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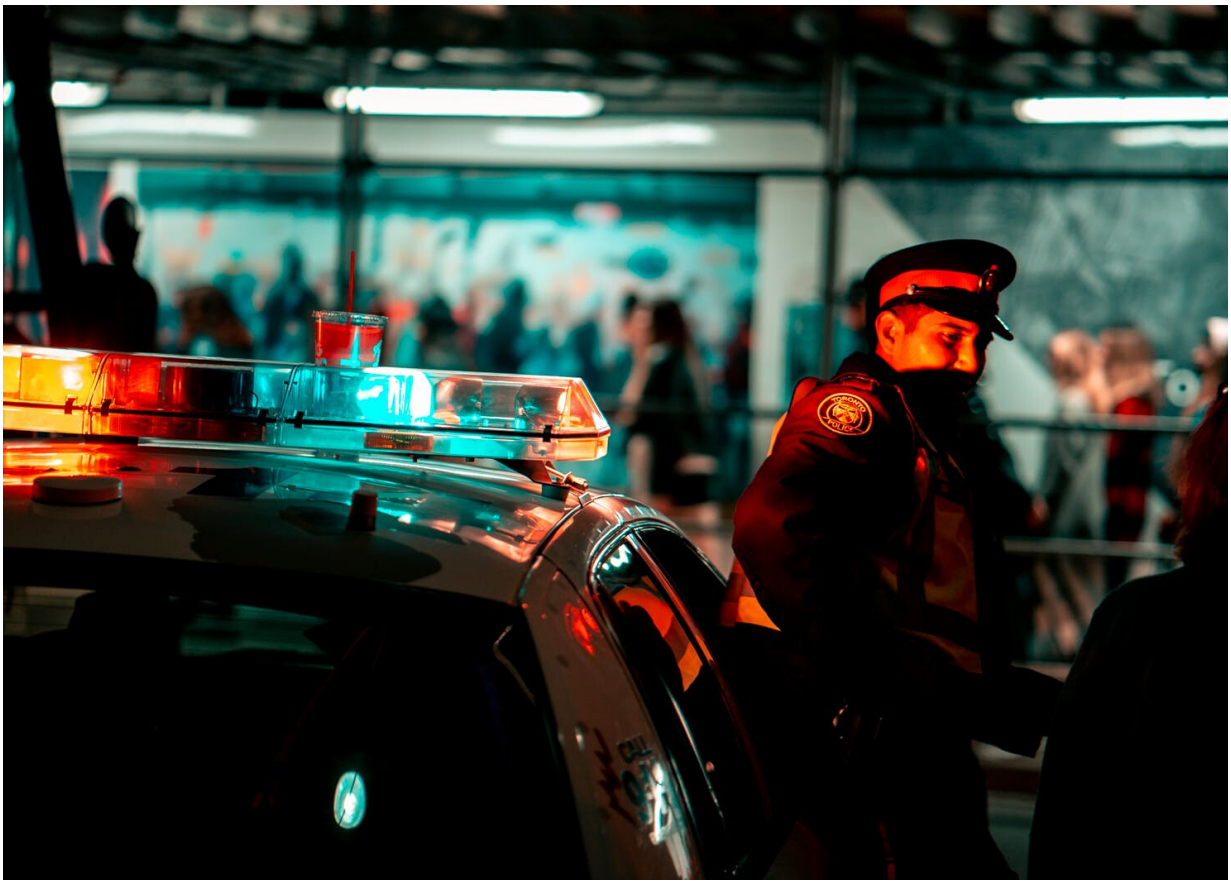
POLICE TECHNOLOGY: ACOUSTIC GUNSHOT DETECTION SYSTEMS



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Abstract: Police departments continually adopt new technology to improve how they investigate and solve crime. Acoustic gunshot detection systems (AGDs) such as ShotSpotter use sound sensors to locate gunshots in a community, improve response times, determine how many shooters are in an area, and identify the types of firearms being used. This article features a literature review on AGDs. Limited research has shown AGDs are reliable in detecting shots fired, but less is known on whether the systems contribute to a reduction in gun crime.

Introduction

Law enforcement agencies across the country are integrating acoustic gunshot detection systems (AGDs), commonly known by brand name Shotspotter, into their policing strategies. AGDs are comprised of outdoor sound sensors that alert police to geographic locations of gunfire. AGDs help police more quickly identify scenes of a shooting, respond, and ensure emergency medical services are quickly obtained. The sensors also help determine the number of shooters in an area and whether the sound came from a semi-automatic weapon.[1] Additionally, the technology can identify when shots are fired from a moving vehicle and the direction the vehicle is heading.[2]

The acoustic sensing system was initially developed to detect and study earthquakes.[3] Robert Showen developed the ShotSpotter software to detect outdoor gunfire in the 1990s.[4] ShotSpotter is used in more than 100 U.S. cities, including Chicago and Peoria.[5] ShotSpotter's 2017 National Gunfire Index shows a combined 86,665 incidents of gunfire in 87 cities. Other brands and models of AGDs are now on the market and the use of AGDs has grown. This article describes AGDs, their prevalence in the country and Illinois, related research, and implications for policing.

AGD Technology

AGD's highly sensitive sensors are placed in elevated locations throughout a designated coverage area determined by law enforcement. When more sensors capture the sound, the system is better able to identify the location.[6] Typically, 15 to 20 sensors are needed per square mile of coverage.[7] This technology can be considered passive; it is only applied when an impulsive sound like gunfire occurs. By contrast, other technologies, such as cameras, are continuously recording. Sensors are constantly monitoring and information recorded is regularly overwritten within hours or days; when the AGD system is activated for a possible gunshot, two seconds before the event and four seconds after the event are transmitted as a recording for review.[8]

The system takes no more than 45 seconds after a shooting to alert the location to a 9-1-1 call center or police officer smartphone or mobile laptop.[9] Sounds with comparable acoustics, such as fireworks, cars backfiring, or helicopters, may trigger a false report, but human review can curb the issue. The system generally cannot detect shots fired indoors, into cars, in cavernous urban areas with many tall buildings, when a silencer is used, or if a victim is shot inches away from the person firing the firearm.

The ShotSpotter AGD system can be costly, ranging from $65,000 to $85,000 per square mile, with a minimum coverage area of three square miles.[10] Equipment and data are available only via lease.[11] Leasing equipment can reduce upfront costs, which helps make the price more manageable for some departments.[12] ShotSpotter owns the data collected with its equipment and leases access to the data to police departments with an annual subscription. These agreements may prohibit departments from releasing the data to the public, so the public is unaware of incidents captured by ShotSpotter or subsequent arrests. In addition, ShotSpotter leases are structured so that police departments lose data access upon contact termination; this can decrease competition in the market.[13]

Prevalence of Use of AGD

In 2018, 100 police agencies and 10 college campuses in the United States were using ShotSpotter, with a combined coverage area of more than 300 square miles.[14] In some cities, such as Washington, D.C., ShotSpotter is integrated with closed circuit cameras, which provides video at the scene.[15] ShotSpotter data have not often been used as evidence in court proceedings, however they have helped corroborate numbers of shots fired and pinpoint when gunfire occurred.

The U.S. military used individual gunshot detectors first in 2011 to help soldiers identify the distance and direction of approaching gunfire.[16] The portable sensors were attached to body armor and weighed less than two pounds. Gunshot detection sensors also can be attached to vehicles and aircrafts, which in combination with stationary sensors, allow for enhanced gunfire detection.

ShotSpotter in Illinois

Numerous jurisdictions throughout Illinois have acquired the ShotSpotter technology. The Chicago Police Department launched its ShotSpotter system in 2012, initially employing it for two 1.5-square-mile areas. Currently, 12 Chicago police districts covering over 100 square miles are using the system making the city ShotSpotter's largest customer.[17] The average cost per district is about $1.5 million and some federal grant funding has offset the costs.[18]

The large cities of Peoria and Rockford use ShotSpotter. Rockford acquired the technology in 2018 paying $310,00 for four-square miles[19] and Peoria in 2013 for $405,000 for a three-year contract focusing on three-square miles.[20] In 2016, Peoria renewed the contract for another three years, doubling the coverage area.[21] The Village of Bellwood has used ShotSpotter technology since 2007 and is entirely covered by the technology, which is integrated with surveillance camera systems.[22] The City of Aurora has employed ShotSpotter since 2009.[23] Calumet City implemented the technology in 2018, paid for with funds recovered from drug busts and other illegal activity.[24]

Research on AGDs

Accuracy in detection. Early research (1998) found the system accurately identified 72 percent of shots fired.[25] The same study found no difference in police response times to technology-detected gunshot reports compared to citizen-reported gunshots.[26] A quasi-experimental study in 2002 found that ShotSpotter could detect 81 percent of gunshots and locate 84 percent of the shots detected.[27] Company-sponsored research in 2011 reported seven departments using the system had faster response times and more efficient investigations. The company hypothesized that by providing more precise locations, investigators may be better able to locate evidence, such as shell casings. In 2013, the manufacturer guaranteed the system would capture at least 80 percent of all outdoor gunshots in the monitored areas. In practice, the company claims an accuracy rate of between 90 and 95 percent.[28]

Increase in dispatches. Initial research findings revealed a 268-percent increase in police dispatches to "shots fired" calls, which may suggest a significant amount of underreported gunfire in some areas.[29] Safety protocols were activated for D.C. officers responding to ShotSpotter incidents as they were encountering an increasing number of armed individuals.[30]

Reduced gun crime. Little academic research exists to support ShotSpotter's effectiveness in reducing gun crime. Investigative reporters in San Francisco, Calif., analyzed ShotSpotter events and found that while law enforcement was alerted to over 3,000 incidents in two and a half years, just one alert resulted in an arrest for a gun-related offense.[31] The company holds that its technology is not aimed at increasing arrests but providing police with information on gunfire that otherwise would have gone unreported.[32] In addition, departments typically place sensors in areas with the most violent crime; it is possible that knowledge of AGDs in a community could cause perpetrators of gun violence to move to other areas.

Discussion and Conclusion

Law enforcement agencies across the country are integrating AGDs into their policing strategies. The technology appears to be accurate with a detection rate of at least 80 percent. Mazerolee found evidence that AGDs increased dispatch to calls for service where gunshots were fired. [33] However, there is insufficient evidence to show AGDs contribute to a reduction in gun crime.

The public, as well as researchers, have raised issues on the confidentiality and lack of transparency regarding AGDs. While much of this technology is taxpayer funded, the data gathered by the technology are proprietary and exempt from the Freedom of Information Act.[34] Law enforcement officials cite the importance of keeping AGD locations confidential to protect the sensors from damage, avoid impairing officers' ability to fight gun crime, and protect the privacy of citizens who agree to allow the sensors on their properties.

The future of ShotSpotter and other AGDSs remains to be seen, but the technology is expanding to meet needs in a variety of arenas. For example, the system is being tested to detect poaching in South Africa.[35] The company also has developed a campus security technology which integrates school layouts with AGD sensors that provide information to police and security personnel during active shooter incidents.[36] A similar concept that detects gunfire by energy and identifies weapon caliber is being considered for implementation in 50 schools in the United States.[37]

ShotSpotter has explored selling its data to a federal agency, such as the FBI or ATF.[38] In addition, the company reports researchers have shown interest in using the data to measure bystander exposure and its collateral consequences.[39] With some departments opting to allow their contracts to expire after not experiencing increases in arrests or improvements in other public safety measures, ShotSpotter is rethinking its business model and considering providing information for empirical research on concrete outcomes. It is also considering making more information available to the public.[40] For example, ShotSpotter agreed to partner with Stanford University School of Medicine to conduct a study to determine if ShotSpotter reduces hospital travel time for victims of gunshots and improves patient outcomes.[41]

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[1] Holliday Smith, R. (2016, May 18). Here's how the NYPD's expanding ShotSpotter system works. *DnaInfo.* Retrieved from https://www.dnainfo.com/new-york/20160518/crown-heights/heres-how-nypds-expanding-shotspotter-system-hears-gunfire/

[2] Goode, E. (2012, May 28). Shots fired, pinpointed and argued over. *The New York Times.* Retrieved from https://www.nytimes.com/2012/05/29/us/shots-heard-pinpointed-and-argued-over.html?_r=2&pagewanted=all

[3] Petho, A., Fallis, D. S., & Keating, D. (2013, November 2). ShotSpotter detection system documents 39,000 shooting incidents in the District. *Washington Post*. Retrieved from https://www.washingtonpost.com/investigations/shotspotter-detection-system-documents-39000-shooting-incidents-in-the-district/2013/11/02/055f8e9c-2ab1-11e3-8ade-a1f23cda135e_story.html?utm_term=.d4bfeb7815d3

[4] Petho, A., Fallis, D. S., & Keating, D. (2013, November 2). ShotSpotter detection system documents 39,000 shooting incidents in the District. *Washington Post*. Retrieved from https://www.washingtonpost.com/investigations/shotspotter-detection-system-documents-39000-shooting-incidents-in-the-district/2013/11/02/055f8e9c-2ab1-11e3-8ade-a1f23cda135e_story.html?utm_term=.d4bfeb7815d3

[5] ShotSpotter. (2018). S*hotSpotter frequently asked questions*. Retrieved from https://www.shotspotter.com/system/content-uploads/SST_FAQ_January_2018.pdf

[6] Petho, A., Fallis, D. S., & Keating, D. (2013, November 2). ShotSpotter detection system documents 39,000 shooting incidents in the District. *Washington Post*. Retrieved from https://www.washingtonpost.com/investigations/shotspotter-detection-system-documents-39000-shooting-incidents-in-the-district/2013/11/02/055f8e9c-2ab1-11e3-8ade-a1f23cda135e_story.html?utm_term=.d4bfeb7815d3

[7] Holliday Smith, R. (2016, May 18). Here's how the NYPD's expanding ShotSpotter system works. *DnaInfo.* Retrieved from https://www.dnainfo.com/new-york/20160518/crown-heights/heres-how-nypds-expanding-shotspotter-system-hears-gunfire/

[8] Stanley, J. (2015, May 5). ShotSpotter CEO answers questions on gunshot detectors in cities. *American Civil Liberties Union*. Retrieved from https://www.aclu.org/blog/privacy-technology/surveillance-technologies/shotspotter-ceo-answers-questions-gunshot?redirect=blog/free-future/shotspotter-ceo-answers-questions-gunshot-detectors-cities

[9] Petho, A., Fallis, D. S., & Keating, D. (2013, November 2). ShotSpotter detection system documents 39,000 shooting incidents in the District. *Washington Post*. Retrieved from https://www.washingtonpost.com/investigations/shotspotter-detection-system-documents-39000-shooting-incidents-in-the-district/2013/11/02/055f8e9c-2ab1-11e3-8ade-a1f23cda135e_story.html?utm_term=.d4bfeb7815d3; ShotSpotter. (2018). S*hotSpotter frequently asked questions*. Retrieved from https://www.shotspotter.com/system/content-uploads/SST_FAQ_January_2018.pdf

[10] Rosenberg, T. (2018, March 20). Fighting Death by Gunshot. *The New York Times*. Retrieved from https://mobile.nytimes.com/2018/03/20/opinion/gunshot-death-doctors.html?referer=https://www.google.com/; Ryan, J. (2016, June 22). Can this new technology reduce shootings in Louisville? *89.3 WFPL: Politics.* Retrieved from http://wfpl.org/shot-tracker-might-not-reduce-shootings-louisville/

[11] Rosenberg, T. (2018, March 20). Fighting Death by Gunshot. *The New York Times*. Retrieved from https://mobile.nytimes.com/2018/03/20/opinion/gunshot-death-doctors.html?referer=https://www.google.com/

[12] Drange, M. (2016, November 17). We're spending millions on this high-tech system designed to reduce gun violence. Is it making a difference? *Forbes*. Retrieved from

https://www.forbes.com/sites/mattdrange/2016/11/17/shotspotter-struggles-to-prove-impact-as-silicon-valley-answer-to-gun-violence/#56fc0af831cb

[13] Doleac, J. L. (2016, February 4). *To reduce gun violence, empower citizens to make their communities safer*. Brookings Institution Op-Ed. Retrieved from https://www.brookings.edu/opinions/to-reduce-gun-violence-empower-citizens-to-make-their-communities-safer/

[14] Associated Press. (2018, June 22). Gunshot detection technology coming to Wisconsin schools. Education Week. Retrieved from https://www.apnews.com/73b68b68d4964c6a9a56ef6c5c5344ca; Gold, H. (2015, July 17). ShotSpotter: Gunshot detection system raises privacy concerns on campuses. *The Guardian.* Retrieved from https://www.theguardian.com/law/2015/jul/17/shotspotter-gunshot-detection-schools-campuses-privacy

[15] Petho, A., Fallis, D. S., & Keating, D. (2013, November 2). ShotSpotter detection system documents 39,000 shooting incidents in the District. *Washington Post*. Retrieved from https://www.washingtonpost.com/investigations/shotspotter-detection-system-documents-39000-shooting-incidents-in-the-district/2013/11/02/055f8e9c-2ab1-11e3-8ade-a1f23cda135e_story.html?utm_term=.d4bfeb7815d3

[16] Osborn, K. (2011, March 15). Army deploying 'Individual Gunshot Detector.' *Army News Service.* Retrieved from https://www.army.mil/article/53292/army_deploying_individual_gunshot_detector

[17] Eadens, S. (2018, January 22). CPD attributes gun violence reduction to new tech. *The Columbia Chronicle*. Retrieved from http://www.columbiachronicle.com/metro/article_9dc1965c-fd80-11e7-99fc-030a05b2d755.html; ShotSpotter. (2018, September 5). *Chicago signs $23 million multi-year agreement to ShotSpotter to extend gunshot detection coverage into next decade*. [Press Release]. Retrieved from https://www.shotspotter.com/press-releases/chicago-signs-23-million-multi-year-agreement-with-shotspotter-to-extend-gunshot-detection-coverage-into-next-decade/

[18] Office of United States Senator Dick Durbin. (2017, October 18). *Durbin calls out AG Sessions for attempting to eliminate vital federal funds from Chicago's gun violence prevention efforts.* [Press Release]. Retrieved from: https://www.durbin.senate.gov/newsroom/press-releases/durbin-calls-out-ag-sessions-for-attempting-to-eliminate-vital-federal-funds-from-chicagos-gun-violence-prevention-efforts

[19] Kokley, J. (2018, October 6). Less gunfire detected in Rockford despite new ShotSpotter technology. *Rockford Register Star*. Retrieved from https://www.rrstar.com/news/20181006/less-gunfire-detected-in-rockford-despite-new-shotspotter-technology

[20] Associated Press (2015, March 1). Peoria police expand use of gunshot detection technology. *Daily Herald*. Retrieved from https://www.dailyherald.com/article/20150301/news/303019939

[21] Associated Press (2015, March 1). Peoria police expand use of gunshot detection technology. *Daily Herald*. Retrieved from https://www.dailyherald.com/article/20150301/news/303019939

[22] GovTech.com. (2007, August 17). Village of Bellwood integrates ShotSpotter to enhance public safety. *Digital Communities News Report*. Retrieved from http://www.govtech.com/dc/articles/Village-of-Bellwood-Integrates-ShotSpotter-to.html

[23] BusinessWire.com. (2008, January 9). Public safety celebrates recent lives saved thanks to proactive police use of ShotSpotter gunshot location system as mission essential tool. *Business Wire*. Retrieved from https://www.businesswire.com/news/home/20080109005247/en/Public-Safety-Celebrates-Lives-Saved-Proactive-Police

[24] Koeske, Z. (2018, April 3). ShotSpotter, a gunshot detection system, goes live in Calumet City. *The Chicago Tribune*. Retrieved from http://www.chicagotribune.com/suburbs/daily-southtown/news/ct-sta-calumet-city-shotspotter-st-0404-20180403-story.html

[25] Mazerolle, L. G. (1998). *Using gunshot detection technology in high-crime areas*. Research in Progress Preview. Washington, D.C.: US Department of Justice, Office of Justice Programs, National Institute of Justice.

[26] Mazerolle, L. G. (1998). *Using gunshot detection technology in high-crime areas*. Research in Progress Preview. Washington, D.C.: US Department of Justice, Office of Justice Programs, National Institute of Justice.

[27] Watkins, C., Green Mazerolle, L., Rogan, D., & Frank, J. (2002). Technological approaches to controlling random gunfire: Results of a gunshot detection system field test. *Policing: An International Journal of Police Strategies & Management*, *25*(2), 345-370.
[28] Petho, A., Fallis, D. S., & Keating, D. (2013, November 2). ShotSpotter detection system documents 39,000 shooting incidents in the District. *Washington Post*. Retrieved from https://www.washingtonpost.com/investigations/shotspotter-detection-system-documents-39000-shooting-incidents-in-the-district/2013/11/02/055f8e9c-2ab1-11e3-8ade-a1f23cda135e_story.html?utm_term=.d4bfeb7815d3
[29] Mazerolle, L. G. (1998). *Using gunshot detection technology in high-crime areas*. Research in Progress Preview. Washington, D.C.: US Department of Justice, Office of Justice Programs, National Institute of Justice.
[30] Petho, A., Fallis, D. S., & Keating, D. (2013, November 2). ShotSpotter detection system documents 39,000 shooting incidents in the District. *Washington Post*. Retrieved from https://www.washingtonpost.com/investigations/shotspotter-detection-system-documents-39000-shooting-incidents-in-the-district/2013/11/02/055f8e9c-2ab1-11e3-8ade-a1f23cda135e_story.html?utm_term=.d4bfeb7815d3
[31] Drange, M. (2016, November 17). We're spending millions on this high-tech system designed to reduce gun violence. Is it making a difference? *Forbes*. Retrieved from https://www.forbes.com/sites/mattdrange/2016/11/17/shotspotter-struggles-to-prove-impact-as-silicon-valley-answer-to-gun-violence/#56fc0af831cbDrange, M. (Reporter). (2016, April 23). *Is ShotSpotter worth the expense?*. [Audio Podcast]. Retrieved from https://soundcloud.com/thisisreveal/216-reveal-b-block-web-master
[32] Ryan, J. (2016, June 22). Can this new technology reduce shootings in Louisville? *89.3 WFPL: Politics.* Retrieved from http://wfpl.org/shot-tracker-might-not-reduce-shootings-louisville/
[33] Mazerolle, L. G. (1998). *Using gunshot detection technology in high-crime areas*. Research in Progress Preview. Washington, D.C.: US Department of Justice, Office of Justice Programs, National Institute of Justice.
[34] SST. (2015, July 7). Customer Success Training Bulletin. Retrieved from https://www.forbes.com/sites/mattdrange/2016/11/17/shotspotter-struggles-to-prove-impact-as-silicon-valley-answer-to-gun-violence/#56fc0af831cb
[35] Petho, A., Fallis, D. S., & Keating, D. (2013, November 2). ShotSpotter detection system documents 39,000 shooting incidents in the District. *Washington Post*. Retrieved from https://www.washingtonpost.com/investigations/shotspotter-detection-system-documents-39000-shooting-incidents-in-the-district/2013/11/02/055f8e9c-2ab1-11e3-8ade-a1f23cda135e_story.html?utm_term=.d4bfeb7815d3
[36] Brennan, W. (2017). Bulletproofing America: Could technology help prevent mass shootings? *The Atlantic*. Retrieved from https://www.theatlantic.com/magazine/archive/2017/01/bulletproofing/508754/
[37] Associated Press. (2018, June 22). Gunshot detection technology coming to Wisconsin schools. *Education Week*. Retrieved from https://www.edweek.org/ew/articles/2018/06/22/gunshot-detection-technology-coming-to-wisconsin_ap.html
[38] Drange, M. (Reporter). (2016, April 23). *Is ShotSpotter worth the expense?*. [Audio Podcast]. Retrieved from https://soundcloud.com/thisisreveal/216-reveal-b-block-web-master
[39] Stanley, J. (2015, May 5). ShotSpotter CEO answers questions on gunshot detectors in cities. *American Civil Liberties Union*. Retrieved from https://www.aclu.org/blog/privacy-technology/surveillance-technologies/shotspotter-ceo-answers-questions-gunshot?redirect=blog/free-future/shotspotter-ceo-answers-questions-gunshot-detectors-cities
[40] Drange, M. (2016, November 17). We're spending millions on this high-tech system designed to reduce gun violence. Is it making a difference? *Forbes*. Retrieved from https://www.forbes.com/sites/mattdrange/2016/11/17/shotspotter-struggles-to-prove-impact-as-silicon-valley-answer-to-gun-violence/#56fc0af831cb; Drange, M. (Reporter). (2016, April 23). *Is ShotSpotter worth the expense?*. [Audio Podcast]. Retrieved from https://soundcloud.com/thisisreveal/216-reveal-b-

block-web-master; Kokley, J. (2018, October 6). Less gunfire detected in Rockford despite new ShotSpotter technology. *Rockford Register Star*. Retrieved from https://www.rrstar.com/news/20181006/less-gunfire-detected-in-rockford-despite-new-shotspotter-technology

[41] ShotSpotter. (2019, July 24). *ShotSpotter announces innovative trauma collaboration to study impact of gunshot detection on patient outcomes*. [Press release]. Retrieved from https://www.shotspotter.com/press-releases/shotspotter-announces-innovative-trauma-collaboration-to-study-impact-of-gunshot-detection-on-patient-outcomes/

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