

Intelligent Intervention

Assessing Gun Violence Reduction Programs with Quantitative Methods

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Overview

- 1 Introduction
- 2 Tools for Social Workers
- 3 Intervention Attempts and their Impacts
- 4 Cellular Automata Models of Gun Crime in Chicago, Illinois
- 5 Conclusions and Future Work

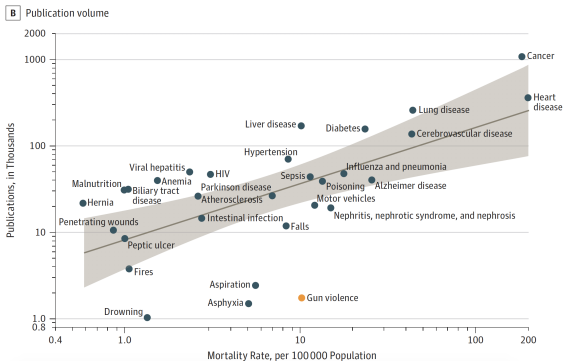
Presentation Objectives

- Review the tools for social workers to help prevent gun violence
- Present intervention strategies and their quantitative evaluations
- Introduce a mathematical model of gun crime in Chicago, Illinois, and discuss how interventions will be incorporated

The Cost of Gun Violence in the United States

- Gun violence costs the United States \$229 billion annually
- 31,000 deaths and 78,000 non-fatal injuries
- Homicide is the leading cause of death in black males aged 10-24

- 80% of homicides involve the use of a firearm
- (Kellerman 1993) Having a gun in the home increases the risk for homicide occurring in the home
- (1996) Dickey Amendment



Individual Cost of Gun Violence

- Adults reporting exposure to gun violence as children showed an increased likelihood for chronic health conditions

Health Outcome	Risk Increase
Heart Disease	2.2
Cancer	1.9
Stroke	2.4
Chronic obstructive lung disease (COPD)	3.9
Diabetes	1.6
Hepatitis	2.4

Byrdsong 2016

Individual Cost of Gun Violence

- Exposure to community violence also affects mental health, substance use, school engagement, juvenile justice involvement, and STI risk behaviors in youth

Health Outcome	Risk Increase
Poor mental health	2.7
Delinquent behaviors	2.1
Involvement in juvenile justice system	3.5
Low school bonding	1.5
Poor student-teacher connectedness	1.7
Cigarette smoking	2.9
Ecstasy use	9.2
Codeine use	4.6
Alcohol consumption	2.2
Marijuana use	2.9
Use of substances during sex	6.5
Lack of condom use during sex	2.2
Unplanned pregnancy or impregnation	2.0

Tools for Social Workers to Prevent Gun Violence: Safe Storage of Guns in the Home, Extreme Risk Protection Orders, and Other Methods of Gun Violence Prevention



Briefing Motivation

- Social workers have the potential to educate the public and increase public awareness about the devastating effects of gun violence
- Goal 1: Cover recommended programs to prevent gun deaths and injuries
- Goal 2: Discuss gun policy and legislative actions that are promising to reduce gun violence

Asking about Safe Storage to End Family Fire

- *Family fire*: Shootings (both homicides and suicides) resulting from access to unsecured guns in the home
- *ASK* encourages the prevention of family fire through awareness and education
- Gun safety assessment:
 - Is there a gun in the home?
 - If so, is it stored locked, unloaded, and out of reach of children?
 - Are you aware that your state strictly prohibits having loaded and unsecured guns in your house?



Brady Campaign

Extreme Risk Protection Order Laws

- Temporarily removes guns from a person in crisis and at risk from harming oneself or others
- Prohibits these individuals from purchasing additional guns
- Social workers have the ability to educate the public, law enforcement, and court system about ERPOs and advise those at risk



Other Legislative Measures to Prevent Gun Violence

- Background check laws
- Tracking crime guns to their source: holding “bad apple” dealers accountable
- Assault weapons ban
- Tennessee domestic violence bills for this week:
 - Dispossession and Third Party Accountability
 - Domestic Violence Offender Permit Surrender
 - Eliminates Firearm Dispossession Form

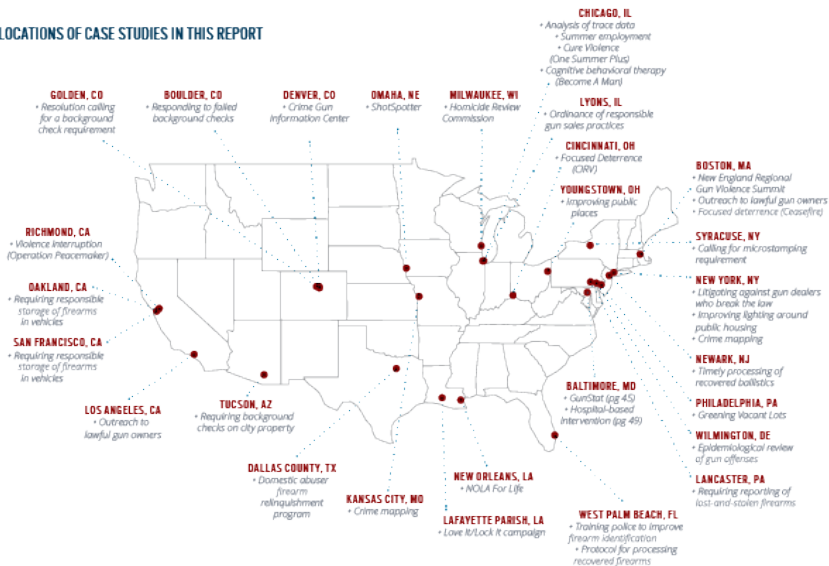
Recommendations for Social Workers

- Become familiar with and integrate End Family Fire (EFF) guidelines in your family practice and interface with families during professional home visits
- Encourage schools of social work to develop curriculum content that includes gun safety education and family fire prevention
- School social workers should include friendly fire education protocols in student assessments and individual education planning
- NASW must continue to address gun violence as a public health priority

Questions?

Intervention Attempts and Their Impacts

LOCATIONS OF CASE STUDIES IN THIS REPORT



Everytown for Gun Safety

Types of Intervention Attempts

- Policing Methods
 - Strategic Subject List (SSL) in Chicago, IL
 - Violent Offender Identification Directive (VOID)
 - “Broken-windows” policing
- Violence Interruption
 - Focused deterrence in Oakland, California
 - Project Longevity
- Community Changes
 - Greening programs
 - Project Safe Neighborhoods
 - Safe Streets



Strategic Subjects List

● Method

- Use co-arrest data to predict the likelihood of someone becoming a homicide victim
- Pass the SSL list on to law enforcement officials, who then create a “persons of interest” list

● Data

- Individual information about arrestees
- Record of police contact with arrestees
- Interviews with law enforcement officials

● Evaluation

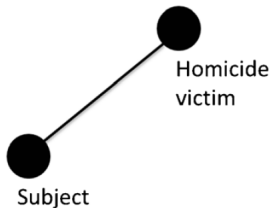
- Autoregressive Integrated Moving Average (ARIMA) Models
- Time-series analysis
- Propensity score matching
- Mediation analysis

● Impact

- Individuals on the SSL are not more or less likely to become a victim of a homicide
- SSL individuals are more likely to be arrested for a shooting

Strategic Subjects List

1st Degree Link



2nd Degree Link

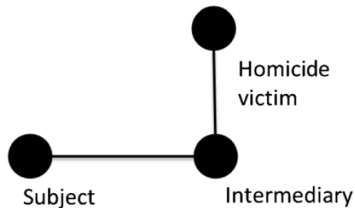


Fig. 2 First- and second-degree co-arrest links

Saunders 2016

The Impact of Violence Interruption on the Diffusion of Violence

- Method
 - Ordinary Differential Equations
 - Population Classes: Susceptible - Transmitter - Victim
- Data
 - Gun ownership from Philadelphia, PA
 - Estimated illegal gun owners
 - Data-informed parameter estimation
- Impact
 - Targeting all potential violence transmitters can reduce gun violence three times more than only gun-owning individuals
 - Violence transmitters, even if they are not participants, can sustain a gun violence epidemic

The Impact of Violence Interruption on the Diffusion of Violence

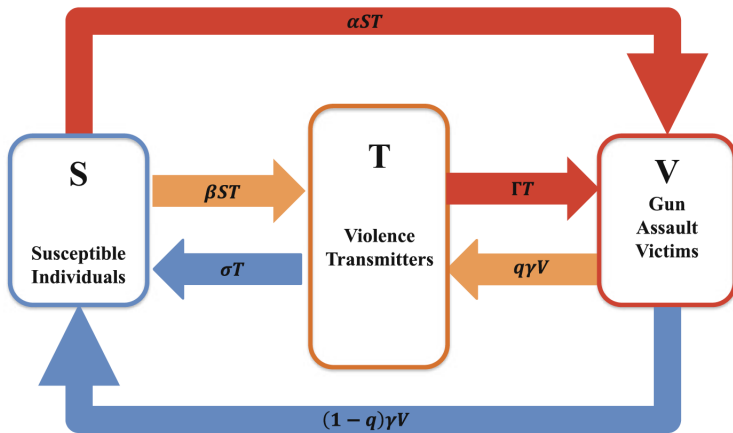


Fig. 1 Flow diagram for STV model

Effects of Greening and Community Reuse of Vacant Lots on Crime

- Method
 - Youngstown, Ohio
 - Identify vacant lots that are strategic for reuse
 - Program 1.0: “Green” lots
 - Program 2.0: Allow communities to reuse these parcels for other purposes
- Data
 - Geographic data
 - Crime Incident data
 - Demographic data
- Evaluation
 - Random-effects generalized linear regression models
 - Poisson models
 - Random-effects spatial Durbin regression models
- Results: Under all models, greening of vacant lots reduces crime in Youngstown

Effects of Greening and Community Reuse of Vacant Lots of Crime

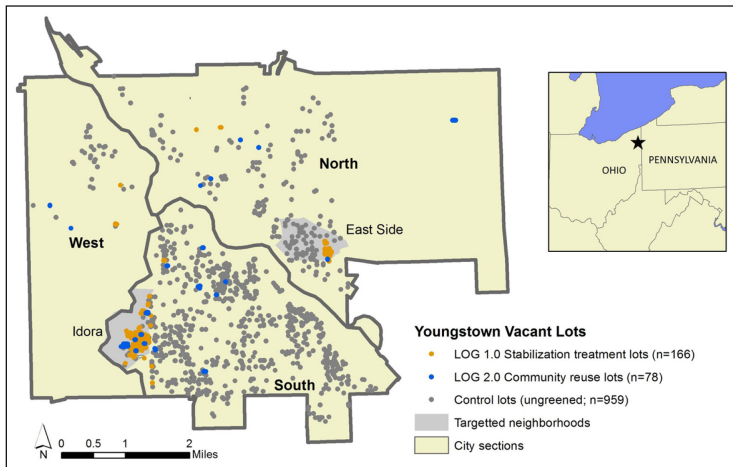
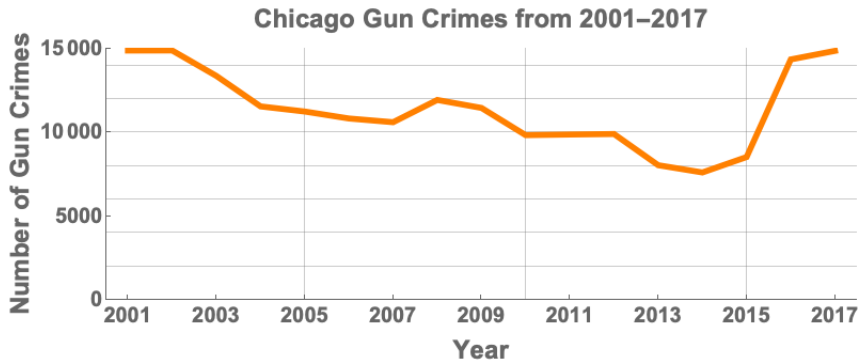


Figure I. Overview map of treatment and control lots in Youngstown, OH.

Questions?

The Impact of Gun Crime in Chicago

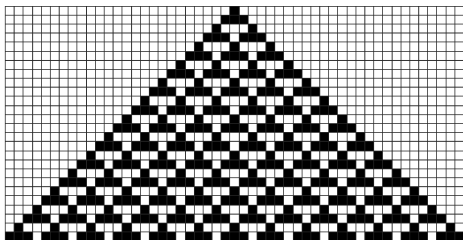
- (2012) Chicago had the highest number of city-wide murders
- Between 2015 and 2016 there was a 68% increase in gun crimes, disproportionately affecting disadvantaged neighborhoods
- Data used for this study:
 - Chicago city crime dataset, 2001 - 2017
 - Selected socio-economic indicators in Chicago, 2008 - 2012



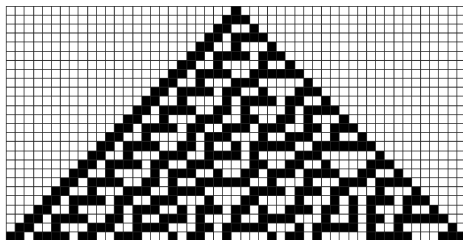
Cellular Automata Models

- Incorporate both space and time
- Composed of a lattice of cells, each existing in a specific state
- Local rules determine how the cell's states change over time

Rule 54

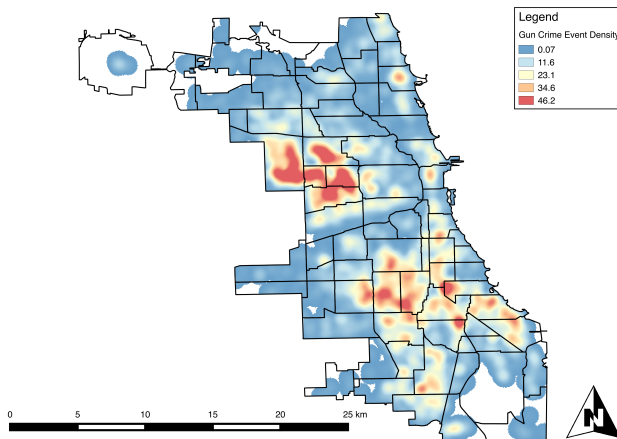


Rule 30



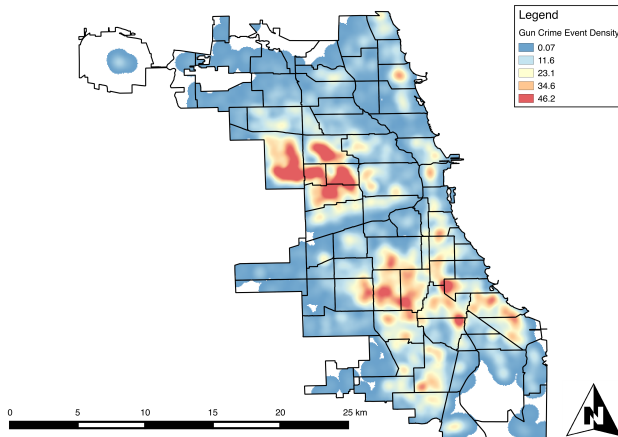
Applying Cellular Automata to Gun Crime in Chicago

- Spatial units → community areas of Chicago
- Temporal units → weeks
- Cell states → level of crime present
- Transition rules → depend on internal factors and on neighborhood influences



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Which socio-economic conditions impact the number of gun crime events?

- Method: Negative Binomial Regression with Subset Selection

- Factors tested:

- Crowding
- Poverty
- Unemployment
- Education level
- Dependents
- Per capita income

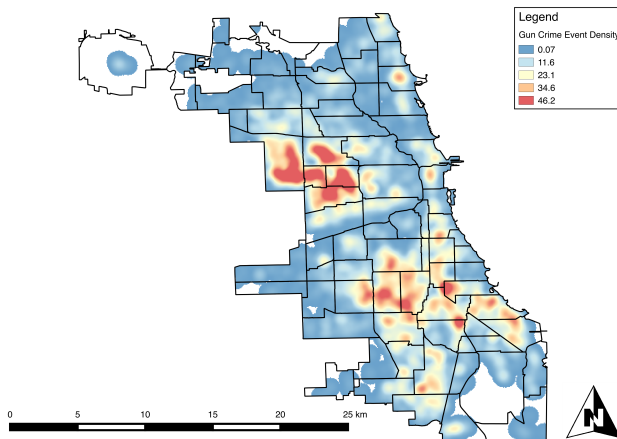
Predictor	Coefficient
Poverty	1.0344
Unemployment	1.1123
Dependents	0.9477

Regression Results

$$\log(\# \text{ Gun Crimes}) = 4.1258 + 0.0338 * \text{poverty} + 0.1064 * \text{unemployment} - 0.0537 * \text{dependents}$$

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How far does gun crime spread in both space and time?

- Method: Bayesian spatio-temporal point process (Loeffler and Flaxman 2017)
- Goal: Distinguish between clustered but non-diffusing gun crime and clustered gun crime resulting from diffusion

Conditional Intensity

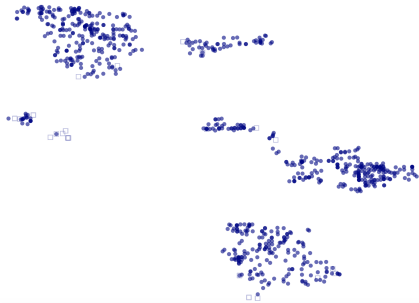
$$\lambda(x, y, t) = m_0\mu(x, y, t) + \theta \sum_{i:t_i < t} \omega \exp(-\omega(t - t_i)) \frac{1}{2\pi\sigma^2} \exp(-((x - x_i)^2 + (y - y_i)^2)/(2\sigma^2))$$

- Triggering kernels for both time (t) and space (x, y)
- $\mu(x, y, t)$: background intensity, weighted by m_0
- θ : the average number of shootings triggered by any particular shooting
- σ : spatial length scale
- ω : temporal length scale

Results of Point Process

Subset of Chicago data

Community Areas 20-25 2008



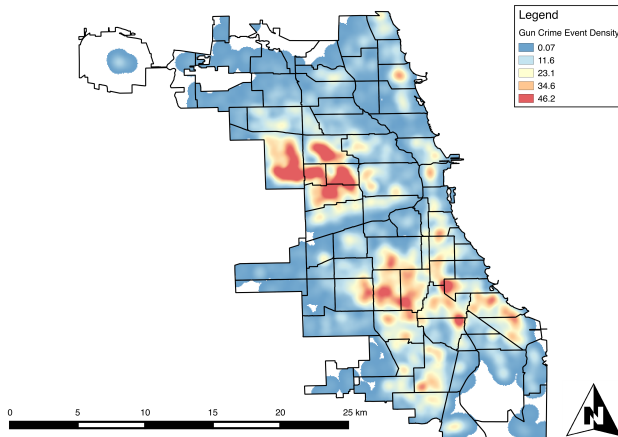
- Overall question: Do gun crimes “trigger” one another in space and time?
- Answer: **yes**
- For every 100 crimes observed at a given location, we expect the next 93 crimes that occur to be caused by the initial 100 crimes
- We expect them to happen very soon after (~ 12 hours) and within a close geographic radius (~ 1.6 km).

Adding Intervention Strategies

- Assess the impact of community-level interventions
- How does controlling each of the components in the model change the spread of gun crime?

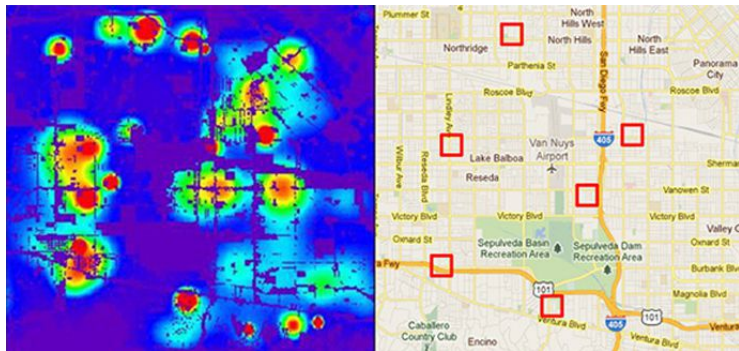
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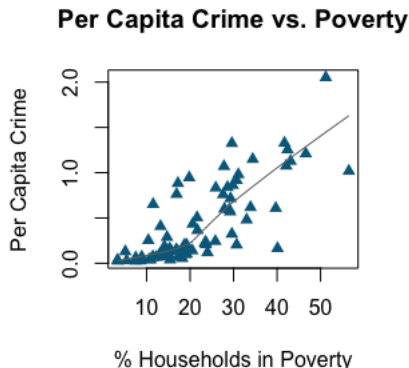
Changing the level of crime present

- There are ~14 levels of gun crime present in community areas of Chicago, Illinois
- Method: k -selection clustering algorithm
- What happens if we remove the highest level of crime?
- Implementation: Increased policing in high-crime community areas



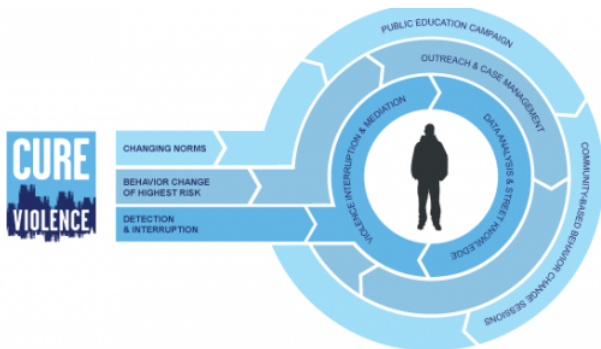
Changing the Internal Factors Present in Communities

- Socio-economic indicators affect gun crime in Chicago
- If we can reduce the impact of some of these factors, how can we change the spread of crime?
- Implementation:
 - Reduce poverty
 - Reduce unemployment
 - Combat the burden of dependents in communities



Changing the Impact of Neighborhood Influences

- Gun crime diffuses in both space and time
- Past crimes trigger future crimes
- If we can reduce how “infectious” gun crime is, can we control the spread?
- Implementation: Community intervention efforts



Conclusions

- Social workers serve an integral part in preventing gun violence at the individual level
- Using quantitative methods before, during, and after implementing interventions can create more effective reductions in crime
- Specifically in Chicago:
 - Gun crime is significantly impacted by poverty, unemployment, and dependents
 - Crime diffuses in both space and time, similar to an epidemic
 - There are a number of ways interventions can be incorporated into data-informed mathematical models to better determine how and when to put programs in place

Future Work

- Incorporate information about socioeconomic status and radius of spread into cellular automata models
- Test different control methods in the cellular automata model
- Create evidence-informed recommendations for how to combat gun crime in Chicago
- Apply this model to other cities and countries to further reduce the public health crisis of gun crime in the United States



NIMBioS

National Institute for Mathematical and Biological Synthesis

Questions?

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