

# NIMBioS Investigative Workshop Summary: Mathematics of Gun Violence

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## Workshop Summary

Gun violence is a major issue in the United States, annually costing \$229 billion and leading to the deaths of 31,000 individuals. Gun violence is also related to gun crime, gang activity, police-involved shootings, and a number of other phenomena. The objectives of this workshop were to (i) review the existing approaches on the mathematics and modeling of gun violence, (ii) identify and prioritize areas in the field that require further research, (iii) develop cross-disciplinary collaborations to gain new perspectives, and (iv) suggest research and data-collection that could assist evidence-based policy recommendations. A webinar preceding the workshop reviewed a subset of the existing approaches on the mathematics and modeling of gun violence. On the first day, we furthered this review of existing topics with three seminar speakers along with questions and discussions. In the afternoon, we split into three breakout session groups, with topics voted on by workshop participants. Overall, the workshop covered nine different breakout topics, spanning from specific modeling methods to general best practices in engaging with stakeholders. The major conclusions were that there are not enough sources of data (and that many existing sources are unreliable), that there is a need for cross-disciplinary collaborations, and that there are a number of unexplored applications of mathematics and statistics to this subject area. At the end of the workshop, we outlined the structure of a report to be published in the next 6-12 months and discussed some tentative journals where this report would be submitted. A number of potential collaborations and other modeling topics were discussed.

The first six breakout topics were voted on by participants before the workshop began, while the other three were decided during group discussion on Thursday afternoon. The topics were:

- Network models accounting for individual and group characteristics
- Investigating the spatio-temporal aspects, including the environment, of gun violence models
- Incorporating and testing theoretical models from criminology, sociology, and epidemiology to explain gun violence
- Developing epidemiological criminology as an emerging paradigm for gun violence modeling
- Best practices for collaborating with stakeholders not just in developing models, but in communicating results effectively and translating results into actionable recommendations
- Methods for appropriate data gathering and quality to provide background information for models
- Approaches for modeling the impacts of legislative policies and alternative intervention methods
- Incorporating new technologies into models of gun violence
- Methods for quantifying the impact of policies targeting rare events.

Oral and poster presentations were also given. The three oral presenters were Sherry Towers, whose talk was entitled, “Contagion in mass killings and school shootings,” George Mohler, whose talk was entitled, “Spatial ranking, embedding, and interventions for heterogeneous human activity data,” and Rosanna Smart, whose talk was entitled, “Approaches to modeling effects of state gun policy: Methodological considerations.” The poster presenters were Jonathan Jay (Alcohol outlets and firearm violence: a place-based case-control study using satellite imagery and machine learning), Veronica Pear (Risk factors for assaultive reinjury and death following a nonfatal firearm assault injury: a population-based retrospective cohort study), Alexandria Volkening (Forecasting U.S. elections using compartmental models of infection), and Shelby Scott (Handguns and hotspots: Spatio-temporal models of gun crime in Chicago, Illinois).

## Workshop Participants

- **Tim Akers**, Center for Research Innovation and Advocacy, Morgan State University
- **Jeremy Auerbach**, Environmental & Radiological Health Sciences, Colorado State University
- **Richard Block**, Sociology, Loyola University Chicago
- **Heather Brooks**, Mathematics, University of California, Los Angeles
- **Shani Buggs**, Violence Prevention Research Program, University of California, Davis
- **Cassandra Crifasi** Johns Hopkins Center for Gun Policy and Research, Johns Hopkins
- **Grant Drawve**, Sociology, University of Arkansas
- **Stephen Eubank**, Virginia Biocomplexity Institute & Initiative, University of Virginia
- **Nina Fefferman**, Mathematics and Ecology & Evolutionary Biology, NIMBioS and University of Tennessee, Knoxville
- **Jason Goldstick**, Emergency Medicine, University of Michigan; Director of Statistics & Methods Section, Research Core, UM Injury Prevention Center
- **Louis J. Gross**, Mathematics and Ecology & Evolutionary Biology, NIMBioS and University of Tennessee, Knoxville
- **Natalie Hipple**, Criminal Justice, Indiana University, Bloomington
- **Jonathan Jay**, FACTS Consortium, Public Health, Harvard University
- **Charles Loeffler**, Criminology, University of Pennsylvania
- **Brianna Mills**, Harborview Injury and Prevention Center, University of Washington
- **George Mohler**, Computer and Information Science, Indiana University, Purdue University Indianapolis
- **Kellen Myers**, Ecology & Evolutionary Biology, University of Tennessee, Knoxville
- **Veronica Pear**, Violence Prevention Research Program, University of California, Berkeley
- **Nancy Rodriguez**, Applied Mathematics, University of Colorado, Boulder
- **Jessica Saunders**, Regulation, Evaluation, and Governance, Stanford University
- **Shelby M. Scott**, Ecology & Evolutionary Biology, University of Tennessee, Knoxville

- **Gary Slutkin**, Public Health, University of Illinois at Chicago
- **Rosanna Smart**, Policy, RAND Corporation
- **Christopher Strickland**, Mathematics, University of Tennessee, Knoxville
- **Jeffrey Taxman**, Psychiatry, Medical College of Wisconsin
- **Miriam Thalos**, Philosophy, University of Tennessee, Knoxville
- **Sherry Towers**, Biosocial Complexity Initiative, Arizona State University
- **Melissa Tracy**, Epidemiology, Biostatistics, State University of New York, Albany
- **Alexandria Volkening**, Mathematical Biosciences Institute, The Ohio State University