al.*, 2015, p. 1409). Complex algorithmic approaches might be able to improve policing decisions as has been extensively demonstrated in a spatial targeting mode (Mohler *et al.*, 2018).

The validity of a focus on repeat offenders has been confirmed by a meta-analysis of over 70 studies of the concentration of crime among offenders. Martinez *et al.* (2017, p. 13) concluded that "a few people do commit the most crimes, and among offenders, a relatively small group are responsible for most crimes. The policy implications we can draw are obvious: focus attention on the most active offenders."

The research literature on effectiveness of tactics against repeat offenders is however small, at least relative to the body of work supporting hot spots policing. Nevertheless, 20 years ago, Sherman *et al.* (1998) were able to review sufficient research to conclude that the proactive arrests of serious repeat offenders satisfied their criteria as an effective strategy. Presently, the prevailing offender-focused strategy in the research literature is focused deterrence (Roman *et al.*, 2018; Scott, 2017). This approach seeks a reduction in harm from specific, identified individuals by increasing the certainty, swiftness and severity of police interdiction and punishment, and communicating the consequences directly to offenders while simultaneously providing motivations to desist from crime. It is rated as effective by most meta-analyses, though with the caveat that the evidence is drawn from a limited number of randomized trials (Braga and Weisburd, 2012; Weisburd and Majmundar, 2017).

The value of a "criminal-not-the-crime mantra" (Harfield, 2010, p. 31) was probably most aptly demonstrated through the Philadelphia Policing Tactics Experiment. This citywide randomized and controlled field experiment pitted three strategies head-to-head in a comparison of effectiveness combatting violent crime; foot patrol, problem-oriented policing, and an offender-focus strategy (Groff *et al.*, 2015). While struggling with some implementation and dosage issues as well as finding no effect from the foot patrol or problem-oriented sites, the study was still able to conclude that the locations where an offender-focus strategy was implemented "produced significant decreases in violent crime, with decreases in 42 percent for all violence and 50 percent for violent felonies" (Groff *et al.*, 2015, p. 42). Furthermore, there was not only a diffusion of benefits to areas immediately surrounding the targeted locations, but also no evidence of erosion of public support for police in targeted areas (Ratcliffe *et al.*, 2015) – what is sometimes hypothesized as a "backfire effect" of focused police operations (Weisburd *et al.*, 2011; Haberman *et al.*, 2016).

For these initiatives, there remains little research guidance on how to select the most serious offenders. Focused deterrence projects have taken a variety of approaches. In some cases the targets were selected from a multi-agency citywide analysis (Braga, Hureau and Papachristos, 2014), in others the mapping of vectors of gang rivalry (Braga *et al.*, 2001), or the offenders were simply "linked" to a series of violent crimes (McGarrell *et al.*, 2006). Often, the method of choosing offenders was either not articulated by researchers, or was based on the subjective choice of police or other criminal justice workers who became "fed up" with a particular group (Braga *et al.*, 2001, p. 32).

Statistically driven efforts to identify potential high-risk individuals have been attempted, most notably in the Philadelphia Adult Probation and Parole Department. The use of an inductive random-forest approach based on a training data set of 30,000 cases by Berk *et al.* (2009) attracted considerable attention, and while the benefits of an actuarial approach were promoted in preference to the existing clinical model, the challenges were certainly not glossed over. The authors note that "an important consequence is that, for every true positive case identified, there will be about 12 false positive cases" and that "others would call attention to the presence of offender race in the model, along with other predictors" (p. 206). The specific variables appropriate for offender prediction remain poorly defined, and many come laden with sociological meaning and political significance.

2.2 Harm-focused policing

Drug researchers have discussed harm reduction for some time (Maher and Dixon, 1999; MacDonald *et al.*, 2005), but it was not until Sherman (2007) drew attention to the potential

value in focusing law enforcement on the most harmful people and places that harm-focused policing became a real consideration. It has been defined as a way to "inform policing priorities by weighing the harms of criminality together with data from beyond crime and disorder, in order to focus police resources in furtherance of both crime and harm reduction" (Ratcliffe, 2015a, p. 3). Harm-focused policing is now a feature in a number of countries, often driven by local crime harm indices (Sherman *et al.*, 2016). Indices exist in England (Weinborn *et al.*, 2017), Northern Ireland (Macbeth and Ariel, 2017), New Zealand (Curtis-Ham and Walton, 2017), and the US States of Pennsylvania (Ratcliffe, 2015b) and California (Mitchell, in press).

Building on Sherman (2007), Ratcliffe (2015b) proposed adoption of a "gravity" score metric developed by the Pennsylvania Commission on Sentencing. In Philadelphia's home state of Pennsylvania, each crime has been assigned a gravity value on a 0–14 scale found in the 204 Pa.Code §303.15 statute. The gravity score is determined by the Pennsylvania Commission on Sentencing, and provides guidance to trial judges seeking an appropriate penalty for a person found guilty of a crime. The current iteration has been in place since 1997.

As Sherman *et al.* (2016) point out, however, the Pennsylvania gravity scale is "quite truncated" and limited, ranging from 1 point for a misdemeanor up to 14 for homicide. As they go on to demonstrate with the Cambridge Crime Harm Index, a metric using an average sentence length is more appropriate and allows for greater flexibility in reflecting different nuances of offending. While a gravity-based index directly reflects an offense gravity measure from the Pennsylvania Commission on Sentencing, a sentence-based score can also be calculated based on the median recommended sentence within the Pennsylvania sentencing guidelines. This provides for more of an interval scale for the sentence-based index, rather than the ordinal scale of the gravity score.

3. A Philadelphia case study

In many regards, the distribution of crime and delinquency across Philadelphia has remained little different from when Shaw and McKay studied it. After mapping delinquency in the city's youths from 1926 to 1928, they concluded that "in the absence of significant disturbing influences the configuration of delinquency in a city changes very slowly, if at all" (Shaw and McKay, 1942, p. 222). The city has long suffered problems of drug corners (Lawton *et al.*, 2005), and shootings and retaliatory violence (Ratcliffe and Rengert, 2008; Wyant *et al.*, 2012). With the appointment of more innovative police leadership in 2008, there has been a growth in police analysis capacity and a concomitant increase in opportunities for more robust empirical research in Philadelphia. In particular, the Philadelphia Foot Patrol Experiment renewed interest in foot patrol as a viable violence reduction tactic (Ratcliffe *et al.*, 2011; Ratcliffe and Sorg, 2017), the afore-mentioned Philadelphia Policing Tactics Experiment promoted an offender-focus, and the Philadelphia Predictive Policing Experiment has explored the value of this emergent tactic in tackling violence (Ratcliffe and Taylor, 2017).

The city of Philadelphia is conterminous with the county of the same name and covers an area of over 140 square miles approximately equidistant between New York City and Washington DC. As of July 2017, the city had 1.58 million inhabitants, the majority of whom were split roughly equally at 45 percent white and 44 percent black. A quarter of the city lives in poverty (US Census Bureau, 2018). The Philadelphia Police Department (PPD) is the city's primary enforcement agency and comprises about 6,600 sworn officers, making it the fourth largest municipal department in the country.

Despite an overall reduction in crime rates over the past two decades, the number of homicides and shooting victims has increased in recent years. Furthermore, compared to the national average, the level of lethal violence in Philadelphia remains high.

It is notable that of the top ten cities with the most homicides, Baltimore and Philadelphia were the only two that faced homicide increases in 2017. Additionally, Philadelphia's increase (by 40 homicides) was the second largest increase across the nation.

As noted previously, criminal activity is heavily concentrated among a relatively small percentage of places and people. Internal analysis of arrest records indicates that only about 1.5 percent of all known criminals are responsible for 80 percent of detected gun crimes in Philadelphia, which greatly exceeds the frequently cited 20:80 rule of thumb. Furthermore, one third of the known criminals with gun crime arrests are repeat gun crime offenders. Clearance rates of violent crimes tend to be low and those not apprehended may commit further violence. It is therefore reasonable to assume that this estimate of the level of gun violence concentration among known offenders may be conservative.

This concentration of crime and violence suggests that data analytics can guide the use of limited resources and efficiently achieve crime reduction. This realization has fueled greater interest in helping operational police commanders become more data-driven and intelligence-led. Since the terrorist attacks of 9/11, the core of a more intelligence-led approach in the USA has been effective sharing and dissemination of intelligence between and within agencies (Carter, 2009; Carter and Phillips, 2015). Carter (2016) has demonstrated the capacity of institutional pressures to promote and drive development of ILP, and Philadelphia is not immune to these pressures. The city's investment in the Delaware Valley Intelligence Center (DVIC) is one concrete example. Formally opened in 2013, the DVIC is a secure space for police officers and analysts from dozens of agencies to provide strategic, tactical and real-time analysis of a variety of problems, such as gun violence, property crime, traffic issues and terrorism-related investigations.

Around the same time, the PPD created a crime analyst position (formally titled Analysis Coordinator) in a six district pilot program. Sworn officers received analytical training through a partnership with Temple University and supported by the Bureau of Justice Assistance. Carter (2016) notes that analysis in not necessarily synonymous with ILP; however, a greater connection between intelligence workers and decision-making (including targeting decisions) is a foundation of better offender triage and management (Ratcliffe, 2016). Therefore, training topics covered substantive, methodological and analytical topics, while emphasizing practical implementation in operational settings.

The program had since expanded and each district is assigned at least one crime analyst. As the scope of the crime analyst program has grown, the department has also invested in civilian analysts with technical and analytical expertise for the Research and Analysis Unit. The analysis section of the Research and Analysis Unit acts as the central training and support hub for the crime analyst program. Reflecting the information sharing role central to the US development of ILP, the section coordinates crime analysis tasks that cross district boundaries and evaluates a variety of city-wide initiatives. The district crime analysts fulfill a dual function integral to the core of intelligence-led work; they act as influencers of decision-making at the local district level, as well as share information with the DVIC (such as "cops' street knowledge" that is often unavailable in centralized databases). As such, together with the Research and Analysis Unit, the district crime analysts' role integrates elements of crime science, ILP and crime analysis.

In an effort to strengthen the analytical capacity and to consolidate intelligence and crime analysis functions that existed across several specialized units, the PPD created an Intelligence Bureau in 2017. Housed at the DVIC, the bureau consolidated the Research and Analysis Unit, DVIC fusion center, Real-Time Crime Center and Criminal Intelligence Unit under one umbrella. The number of analysts in the Research and Analysis Unit increased from 4 to 13 through the merging of civilian analysts and former Criminal Intelligence Unit analysts.

ILP plays a central role. As a fusion center, the DVIC facilitates information sharing with regional and federal partners, and the Criminal Intelligence Unit focuses on information collection through surveillance, human sources, and debriefing of offenders. Collected information is fed to analysts who vet it as intelligence and utilize it in their analysis products. For a large US department, this is an unusual function. While it has long been recognized that the crime analysis function (that can describe "what" is going on) is distinct from the criminal intelligence function (that can explain "why"), in the USA these functions are routinely kept at arm's length (Ratcliffe, 2016; Ratcliffe, 2007). This restructuring brought the city's intelligence and crime analysis functions under the same operational command for the first time. The department has started to reap the benefits of this merger through improved and more insightful intelligence products.

Pertinent to the current paper, a related development is the creation of a GVRTF in 2018 as part of the department's commitment to address the high level of gun violence across the city. The task force's mission is the efficient and comprehensive investigation of gun-related incidents through coordinated efforts. The task force reviews all gun-related incidents across the city, identifies patterns and trends, conducts investigations, and coordinates investigation efforts with both internal investigative units and external law enforcement partners. Gun-related incidents that the GVRTF deals with include shooting incidents, straw purchases, Violation of the Uniform Firearm Act (VUFA) arrests, as well as narcotics incidents (relevant given the strong connection between narcotics and gun violence).

When the department created the GVRTF, one of the first tasks was to examine the most prolific gun violence offenders across the city. Harm scores were used as an objective mechanism to identify such offenders. The next section explains in detail the process by which serious, repeat gun offenders were identified and triaged for further investigation.

4. Harm-focused offender selection

The process of identifying prolific gun crime offenders followed a five-stage process as described in this section.

4.1 Review of gun crime arrests in the past two years

Given the focus on gun violence, the initial data extraction started with identifying offenders who had committed gun crimes recently. This ensured that all offenders included in the analysis had been arrested for at least one gun crime, but were also currently active in committing gun crimes. Gun crimes included homicide, robbery with gun, aggravated assault with gun and VUFA arrest (such as illegal possession of a firearm). Data were queried from a centralized database server using a set of Uniform Crime Reporting (UCR) codes and an arrest date range. In 2016 and 2017, there were about 4,100 arrests and 3,150 unique offenders who fit the criteria. Two years was an arbitrarily selected date range, but it was sufficient to ensure both recency as well as sufficient offenders to provide more than enough viable candidates who had been actively involved in gun crime activities.

4.2 Examination of the entire criminal history of these arrested offenders

After the initial data extraction, each offender's entire criminal history was further queried. This included both violent and non-violent crimes. The average number of gun crime arrests among these offenders was 1.88 and about 44 percent of the offenders had multiple relevant arrests. The average number of total arrests per offender was 5.92.

4.3 Calculation of harm score

We assigned a harm score to each arrest based on UCR codes and summed the score for the totality of each offender's arrest history. We started with the technique described in

Ratcliffe (2015b) to calculate the harm score for each UCR-classified incident for which an offender was arrested (we do not replicate the explanation here, but refer the reader to the cited reference). In an adaptation of that method, we used a time decay function to lower the weight for arrests that occurred less recently. This ensured that if offenders stayed away from criminal involvement, their total harm score could eventually reach zero. The specific time decay function used at the PPD was a combination of a step function and exponential decay over time. In order to account for a period of incarceration where offenders were physically incapacitated from committing crimes on the street, harm score retained a full weight for three years after each arrest. After three years, each harm score was adjusted downwards as time passed from each arrest (Table I). While it would have been ideal to account for the actual length of incarceration, lack of data system integration across city and state departments prohibited us from implementing this operationally.

For example, an offender with a robbery gun arrest received a weight of 10.3 using the gravity-based harm scores and 82.5 using the sentence-based harm scores. If the arrest occurred five years ago, the weight was multiplied by 0.91 using the time-decay multiplier as shown in Table I. For an offender with multiple arrests, the weight assignment and calculation processes were repeated for each arrest. Finally, the weights were summed in order to calculate the total harm score for each offender. Notably, this calculation does not necessarily require specialized software and weights can be assigned through a lookup function in Excel. The time-since-each-arrest can also be calculated in Excel with a simple function (subtracting an arrest date from the current date). Calculating the total harm scores is achieved by grouping offenders and summing values via Excel's Pivot Table.

During the initial implementation of the harm score approach by the PPD, we found that offenders with numerous narcotics arrests were often ranked high in harm score. We often observed this with offenders who were in our data set due to one or two gun-related offenses but numerous narcotics possession arrests. Consequently, given the focus on identifying gun crime and violent offenders in the present analysis, simple (no weapon) narcotics arrests were excluded. The UCR system follows the hierarchy rule where the most serious crime type gets recorded when multiple crime types are involved in a single incident. In the PPD's system specifically, weapon offenses (VUFA) are coded as a 1,500 series offense. They are therefore a more serious offense than narcotics (UCR 1,800 series). Thus, narcotics offenses with firearms present were included, but non-weapon narcotics incidents were excluded. After assigning the weighted harm score, the result was summed for each offender to identify the total harm score for each offender, and rank ordered.

4.4 Cross-checking the list with current incarceration status

After creating a rank-ordered list of harmful offenders, we then checked the current incarceration status for each offender in order to remove offenders who were incarcerated and thus not on the streets to commit crimes. This included looking up information from a local jail as well as state/federal correctional facilities.

Year	Harm score multiplier
1–3	1.00
4	0.95
5	0.91
6	0.82
7	0.69
8	0.52
9	0.31
10	0.06

Table I. Time-decaying weight for harm score calculation

4.5 Integration with other data sources and evidence

At this stage the intention was to integrate and refine the harm-focused list with the investigative knowledge of experienced detectives and other stakeholders in the organization. We envisioned this as a way to integrate information that might not be present in the arrest database. This might include, but not be limited to, suspected involvement in shootings, involvement in gang activity, or people suspected of orchestrating organized criminal activity without necessarily committing crimes themselves.

In reality, we discovered that the GVRTF developed its own lists of offenders in each of six divisions of the city, while maintaining our harm-focused list as a citywide list. This raises some operational challenges with determining which list (or combination of lists) to use. It also involved concern about whether to maintain separate lists and focus on offenders who are on all lists, or highly positioned on most. Analytically, however, it provided an ideal opportunity to compare the offenders on each list across a number of metrics.

Table II summarizes the top ten harmful gun crime offenders identified through our harm-focused approach, and shows a summary of their arrest involvement (based on their lifetime offending records). All of the offenders have violent criminal histories, and the immediacy of the list is indicated by the young age of the most harmful offender (current age at time of analysis shown).

5. Comparative analysis

At a basic operational level, since the inception of the GVRTF, a number of the prolific offenders identified by the harm score approach have been arrested. More empirically, the utility of the harm score approach can be illustrated through a comparison of prolific offenders that were identified via more traditional means, as we do in this section of the paper.

In particular, harm score and arrest criminal history were compared between lists of prolific offenders identified through three different policing approaches. First, a list of prolific offenders was obtained from high-crime districts by surveying district crime analysts (district analysts). Each district identified between five and ten prolific offenders, but we did not define the mechanism by which they chose the offenders. The analysts tended to emphasize their personal perception and knowledge of prolific offenders. Their lists also tended to reflect individuals identified or discussed in recent Compstat meetings (with a 28-day cycle) at the time of the survey, rather than incorporating people drawn from a comprehensive examination of a longer time period.

Second, the GVRTF detectives in each of the city's six divisions also identified prolific offenders based on their knowledge of the entire city (GVRTF). Unlike the district analysts' list, the GVRTF-identified offenders could be resident anywhere in the city and not just a particular area. The third list was the harm score list we generated centrally, as detailed in this paper (harm-focused). To make this a more conservative comparison and comparable in

Table II. Summary of harm scores and the number of arrests by crime type among Philadelphia's prolific offenders

Rank	Age	Harm score	Homicide	Robbery	Rape	Aggravated assault	Gun crime	VUFA	Part I violent
1	15	144.2	0	19	0	3	14	0	22
2	37	93.8	1	6	0	2	10	2	9
3	31	86.9	0	9	0	0	9	1	9
4	30	85.6	0	7	0	1	9	1	8
5	48	84.5	4	0	1	4	7	0	9
6	36	78.5	0	6	0	4	9	2	10
7	23	77	0	5	0	2	8	1	7
8	35	76.6	0	7	0	0	8	1	7
9	28	75.9	0	3	0	4	9	2	7
10	28	74	0	8	0	2	8	1	10

scope to the district analysts, we only selected offenders who were resident in the ten districts that were the focus of the district analysts. This gave an advantage to the GVRTF list as this was the only one able to select offenders from across the city.

In summary, across ten of the city's 21 high-crime police districts, we compare: the mean harm scores of 60 prolific offenders selected by the district analysts; 60 prolific offenders selected citywide by the detectives assigned to the GVRTF; and the top 60 prolific offenders chosen from the harm-score generated list of known offenders in the ten high-crime districts[1]. We calculated harm scores for these lists based on both the gravity method and the sentence method.

6. Results

Table III summarizes the comparison analysis of harm score and gun crime arrests, based on the gravity method of harm calculation (columns 3 and 4) and the sentence-based method (columns 5 and 6). The gravity method is based on a sentence scale running from 0 to 14, as described in Ratcliffe (2015b). Harm score was calculated using the median sentence length (sentence-based, as described in this paper) in order to examine the robustness of this comparison. As can be seen in Table III, the results were similar.

Overall, the results indicate that the harm-based approach identified prolific offenders that had committed more gun crimes and had committed more serious crimes for a greater number of times (as represented by a higher harm score). Analysis of variance statistically confirmed such a pattern ($p < 0.001$), with Tukey multiple pairwise-comparisons indicating statistically significant differences between the harm-based approach and the two more traditional approaches ($p < 0.001$) for both the gravity-based and sentence-based metrics. From a practical standpoint, the harm-based approach also identified prolific offenders who had an average of more than five gun crime arrests, while the mean number of gun crime arrests was about 3 and 3.7 for the district analysts' lists and GVRTF lists respectively (the last column in Table III).

7. Discussion

The harm score approach is a promising tactic to objectively identifying problematic and harmful offenders by taking into account both the quantity and quality (severity and type) of arrest incidents in a single metric. This actuarial mechanism represents a major shift from clinical models of offender selection, often based in intuition and experience. The results show that the harm-focused algorithm significantly outperformed the clinical judgments of the crime analysts and detectives in identifying offenders with a higher average number of gun crime prior arrests.

Notwithstanding the improvements in harm-focused targeting, our approach has an additional merit. Its transparent approach can be clearly articulated, made public and opened for discussion. Given the current challenges facing police-community relationships with regard to trust and legitimacy (President's Task Force on 21st Century Policing, 2015), a harm-focused approach that uses objective data may be perceived as more appropriate in a democratic society than the "black box" of officer intuition and opinion. By publicizing the

Table III. Harm scores and gun crime arrests of prolific offenders by sources

Source	n	Mean harm score (gravity-based)	SD (gravity-based)	Mean harm score (sentence-based)	SD (sentence-based)	Mean number of gun crime arrests
District analysts	60	24.1	24.5	195	200	3.13
GVRTF	60	21.4	26.7	164	207	3.72
Harm-focused	60	48.4	19.1	376	150	5.42

metric by which offenders are triaged for additional focus, a police department can minimize accusations of bias. In response, it may be that a community chooses to adjust the weightings for particular crimes, or to ask police to ignore events that are older than a certain date (as we do here). The introduction of an objective metric allows the police and community to work together to determine the values and concerns that they wish to collectively address. As Neyroud and Disley (2008, p. 231) note "New technologies have the potential to revolutionise policing. We need to match our attention to their crime-control effects with equal consideration of the ways in which they are portrayed and perceived by the public." We would argue the approach suggested here to select offenders for greater attention passes Sherman *et al.*'s (2016) three tests of being democratic, reliable and cost effective.

The relative simplicity of the approach has the potential to accommodate a variety of applications; however, we also recognize that the situation in Philadelphia is the culmination of efforts to quantify harm that have been occurring for some years now (see Ratcliffe, 2015a, b). For example, harm score has been used as a weight in traditional hot spot mapping (Macbeth and Ariel, 2017; Mohler *et al.*, 2018). Harm scores have also been used in the department's internal analysis to identify the most problematic groups (e.g. gangs) by aggregating harm scores among group members to prioritize policing efforts. Of course, these tools are only of value if they are effectively used operationally by police agencies. The efficacy of an algorithm is less important (to Saunders *et al.*, 2016, p. 367) than ensuring that "law enforcement needs better information about what to do with the predictions – the 'prevention' part of predictive policing." We do not have the space in this paper to explore this area, but this is an emerging research concern for predictive policing.

The harm score calculation allows additional factors to be included in the model. For example, depending on the objective of a particular police operation, harm score for individuals with active warrants could be weighted higher. UCR codes (the codes that the department uses in its record management system) do not distinguish shooting incidents. In other words, aggravated assault with a gun could range from a generalized demonstration of a firearm as a threat to a life-threatening injury. If the victim status is known, shooting victim incidents' harm score can be weighted higher. Harm scores can also be used in conjunction with other analysis techniques. For example, harm score can be used within the context of social network analysis (Bright *et al.*, 2018; Bichler *et al.*, 2017) and to supplement the interpretation of network statistics in key player identification analysis.

One advantage of harm scores is that it is not necessary for each agency to calculate their own. The harm score in Philadelphia is derived from the Pennsylvania sentencing guidelines (Ratcliffe, 2015b) and as such would be applicable to the more than 1,000 police agencies in the state with little adaptation. Recent efforts have developed crime harm indices in other places such as California (Mitchell, in press), and in the UK (the Cambridge Crime Harm Index, see Sherman *et al.*, 2016).

While we are promoting the actuarial nature of a harm focus, there is also room for intelligence and qualitative information to supplement the analysis with nuance and context. Starting from the data, a priority list of offenders and/or places can be created objectively. Subsequently, the priority list can be adjusted by considering intelligence, investigative leads and other qualitative information. This list can become the foundation for focused intelligence collection efforts (Coambs, 2011; Higgins, 2009), a core component of the intelligence cycle (Carter, 2004). This will ensure that the prioritization of limited resources will be accomplished in an objective and accountable manner, while at the same time achieving more precise and focused analysis with contextual information.

The value of this integrated approach where data-driven harm score calculation and qualitative assessment complement each other is illustrated through supplemental analysis of the lists. First, five of the GVRTF offenders overlapped with the harm score-based list.

While the number may appear small, remember that thousands of offenders were potential candidates. This suggests some support for supplementing harm-focused lists with the "old knowledge" (Ratcliffe, 2008) of the policing craft (Willis, 2013). Second, the GVRTF, district analyst, and harm-based lists each included several individuals who subsequently became gun violence victims in the following year. The original objective of the current research was not to assess the likelihood of victimizations prospectively; however, this observation does provide additional support to the finding of a consistent overlap between violent offending and victimization (Schreck *et al.*, 2008). It may be that law enforcement tradecraft and officer street knowledge can fine-tune the direction of police attention to lethal violence incidents. Future research may help the policing field assess the operational impact of a harm-focused prioritization and integrated approach.

We acknowledge numerous limitations in the approach promoted here. For one, the data employed are arrest data with known limitations (Coleman and Moynihan, 1996). It is possible that arrests do not reflect eventual convictions, especially in the USA where so much of the criminal justice system relies on plea bargaining and the adjustment of charges, regardless of the actual crimes committed. Of course, while arrest data can reflect certain police biases, conviction data can also reflect prosecutorial biases. Being particularly aware of the challenges of using drug arrest data, we exclude the non-weapon arrests from our analysis.

And while arrest data have the benefit of being easily accessible for police departments, for complex investigations of organized crime groups it is possible to miss the key players who avoid arrest (for aficionados of *The Wire*, this is the Avon Barksdale problem). Our method does not solve these issues, and the use of arrest data must be conducted with these caveats in place; hence, the option to start with data-driven prioritization (harm scores) and optionally adjust the resulting list through intelligence and investigation.

The operational impact of harm-focused efforts, rather than focusing on a few serious crime types, remains unknown and a key consideration and concern for police command staff. Abundant research evidence suggests focusing on repeat offenders is a promising policing tactic in crime reduction. However, if the aim of a police operation is the disruption of criminal network whose key players may have few arrest records and a low harm score, it will require further research to assess if a bigger impact on crime reduction will be achieved through focusing on the removal of the key players or prolific offenders with high harm scores in the organization.

For now, however, the statistical evidence shows that an analytically driven approach tends to identify harmful offenders with a higher number of gun crime priors more effectively than intuition and experience funneled into a clinical approach, even when one method had a structural advantage by being able to select the worst offenders from the entire city. Starting with a data-driven list to prime a clinical refinement for operational purposes might be a more effective and defensible approach to offender selection than currently exists in many police departments. It should certainly be a starting point for discussion around refinement of offender triage methods.

Note

1. Originally, the districts' and the GVRTF's lists contained a total of 78 and 66 offenders, respectively. These original sample sizes varied for several reasons. The number of stratified units varied (ten districts and six divisions). Furthermore, the GVRTF's list came from the unit's on-going operation rather than conducting a separate survey with strict instructions, but this emphasizes the practicality and reality of the current research. As this originally created a problem of unequal sample sizes across groups, in order to provide the most conservative and robust comparisons, the top 60 offenders were selected from the respective original lists based on harm scores. This is the most conservative approach we could adopt, as these would have a higher aggregate harm score than the original lists with larger samples. In the end, analysis using the original lists showed the same overall results as the narrowed lists that are presented in this paper.

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