



# USING NETWORK ANALYTICS TO MEASURE GROUP USE OF FORCE AMONG POLICE

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## Abstract

The partnership model employed by General Duties or Patrol officers, in which at least two officers attend any given event, mean that network analytics are particularly suited to measuring group behaviour. Application of network analyses offer opportunities for greater insight into the behaviour of officers, and in particular, to detect groupings of officers who may not be adhering to agency policy. The use of force by police is one of the most important aspects of the profession. Inappropriate application of force by officers can undermine the legitimacy of agencies, and community trust. As a result, it is essential to maintain appropriate training, policy measures, and an understanding of whether the use of force is appropriately implemented by officers. To better understand how this phenomenon might be monitored in practice, this paper discusses the utility of Social Network Analysis (SNA). To demonstrate how this may function in practice, SNA is applied to an open use of force dataset from the Indianapolis Metropolitan Police Department. First, SNA is used to consider whether there are groupings of Patrol officers that more frequently engage in use of force together. Groups of Patrol officers that, when they use force together, are more likely to hospitalise a civilian, are then considered. This analysis demonstrates a relatively simple methodology that may be used to consider how force is being implemented by officers that commonly engage with the community. Ultimately, findings suggested that relatively small groupings of officers were responsible for a large proportion of both use of force and severe use of force incidents. Among these groups there was a comparatively high degree of connectedness. This research holds implications for measuring group behaviour of officers and identification of potentially problematic behavioural subcultures within agencies.

## Introduction

It is widely recognised by researchers, law enforcement agencies, and the community that the use of force (UOF) by police is one of the most concerning issues in policing—especially when members of the public are seriously injured (Bennell et al., 2021; Hickman et al., 2021; Kaufman, et al., 2017). While police-citizen interactions that result in the UOF are relatively rare events (Adams, 2010), when they do occur, the consequences can be serious. For example, UOF may result in serious injuries or fatalities to not only members of the public, but also to the officers themselves (Hine et al., 2018).

Research into police UOF has commonly featured analysis of individual incidents, or the factors associated with UOF events. However, the application of group-based metrics, such as network analytics, has offered an alternate approach. Network analyses were first used to consider behaviour of police around 2016 (Bouchard & Malm, 2016; Roithmayr, 2016). Since this time, these analytics have provided substantial insight into how officers behave in groups. The present research considered the group characteristics of UOF by police, with particular focus on severe UOF incidents in which a member of the public was hospitalised.

## Use of force by police

Policing research typically considers the impact of different UOF types. For example, the analysis of incidents involving conduct energy weapons suggest that they often result in less severe injuries than alternative UOF types (Taylor & Woods, 2010; Terrill & Paoline, 2012). Miller and Chillar (2022) considered the impact of body-worn cameras on fatalities of community members. This research identified an important aspect of UOF, police agency policy change. In particular, they found difficulty controlling for consistent policy changes relating to UOF practice by police, resulting in difficulty in measuring the factors associated with UOF through traditional analytical methodologies (Miller & Chillar, 2022). Hickman et al. (2021) explored UOF through variables such as multiple injury outcomes, citizen demographics and characteristics, officer demographics and agency characteristics, and incident characteristics. Intuitively, injuries to suspects were associated with quick resolution of the incident. Conversely, injury was more prevalent when the community member was fleeing, a finding that was consistent with prior UOF research identifying resisting police as a correlate of injury (Bolger, 2015; Dunham & Alpert, 2015; Engel et al., 2000; McCluskey et al., 2005).

Recently, the use of network analytics to consider the group behaviour of officers has notably increased, however this research has primarily focused on deviance among police. The present study does not delineate between UOF that was or was not improper; this information was not available. However, it is important to consider the analytical approach of the relatively brief body of literature employing network analytics. Wood and colleagues (2019) detailed the nuanced

learning and social environment of policing, with prior literature suggesting that the behaviour of individual officers likely develops and adapts in response to their peer group (Haynie & Osgood, 2005). The network approach to analysing officer behaviour is facilitated by the construction of the policing environment; officers are typically assigned partners, and these partners typically attend or respond to incidents together. While this model supports the development of group culture, it also supports the development of networks of analysable behaviour (Wood et al., 2019). Functionally, these networks facilitate the quick adaptation of new officers to the policing environment, benefiting themselves and their peers. However, where that environment features a strong subculture, it is possible that early-career officers will adapt to that subculture, and take on the norms of these officers, through a process of positive reinforcement (Sierra-Arévalo, 2021).

Zhao and Papachristos (2020) considered the network position of officers that discharge of firearms at community members. This research suggested that it was not necessarily the officers with a high rate of UOF that were prone to discharge of firearms, rather a group that were termed 'brokers'. These brokers were typically connected to officers that committed comparably high rates of UOF, while not engaging in a substantial number of UOF incidents themselves. Quispe-Torreblanca and Stewart (2019) sought to understand the contribution of the peer group on officer behaviour by considering the influence of individual misconduct prone officers on their immediate peer group. These officers appeared to increase the likelihood of similar, misconduct behaviours among their peer group, supporting the notion of adaptation, and learning among the immediate peer group. While the emergence of network analyses in the study of police is relatively recent, it has already contributed considerable insight into how police behave in groups, and offers a potential method for understanding the presence and characteristics of possible subcultures within agencies.

## Research questions

Prior literature employing network approaches has associated serious use of force, including the discharge of firearms, with a small number of important officers. These individuals were often found in, but not necessarily central to highly clustered networks or groups of officers. The present research sought to further understand UOF networks by measuring (1) the network characteristics and differences of UOF, and severe UOF networks, and (2) whether these analytics could be used by policing agencies to understand emerging subcultures among their staff.

## Background: The Indianapolis policing jurisdiction

Indianapolis is the capital of the State of Indiana, located in Marion County. The Indianapolis Metropolitan Police Department has a diverse and complex history, including adopting racial and gender equality approaches to patrol duties relatively early (City of Indianapolis, 2016; Indianapolis Police Historical and Educational Foundation, 2008). In 2007, the Indianapolis Police Department

merged with the patrol division of the Marion County Sheriff's Department to form the Indianapolis Metropolitan Police Department (IMPD) (Hipple et al., 2019). Given the present research considers UOF incidents among the merged IMPD beginning in 2018, literature considering the historical aspects of this policing jurisdiction will not be considered (see Hipple et al., 2019 for further detail prior to 2007). At the time of the merge of policing departments, the newly formed IMPD had jurisdiction over 850,000 community members (United States Census Bureau, 2015), and employed 1,589 sworn officers (Reaves, 2015). Among these officers, around 80% were attributed to patrol duties (Hipple et al., 2019).

The jurisdiction served by the IMPD is subject to notable disadvantage. In this region, 20.1% of residents live below the poverty line, with a comparative rate of 13.5% among the rest of the State of Indiana (Haberman et al., 2020). Offence rates per 100,000 residents in Indianapolis were notably higher than among cities with analogous populations across the United States. Indianapolis reported a rate of 0.014 violent crimes per resident in the 2016 reporting period (Federal Bureau of Investigations (FBI), 2016), compared to 0.009 per resident among cities with similar population sizes (FBI, 2016; Haberman et al, 2020). Acquisition based crimes, robbery and burglary, were reported at a similar comparative rate of incidence; however, theft of motor vehicles, did not see the same disparity in incidence (FBI, 2016; Haberman et al, 2020).

The state of Indiana, and more specifically the jurisdiction of the IMPD, has featured several notable UOF incidents across time. In the year prior to writing, IMPD officers were arrested and criminally charged for domestic violence (Smith, 2021), and the on-duty battery of demonstrators during a protest of the death of George Floyd (Smith, 2020). In mid-2020, the IMPD responded to nationwide protests, and the inappropriate UOF by officers at these protests, by issuing a new set of guidelines for the UOF. These guidelines emphasised de-escalation, that force should not be used against suspects that were under control and prohibited the use of neck restraints or chokeholds, among other reforms (Mack, 2020).

## Methodology

### Data description

Project Comport (2019) was a fellowship project run by the Code for America organisation. This project developed an open data portal designed as a tool for law enforcement agencies to improve accountability and transparency by opening access to internal affairs related data. The service provided an accessible resource for policing agencies to share data, with the intention of facilitating more effective community engagement and transparency.

As part of operational procedures, the IMPD gather data relating to UOF incidents, which consisted of a range of features, including a unique identifier attributed to each officer and each UOF incident. These data allowed for the development of a network approach to understand

which officers were present together at UOF incidents. Additionally, data also indicated whether the incident directly resulted to the hospitalisation of the citizen; these incidents are referred to as a severe UOF. Records were excluded where the hospitalisation related to a pre-existing injury, or an injury that did not result from the specific UOF incident by police.

Social Network Analysis (SNA) is described as a network in which individuals that are linked to each other, to the extent that they participate in at least one event together. This is known as a one-mode network (see Borgatti et al., 2013 for a graphical representation). Data used here allows for the SNA of officers to describe their involvement in common UOF, and severe UOF incidents, with incidents representing the connections between these officers.

To describe this technique, and how it may be used by policing agencies to consider the group-based police behaviour, data were gathered for the 12 months beginning in October 2018. These data were then separated into UOF events that did not result in hospitalisation of a citizen, and those that did. After separation, there were 1,586 unique severe UOF incidents, and 3,033 non-severe UOF incidents. The most common reason reported for a severe UOF event was resisting arrest (41.4%), followed by non-compliance (24.63%). The most common type of force used, resulting in the hospitalisation of a citizen, was physical force such as a forcible takedown, tackle, knees or elbows (83.8%). Among UOF events that resulted in hospitalisation, 94.3% featured criminal charge brought against a citizen. These data were structured to facilitate SNA, as a means of comparison between time periods, and types of UOF events.

## Analysis

Data were analysed using the 'dplyr', 'igraph' and 'ggplot2' packages of the statistical analysis software R. Sociocentric networks (Marsden, 2002) were computed to understand whether networks of severe UOF presented similarly to UOF that did not result in hospitalisation of a citizen for the year in question. Given this research intended to consider structures within each network as they naturally occurred, this was an undirected network approach. Producing the sociograms, also known as graphical representations of the UOF events that linked officers, for these networks was the first step in this process. However, to understand what these graphs mean relating to the behaviour of officers, it was important to apply metrics that could explain them. To do so, the diameter and density of the networks were considered, alongside connectedness, measured using a metric known as the 'mean shortest path length'. Finally, the ways in which officers that used force grouped, and whether there were identifiable sub-groups that commonly used force together, were considered.

### Network diameter and density

The diameter of the network is a simple measure to consider the size of a network and to compare interconnectedness of officers (Sosa et al., 2021). Where two individuals are connected by a UOF

event, the network has a diameter of 1. If either of these individuals are connected to a further officer by UOF, the diameter of this network is 2, and so on. The diameter is represented by the longest network of individuals, and provides a measure of network size that may be used for comparison.

The density of a network is an important measure that allows for comparison of the connectedness of networks. Network density is the number of connections between individuals that exist in that network as a proportion of those that could exist between every pair of individuals in the network (Sosa et al., 2021).

### **Mean shortest path length**

The mean shortest path length is a key metric for measuring the extent to which the network of officers is clustered, in particular whether UOF is densely clustered among a grouping of officers. Prior literature has suggested that adverse events among police are typically attributed to a small, highly clustered group of officers. The mean shortest path length is designed to identify such a network. This metric is defined as the average number of steps along the shortest paths for all possible pairs of individuals (Mao & Zhang, 2013). Where this metric is low, the network is considered to be more clustered (Perez & Germon, 2016). The shortest path length between two individuals refers to the famous 'six degrees of separation' notion established by Travers & Milgram (1969).

### **The Girvan-Newman algorithm for identifying communities**

In this research, a community is considered to be a sub-group of individuals with notably denser connections than those among the rest of the network (Radicchi et al., 2004). The Girvan-Newman algorithm (Girvan & Newman, 2002) provides a method for community detection by removing connections using the Edge Betweenness Centrality (EBC) value. The highest EBC values are attributed to individual edges that connect separate parts of a network (Lu & Zhang, 2013); these are the connections that are removed first, before iteratively removing the next highest until a series of discrete communities are identified.

## **Results**

### **Demographics**

The demographics of officers in these data were relatively analogous to the literature when considering larger datasets of policing agencies (Harris, 2014; Huff et al., 2018; Kane & White, 2009). Officers were typically in their mid-30s with around eight years of service. Table 1 provides officer and citizen demographics, and situational characteristics of UOF incidents. Physical force was the most common force methodology, and the most common reason for using force was a citizen

resisting arrest. The rate of arrest post-UOF was high, but it was important to note that not all UOF arrests resulted in a citizen being charged with an offence.

Table 1. Demographics of officers that engaged in use of force by year

Officer demographics		
Age of officer (years)		34.8
Years of service		8.1
Gender of officer (%)	Male	90.6
	Female	9.4
Citizen demographics		
Age of citizen (years)		30.15
Gender of citizen (%)	Male	79.1
	Female	20.6
	Unknown	0.3
Situational characteristics		
Most common UOF type (%)	Physical force	83.8
Most common UOF reason (%)	Suspect resisting arrest	41.4
Rate of arrest post UOF (%)		88.9
Proportion of arrests resulting in charges (%)		94.3

## Measuring the network

Two sociograms were produced, one considering incidents that did not result in the hospitalisation of a citizen, and the other considering severe UOF incidents. The characteristics of these sociograms (see Figures 1 and 2, described in Table 2) suggested that they were notably different. Figure 1, describing UOF that did not result in hospitalisation, featured an inner network of connected officers; however, there were a noteworthy number of officers that were disconnected from this core group. This was reflected in Table 2, with the network metrics indicating a smaller and less dense network than identified among instances of severe UOF. Comparatively, Figure 2 demonstrated highly connected, and densely clustered networks of officers that engaged in severe UOF. Figure 2 did not feature the disparate outer incidence of UOF found in Figure 1. Rather, severe use of force was highly connected and localised among a discrete officer grouping.

Table 2. Comparative network characteristics for each year

Use of force not resulting in hospitalisation	
Diameter of network (Vertices)	32
Density	0.00232
Mean shortest path length	11.92
Use of force resulting in hospitalisation	
Diameter of network (Vertices)	58
Density	0.00349
Mean shortest path length	18.86

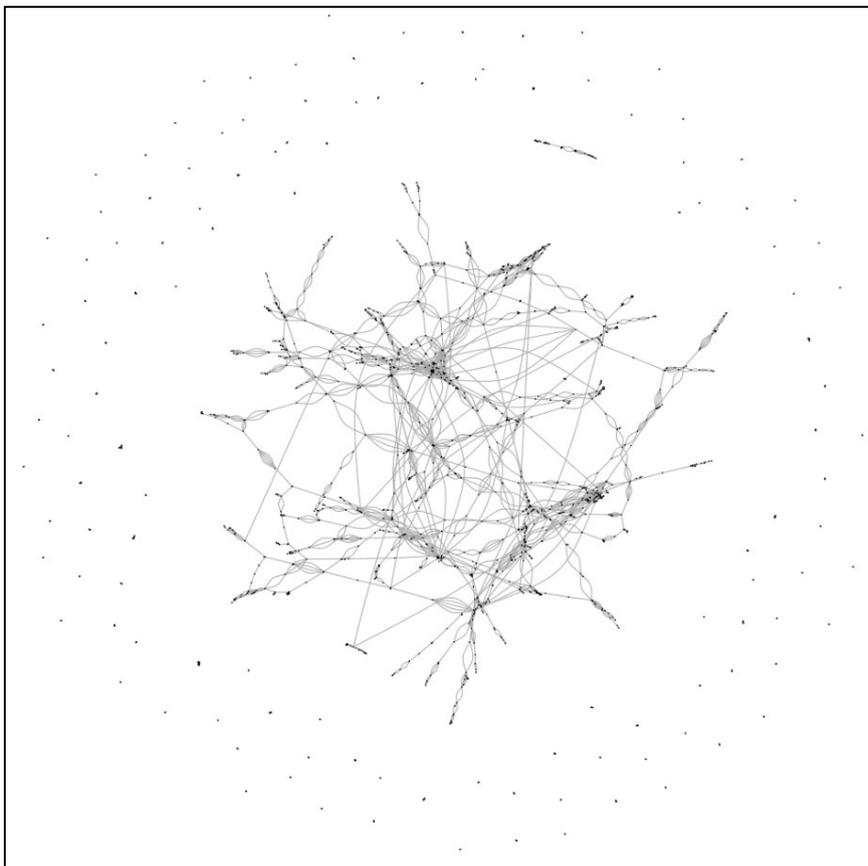


Figure 1. Sociogram for use of force incidents that did not result in hospitalisation of a citizen, year beginning October 2018

## Sub-groups of officers within networks

The Girvan-Newman algorithm was then applied to consider whether there were any identifiable sub-groups of officers within these networks. The number of communities detected was roughly representative of the data, with the number of UOF incidents that did not result in hospitalisation substantially higher than those that did. Table 3 suggested that the average size of communities among severe UOF networks was smaller than non-severe UOF networks. Although this is partly a function of the sample size considered in each group, it is also a reflection of the officers that are engaging in severe UOF events. When the findings in Table 3 are viewed in the context of those in Table 2, it appears that the size of communities

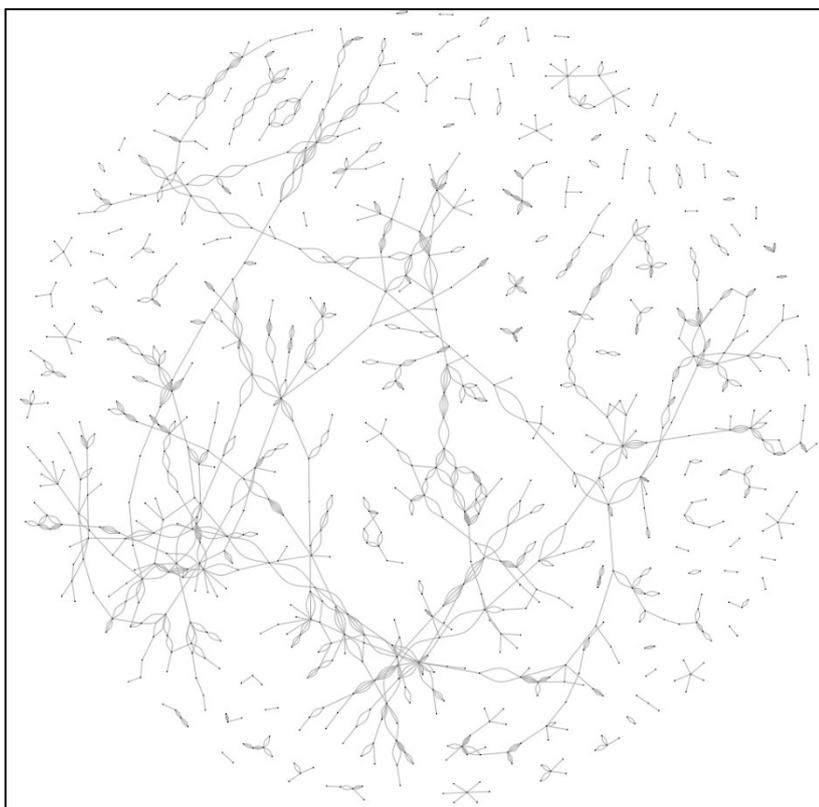


Figure 2. Sociogram for severe use of force incidents, year beginning October 2018

identified among severe UOF networks may be mediated by officers consistently committing severe UOF incidents with the same group peers. This was an important finding as it provided some evidence for sub-groups among these officers that were more inclined to use severe force.

Table 3. Comparative community characteristics for each year

Use of force not resulting in hospitalisation	
Number of communities	162
Largest community size (vertices)	82
Smallest community size (vertices)	2
Mean community size (vertices)	9.98
Use of force resulting in hospitalisation	
Number of communities	122
Largest community size (vertices)	47
Smallest community size (vertices)	2
Mean community size (vertices)	7.81

## Discussion

While prior research has considered UOF among police from a variety of perspectives, the application of network analytics is an emerging area. Holz, Rivera and Ba (2019) found that where police were injured as a result of an interaction with a citizen, the peers of that officer were notably more likely engage in any type of UOF event in subsequent weeks. Ouellet and colleagues (2019) extended this notion with similar findings, suggesting that where officers demonstrated a particular propensity for UOF, they may need to be restricted from regular duties until it can be established whether this is a problematic trend and if remediation is required. The present research identified discrete groupings of officers that were responsible for severe UOF incidents at a higher rate than other officers, suggesting certain officers engaged in severe UOF more often than others in similar positions. It may be that groupings of officers that demonstrate a proclivity for use of force and, in particular, severe UOF require a greater focus. The present methodology offers an approach that may be implemented by policing agencies to understand whether there are emerging officer groupings of concern, not only relating to UOF, but any relevant subject matter.

It appears that possible restrictions in duties may be an essential management technique for these officers where the frequency or severity of UOF is considered problematic. Chalfin and Kaplan (2021), and Sierra-Arévalo and Papachristos (2021), both considered the effect of removing problematic officers' access to operational policing duties, and the downstream effect this may have across several years. Although featuring marginally different assessments of the estimated effect of removing these officers, their research supported the impact of intervention and remediation methodologies in reducing likelihood of problematic behaviour. When considering UOF alone, network analytics may prove a useful approach to identification of officers whose behaviour requires further consideration and potential remediation.

## Limitations

These data were considered to be naturally occurring (Lester, et al., 2017), meaning that the initial purpose was not research, rather departmental monitoring and reporting by police. As noted in prior literature, reporting and data entry are limitations when using administrative data (Cubitt et al., 2020). Incidents of severe UOF were employed as the unit of analysis for this research, an approach which has been supported in prior research (Rozema & Schanzenbach, 2018; Ouellet et al., 2019). It is a relatively established notion that UOF may be higher among officers with a greater rate of interaction with the community, and certainly among more proactive officers (Lersch et al., 2006). It may be the case that proactive officers are more predisposed to severe UOF events, by virtue of simply being present at a higher rate of UOF events.

The rate of UOF incidents reported in these data likely underestimates the full scope of UOF by officers. Employing hospitalisation of a citizen as the threshold for severe UOF may minimise the volume of unreported incidents. Nevertheless, analytically, reported incidents of UOF are commonly considered to be strong proxies for officer behaviour (Rozema & Schanzenbach, 2018).

The context in which use of force events occur may be central to understanding differing rates of force between groups. To focus this research, only officers that undertook general patrol duties were considered, and as a result, these findings are not generalisable beyond Patrol officers. However, this research was not able to consider spatial, temporal, or environmental patterns in UOF. For example, it is possible that external factors such as roster patterns may also impact on UOF among groups of officers. This research could not consider these factors, they simply were not present in the data; yet, it is an important area for future analysis. In addition, the training history, and frequency of dispatch to high-risk duties may be an important consideration alongside these findings, where the data is available.

Further, this research was not able to compare UOF networks to the broader peer network of officers, or officer interactions with members of the public. Future research would benefit from the ability to include data relating to officer interactions with members of the public, as this may provide additional context. It is an implication for these findings and for any implementation of these techniques into practice that, where data allows, it may be effective to consider interactions with citizens and officer productivity alongside the rate and network characteristics of UOF.

## Conclusion

While a large proportion of UOF research considering behaviour of police employs the individual characteristics of officers for analysis, the network characteristics of officers provide substantial insight into the nature of group behaviour. The present research considered the ways in which networks of UOF and severe UOF function. The environment in which policing agencies operate results in unique risk for the development of subcultures. It is therefore important that workforce analytics, using techniques such as those employed here, are implemented to refine the distribution of police assets to the most appropriate locations, or groups, to have the greatest impact. This research has shown how these analytics might be used to consider groupings of officers and the way that they use force. Further, this approach offers opportunity for considering whether there are subcultures emerging among some groups of officers, which may allow agencies greater opportunity for early intervention where it is deemed necessary. With the increased use of analytical approaches to understanding emerging issues among police, SNA stands to make a significant contribution, and provide important opportunity to policing agencies.

## Implications for practice

The use of network analytics has provided substantial insight into policing practices (Bouchard & Malm, 2016; Ouellet et al., 2020; Papachristos & Sierra-Arevalo, 2018). While the ability to evaluate larger networks is important, the ability to identify groupings within those networks is pivotal for understanding group behaviour and culture (Cubitt, 2021). Findings here suggest that UOF and severe UOF was more common among certain groupings of officers. Although we cannot be certain whether this was attributable to learned behaviour among officers resulting in the creation of subcultures that are more likely to engage in these behaviours, this methodology provides a useful approach to identifying groupings of officers that may require a greater level of attention. Importantly, the implementation of this type of analysis holds implications for the ways in which education and training assets are distributed. SNA may offer an opportunity for more accurately distributing assets to emerging subcultures of concern, thereby improving opportunities to alleviate likelihood of emerging maladaptive groupings of officers.

This research has not included analysis of complimentary data; however, it is possible that policing agencies may find utility in parallel analysis of associated data sources. For example, while the legitimate use of force is a factor in any given policing agency, and the analysis here only considered those that were legitimate, there are some uses of force that result in complaints of misconduct. Network analytics of complaint data (Cubitt, 2021), or parallel analyses of complaints using complimentary methods (Cubitt et al., 2020), may provide additional insight into the prevalence of misconduct among groups of officers that disproportionately use force or severe force. These complimentary methods may provide considerable insight into the behaviour and policy adherence of officers.

Finally, the ability to identify key actors in these networks is the natural next step of this research. Roithmayr (2016) suggested that behaviour among police may function as a form of social contagion, a notion that has since found empirical support (Quispe-Torreblanca & Stewart, 2019). This theorised social contagion has been likened to the manner in which violence may diffuse through networks of offenders (Green et al., 2017; Papachristos et al., 2012). However, using the approach taken here, it was not possible to consider the presence of a contagion effect, or whether one officer was the root cause of severe, or non-severe, UOF groupings. While it is an important implication of this research that discrete groupings of officers were able to be identified, if the contagious nature of these events is attributable to an individual or several index officers, the next step will be to assess whether severe UOF is more common in the immediate network of certain officers.

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