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The Value of Less-Lethal Weapons

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ABSTRACT

Less-Lethal Weapons, including electric Tasers, velocity-reduction bullet-capture projectiles, rubber bullets, beanbag rounds, and other less-lethal projectiles used in police departments, federal and local law enforcement agencies, and military policing operations, as well as for private use, are topics of significant debate in recent years. These weapons can reduce collateral damage, reputational risk, and legal exposure while preventing wrongful and unnecessary deaths caused by conventional bullet wounds. Yet, opponents have highlighted concerns regarding the safety and effectiveness of these weapons, as well as their potential to cause injury or even death. While the primary duty of law enforcement officials is to preserve order and execute the law while protecting individual rights, they ultimately achieve these goals by exercising their coercive authority. Society expects police officers to rely on their professional training and judgment when using physical force to defend citizens and themselves or to apprehend criminal suspects. Because police officers must occasionally participate in physical acts of coercion, it is unavoidable that some of these interactions may result in bodily injuries to individuals, including the officers themselves. These injuries have real costs, such as medical treatment, lost wages, municipal liability, court claims and settlements, riots, and legal or even criminal exposure, as well as less-tangible collateral costs, such as the erosion of police legitimacy and public trust, which are more difficult to quantify but arguably more influential in shaping long-term public perceptions than personal injuries alone. Less lethal technology eliminates some of the concerns raised by lethal weaponry. This study reviews the advantages and disadvantages of these less-lethal weapon technologies versus traditional firearms for use by the police force, federal agencies, and military police while also performing advanced analytics to model the valuation and return on investment for a law enforcement organization implementing such technologies.

KEYWORDS

Less-lethal weapons; return on investment; safety assessment; weapon efficacy

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1. Introduction

In recent years, the use of fatal force by law enforcement organizations has been a divisive issue, with numerous examples of police brutality and excessive use of force garnering public attention. As a result of these instances, interest in Less-Lethal Weapons (LLWs) as a complement to existing conventional firearms has increased. LLWs are designed to incapacitate a criminal or suspect without causing death or significant injury whenever possible.

On the one hand, the Thurgood Marshall Institute identified 167 publicly announced settlements between law enforcement organizations and gunshot victims and their families, totaling $2.24 billion in compensation over the last decade (National Police Funding Database, 2023). In addition, the Institute's National Police Funding Database contains detailed settlements by individuals and settlements linked to internal police department misbehavior. Between 2005 and 2020, 42 nonfederal police officers were convicted of various shooting incidents (e.g., 5 for murder, 2 for reckless homicide, 3 for negligent homicide, 11 for manslaughter, 5 for voluntary manslaughter, 6 for involuntary manslaughter, 8 for misconduct, and 2 for aggravated assault and reckless discharge of a firearm).

When incidents occur, news of such police shootings saturates the airwaves and the Internet. An article in *Scientific American* strikes home, stating that:

On Tuesday, August 6, 2019, police shot and killed a schoolteacher outside his home in Shaler Township, Pennsylvania. He had reportedly pointed a gun at the officers. In Grants Pass, Oregon, that same day, a 39-year-old man was shot and killed after an altercation with police in the state police office. And in Henderson, Nevada, that evening, an officer shot and injured a 15-year-old suspected of robbing a convenience store. The boy reportedly had an object in his hand that the police later confirmed was not a deadly weapon. In the United States, police officers fatally shoot about three people per day on average, a number that's close to the yearly totals for other wealthy nations. A pair of high-profile killings of unarmed black men by the police pushed this reality into the headlines in the summer of 2014. Waves of public protests broke out after the fatal shooting of Michael Brown in Ferguson, Missouri, and the death by the chokehold of Eric Garner in New York City. (Peeples, 2019)

On the other hand, police officers and armed federal field agents have a critical responsibility to keep the community safe, arresting dangerous criminals while keeping themselves safe at the same time. The latest statistics released by the Federal Bureau of Investigation (FBI; 2021) show a staggering and stark reminder of how dangerous law enforcement work is:

- 59 police officers were killed in the line of duty from January 2021 to September 2021.
  This includes two special agents from the FBI's Miami Field Office.
- 60,105 officers were assaulted in 2020; 18,568 (30.9%) of them sustained injuries.
- 44,421 officers were assaulted with personal weapons (e.g., hands, fists, or feet); 25.8% of these officers were injured.
- 2,744 officers were assaulted with firearms; 6.1% of these officers were injured.
- 1,180 officers were assaulted with knives or other cutting instruments; 9.7% of these officers were injured.
- The remaining 11,760 officers were assaulted with other types of dangerous weapons; 16.8% of these officers were injured.

Although there is no guarantee that the deployment of LLWs will prevent death or serious injury or help reduce criminal liability while protecting the police officer, such weapons decrease the odds of these risks occurring. It is considered that neither the officer nor the federal agency will be held accountable for civil or criminal action if it can be demonstrated that the officer behaved within the limits of his or her official duties and that the execution of said duties is within standard operating procedures. Through adequate training and the use of less-lethal technology, the amount of money paid out to victims and their families due to the reckless actions of police officers in lethal force situations will be greatly decreased.

LLWs include a variety of nonlethal munitions meant to incapacitate a target without causing death or significant injury. They include rubber bullets, beanbag rounds, and other less-lethal sorts of projectiles. Tasers, in contrast, are electroshock weapons that use electrical current to momentarily paralyze a suspect by disrupting muscular function. Both technologies have been widely adopted by law enforcement agencies across the globe, but their application has also been the topic of significant dispute.

The use of force by law enforcement officials has been a subject of public concern and debate, particularly in instances where lethal force has been employed. In recent years, the employment of LLWs, such as shock weapons, pepper spray, and rubber bullets, has gained favor as an alternative to traditional lethal weaponry. Yet, the efficacy and effects of LLWs in minimizing fatalities and injuries in law enforcement interactions have not been well explored. This study's objective is to investigate the value of LLWs in law enforcement by analyzing their effectiveness in minimizing fatalities and injuries during law enforcement interactions and their value-add. It focuses on analyzing the possible advantages and disadvantages of employing less deadly weapons in law enforcement, including their impact on public perception and trust in law enforcement. The findings of this research will provide crucial insights into the use of less-lethal weapons in law enforcement and the return on investment of these technologies in order to influence policy and practice recommendations for law enforcement agencies to effectively and safely incorporate LLWs into their use-of-force continuum.

This study presents a thorough review of the advantages and disadvantages of alternative ballistics technologies, in particular, the LLWs for use by police and military police. It will evaluate the decrease of collateral damage, reputational risk, pointless fatalities from fatal bullet wounds that can be avoided with LLWs, wrongful death claims, and legal criminal exposure for the police officer or federal agent. However, due to the limitations and scope of this study, it will not review the development, engineering, or physics of these LLWs. For instance, for the purposes of this study, we assume that the LLW has been thoroughly tested and vetted by qualified law enforcement officials and that it works as advertised. Any discussion on its efficacy, ease of use, robustness, reliability, and other associated properties will be based on the literature survey of prior research.

Section II continues with an academic literature review of the extant and state-of-the-art research to date. Section III delves into the details and characteristics of LLWs as well as the pros and cons of LLWs versus conventional weapons. Section IV provides examples of when LLWs might be advantageous over conventional weapons and focuses on Alternative Ballistics' new product, "The Alternative." Section V looks at the quantitative analytics applied to the study and simulates the potential return on investment and value-add, justifying the implementation of LLWs. Some key conclusions to the study are provided in Section VI.

2. Literature Review

LLWs are weapons intended to incapacitate or subdue a target without causing death. In various situations, including riots, crowd control, and individual arrests, law enforcement, the military, and private security agencies employ them. The value of LLWs lies in their ability to reduce the risk of death and injury to both the target and the user while still allowing for effective control. This literature review investigates the existing research on the value of LLWs, including their efficacy, safety, and limitations.

Economically, truly nonlethal devices would significantly alter the emphasis of economies and reallocate funds to solve many of the world's most pressing needs. For example, the United States could save billions of dollars in lawsuits, medical expenditures, and pension benefits related to police service alone (Bostic, 1994).

The ability of police officers to use both lethal and nonlethal force is a distinguishing characteristic of the police profession (Bittner, 1970). This aspect of police work contributes to officers' exposure to high levels of risk, which may result in litigation, liability claims, or citizen complaints (Archbold, 2005). According to reports, improper use of lethal and nonlethal force by police officers during an arrest and improper service of due process are two

instances in which damages are likely to be sought and settlements paid to citizens (Blalock, 1974; del Carmen, 1991; Newell et al., 1993).

The ultimate form of protection for police officers is nonlethal weapons, as the use of lethal weapons consistently generates doubt and anxiety before use. By definition, nonlethal technology removes the concerns raised by lethal weaponry. Importantly, law enforcement could finally eliminate the enormous chasm that physical force has created between police and the communities they serve (Bostic, 1994).

2.1. Current Policies

The current public policy mandates that officers on the street use the least amount of force necessary to make an arrest or suppress a disturbance. Even when uses of force are deemed justifiable, they are nevertheless susceptible to lawsuits, especially in our litigious society. A recurring element in the existing literature on litigation against the police force is that citizens are filing such claims at an unprecedented rate. Since 1961, litigations against the police have continued to increase due to several court rulings, the litigious nature of modern society, and a trend toward holding public authorities more accountable for their acts (Hougland, Mesloh, and Henych, 2005).

When police in a democracy use force and cause injuries, concerns about police abuse develop, lawsuits frequently follow, and the police's reputation is put at risk. Injuries also incur medical bills for destitute suspects, workers' compensation claims for injured officers, and damages paid in settlements or court judgments (Bulman, 2011).

The primary duty of the police is to preserve order and execute the law while protecting individual rights. Yet, they ultimately achieve these goals by exercising their coercive authority. We expect police officers to rely on their training and good judgment when using physical force to defend citizens and themselves or to capture criminal suspects. Because police officers must occasionally participate in physical acts of coercion, which may involve deadly weapons, it is unavoidable that some of these interactions may result in bodily injuries to individuals and the officers themselves. These injuries have real costs (such as medical treatment, lost wages, and municipal liability) as well as less-tangible collateral costs, such as the erosion of police legitimacy and public trust, which are more difficult to quantify but arguably more influential in shaping long-term public perceptions than personal injuries alone (Hickman et al., 2021).

The use of LLWs is a good strategy for minimizing civilian and officer harm. There is a need for greater quality evaluations of police use of LLWs to inform policy and practice for reducing harm during violent police-citizen interactions. Police departments contemplating adopting, continuing, or expanding the use of these weapons should proceed cautiously, considering the best available scientific evidence and the necessity to maintain rigorous academy and in-service training (Sheppard and Welsh, 2022).

The U.S. military has spent the last two decades conducting counterinsurgency (COIN) operations, primarily in the Middle East. During this time, many instances of unnecessary lethal force often resulted in the death of civilian noncombatants. These deaths eroded the trust of the civilian population and ultimately undermined the mission of winning the hearts and minds of the local populace. As the Navy and Marine Corps shift their focus to the Pacific Theater, the U.S. government may need to engage in COIN operations, stability operations, training host nations in policing operations, policing its internal forces, embassy defense, key leader engagements (KLE), and noncombatant evacuation operations (NEO), all of which may require a level of physical force to ensure the safety of the personnel involved or to ensure the effectiveness of the operation. The misapplication of the required force could become a strategic blunder. With the aim of minimizing such missteps, in 2020, the U.S. Department of Defense (DoD) executive agent for the nonlethal weapons program, Commandant of the Marine Corps General David Berger, in a planning guidance, laid the DoD's pathway for further research and development of LLWs.

2.2. Police Violence and Continuum of Force

The literature surrounding police use of force does not have a common definition for the term "police violence" (Stinson, 2020). However, research has found that most police agencies use a linear continuum to measure the level of force (Terrill and Paoline, 2013). Similarly, the United States Marine Corps (USMC) uses a linear continuum model as well, called the Continuum of Force model (Figure 1). Using this model, contact controls, compliance techniques, defensive tactics, and deadly force will be considered violence. Throughout this article, this continuum will be used when discussing violence, whether from domestic law enforcement personnel or from uniformed service members acting in a police role. Importantly, violence is not interchangeable with brutality. Violence is the lawful application of force, and brutality is the unlawful application of force. This distinction becomes important when navigating the social influence of applying force.

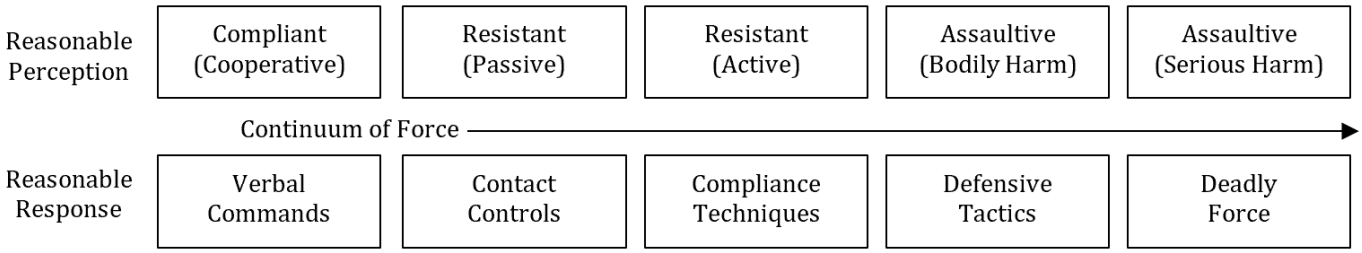

Figure 1. Continuum of Force Model.

2.3. LLW Classifications

Grocholski et al. (2022) provided the following list of currently used LLW classifications for distinguishing the applicability of an asset. Notably, each specific LLW in each classification may achieve its intended goal in a vastly different way.

- Acoustic systems. The acoustic hailing device (AHD) can be used to communicate orally at long distances—e.g., to tell someone to back away. The experimental concept of Laser-Induced Plasma Effects may use lasers to create a distant ball of plasma that can create sounds, including human speech, to persuade people to alter their movements or behavior.
- Laser dazzlers. These include the currently fielded Ocular Interrupter (OI) and developmental Long-Range Ocular Interrupter (LROI), both of which create intense glare that prevents people from being able to see their environment well but without any permanent effects (in keeping with the Protocol on Blinding Laser Weapons). They can also be used to gain someone's attention (hail) at long ranges.
- Integrated-effects systems. The still-in-development Escalation of Force (EoF) Common Remotely Operated Weapons Station (CROWS) includes acoustic, light, and laser dazzling capabilities.
- Flash-bang grenades. These create a burst of intense light and sound to distract and temporarily incapacitate individuals.
- Blunt impact munitions. These include rubber bullets, beanbag rounds, grenades that disperse rubber pellets, and other systems intended to strike individuals to temporarily incapacitate them while limiting the scope of permanent injuries.
- Electro-muscular incapacitation systems. These short-range devices use an electrical current to induce incapacitating muscle contractions. Tasers allow a modest degree of standoff distance.
- Riot control agents. These are non-lethal chemical irritants, such as pepper spray and tear gas, which are typically reserved for law enforcement and crowd-control situations. The Chemical Weapons Convention

precludes their use in warfare; however, U.S. interpretation and ratification of the Chemical Weapons Convention allows for very limited use as delineated in Presidential Executive Order 11850. Pepper spray can be used at short ranges, while pepper balls can be used to disperse effects over wider areas.

- Millimeter-wave systems. The Active Denial System (ADS) emits a focused beam of millimeter-wave energy to safely and rapidly cause a temporary, immediately reversible heating sensation to deny personnel access to an area or encourage them to move. A developmental version, ADS Solid State, will reduce system weight and power requirements to improve mobility.
- Microwave systems. JIFCO is also completing prototype development and assessment for systems that temporarily interfere with vehicle electronics using high-power microwaves, including short- and long-range Radio Frequency Vehicle Stoppers (RFVSs) for stopping land-based vehicles and the Vessel Incapacitating Power Effect Radiation (VIPER) system for maritime use. Similar systems are envisioned to counter unmanned aerial vehicles (UAVs).
- Mechanical vehicle/vessel-stopping technologies. The Single Net Solution–Remote Deployment Device (SNS-RDD) consists of a spiked net deployed to stop land-based vehicles, and the Pre-Emplaced Vehicle Stopper (PEVS) injects electricity into a vehicle to damage its electronics. The Maritime Vessel Stopping Occlusion Technologies (MVSOT) include drogue lines (which tangle the propellers) and occlusion technologies (which coat propellers to reduce efficiency and effectiveness) (Grocholski et al., 2022).

Grocholski et al. (2022) emphasized that some cyber and electronic warfare capabilities may fall into a specific category; however, those capabilities do not fall under the authority of DoD Directive 3000.03E. Therefore, cyber and electronic warfare capabilities will not be included in the research.

2.4. Effectiveness, Safety, and Limitations

Many studies have assessed the efficacy of LLWs in a variety of contexts. According to a study undertaken by the National Institute of Justice (NIJ), conducted-energy devices (CEDs) such as Tasers lower the risk of injury to arresting officers and suspects (Kaminski et al., 2009). Similarly, a meta-analysis of various investigations revealed that CEDs are useful for subduing suspects without causing serious harm (Strote et al., 2011). Moreover, research done by the Police Executive Research Forum (PERF) discovered that the use of pepper spray in police encounters led to a reduction in injuries to both officers and suspects (Riehl, Peltzer, and Edwards, 2014).

When analyzing LLWs, safety is of utmost importance. Although these weapons are designed to decrease the chance of lethal harm, they are nonetheless capable of causing bodily harm or death in some circumstances. According to research conducted by the NIJ, CEDs have a low risk of significant injury or death (Kaminski et al., 2009). However, another study indicated that using CEDs was associated with a higher risk of damage than alternative options for using force (Strote et al., 2011). Similarly, a Canadian Broadcasting Corporation (CBC) study indicated that using pepper spray resulted in several cases of severe damage or death (CBC, 2018).

Even though LLWs can be successful in certain circumstances, their limits should be considered. The possibility of misuse or abuse by users is a limitation. According to a report by Amnesty International, the misuse of Tasers by law enforcement officers has resulted in some deaths (Amnesty International, 2014). Another drawback is the probable ineffectiveness of LLWs against specific targets. Due to their stature, clothing, or medical issues, certain persons may be more or less resistant to the effects of pepper spray or CEDs than others (Riehl et al., 2014).

3. Pros and Cons of Less-Lethal Weapons

In police law enforcement and military policing operations, less-lethal alternative technology has various benefits over traditional weaponry. For example, the ability of less-lethal ammunition to incapacitate a target

without causing major harm or death is one of its primary advantages. This is especially beneficial in cases where the use of fatal force is not warranted or when police officers must restrain a subject without causing harm. In addition, the use of such technology decreases the risk of collateral damage and reputational harm, as well as the number of unnecessary deaths and lawsuits connected to wrongful death, thereby reducing police officers' or federal agents' criminal exposure.

The number of deaths and injuries related to gun violence is staggering in this country, and whatever actions can be taken, however small, to reduce these numbers should at least be under consideration. Figure 2 shows the latest 7-year review of gun-related deaths and injuries in the United States, which includes both law enforcement actions and civilian statistics.

Table 1. Gun Violence in the Last 7 Years (Adapted from the Gun Violence Archive, 2023.).

Gun Violence	2016	2017	2018	2019	2020	2021	2022
Deaths (Willful, Malicious, Accidental)	15,139	15,742	14,943	15,509	19,558	21,009	20,200
Suicides by Gun	22,938	23,854	24,432	23,941	24,292	26,328	pending
Injuries (Willful, Malicious, Accidental)	30,586	31,358	28,285	30,199	39,542	40,603	38,550
Children (Aged 0–11) Killed or Injured	665	734	665	696	1,001	1,065	995
Teens (Aged 12–17) Killed or Injured	3,154	3,296	2,883	3,129	4,159	4,645	5,157
Mass Shooting	383	348	336	417	610	690	647
Murder-Suicide	549	608	623	632	570	594	670
Defensive Use	1,993	2,118	1,889	1,619	1,513	1,295	1,178
Unintentional Shooting	2,235	2,065	1,696	1,912	2,336	2,027	1,626

3.1. Reduction in Collateral Damage and Increasing Trust

Conventional weapons are designed to kill or injure a target. Employment of LLWs can reduce collateral damage, the unintentional injury inflicted on individuals, bystanders, and property during law-enforcement operations. The use of tear gas, pepper spray, shock guns, or velocity-reduction alternative ballistics technology, for instance, can incapacitate a criminal without causing fatal physical harm or environmental damage. Less-lethal ammunition, in particular, is meant to limit the potential of collateral damage by employing bullets less likely to penetrate walls or other objects while still being able to subdue a suspect or criminal. In contrast, the use of lethal weapons can result in fatal injuries that could have been avoided if less-lethal alternatives were available. Figure 3 shows that there were 10,743 police-related shooting deaths in the United States between 2013 and 2022, segregated by age groups (Mapping Police Violence, 2023). What is most heartbreaking in this chart are the hundreds of children and teens killed or injured each year by gun violence.

Jackson (2015) further explains the importance of establishing trust between a police force and the public being policed. However, building this trust is increasingly difficult. Specifically, Jackson points out that police have come under increased scrutiny due to the prevalence of videos and social media. While video, both by bystanders and by body-worn cameras, increases transparency, which can increase trust, it also hinders the ability of departments to control what is released to the public. According to Jackson, this is specifically troublesome when investigations are ongoing and police departments cannot provide clear answers to why specific actions were taken. Such circumstances create rumors that spread rapidly and are often untrue. The conclusion can be drawn that employing the appropriate amount of force at the appropriate time will help build the public's trust. LLW bridges a gap in the force continuum that allows a policing force to use the appropriate amount of force at the appropriate time.

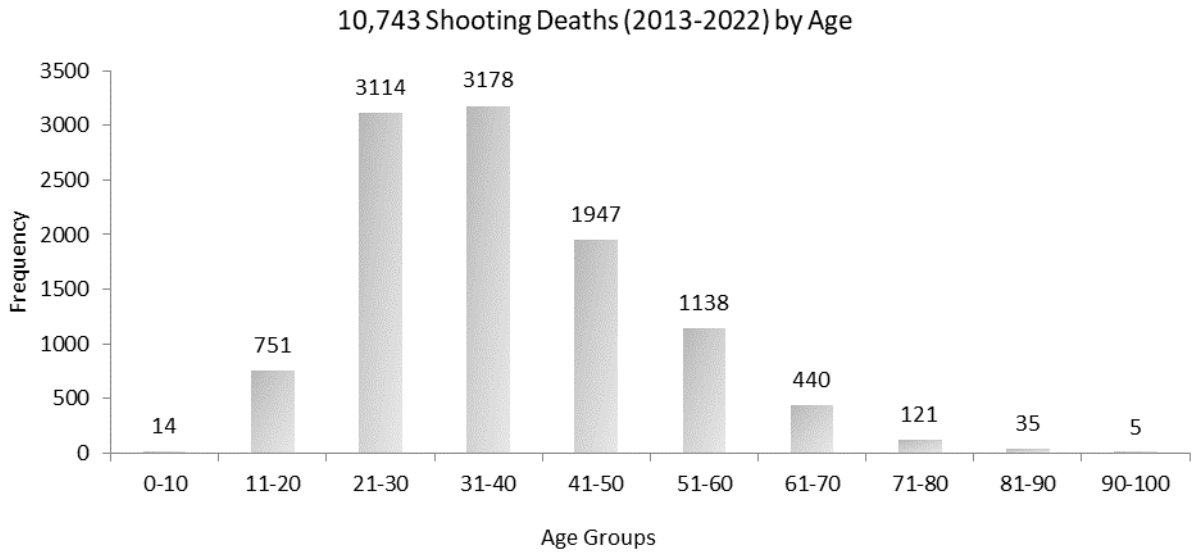

Figure 2. Police-related Shooting Deaths in the United States Between 2013 and 2022.

3.2. Reduction in Reputational Risk for Law Enforcement Agencies

In addition to limiting collateral damage, alternative, less-lethal technologies can lessen law enforcement organizations' reputational risk. Incidents of police brutality or excessive use of force can harm a law enforcement agency's reputation and weaken public confidence. Law enforcement officers can reduce the danger of causing hurt or death by using LLWs and help foster community trust. The excessive use of fatal force can harm the public's view of law enforcement and lead to unfavorable media coverage, demonstrations, and even protests and riots. In addition, using LLWs may be regarded as a more humanitarian and less confrontational approach to police enforcement, which can further build community trust and support.

3.3. Reduction in Cases of Wrongful Death

The use of fatal force by law enforcement officials has been questioned, especially in circumstances when the subject killed was unarmed or posed no immediate threat to the officer or others. The wrongful use of firearms and stun guns has become a big concern. The use of Tasers, which has been related to a number of deaths, is another concern. Despite the fact that Tasers are intended to be a nonlethal alternative to weapons, they can nevertheless inflict serious harm or death, especially in those with pre-existing medical issues. As a result, there has been controversy regarding the police use of Tasers and whether they should be viewed as a safe alternative to weapons.

As a result of these problems, the number of wrongful death claims filed against police departments and individual officers has increased. These lawsuits are filed by the families of victims slain by police in an effort to receive recompense for their loss and justice for the family and to prevent future incidents. In these circumstances, evaluating whether the use of lethal force was justifiable is one of the central issues. In specific circumstances, police officers are permitted to use deadly force, such as when they or others are in imminent danger. The use of lethal force may be deemed unjustified if, however, the officer used excessive force or did not adhere to the necessary protocols. Often, wrongful death claims involve parties, such as the police agency, the officer involved, and the city or county where the incident occurred. To prevail in a wrongful death lawsuit, the plaintiff must demonstrate that the death was caused by the defendant's negligence or willful actions. Figure 4 shows the number of police shooting deaths in the last decade based on threat levels and weapons status.

Table 2. Police-related Shooting Deaths by Category in the United States Between 2013 and 2022.

Weapons Status		
Allegedly Armed	8,022	71.7%
Unarmed/Did Not Have Actual Weapon	1,521	13.6%
Unclear	986	8.8%
Vehicle	667	6.0%
Total Cases	11,196	
Threat Level		
Attack	5,101	45.6%
Undetermined	2,881	25.7%
Other	2,256	20.2%
Brandished Weapon	363	3.2%
Unclear	163	1.5%
Sudden Threatening Movement	160	1.4%
Used Weapon	144	1.3%
None (No Weapon)	128	1.1%
Total Cases	11,196	

3.4. Reduction in Legal Liability and Criminal Exposure of Officers

When officers use excessive force, they may face criminal or civil penalties for breaching the suspect's civil rights. Claims filed against law enforcement agencies and federal agents for wrongful killing can be expensive and damaging to the reputation of law enforcement agencies, as well as corrosive to public confidence. By providing a less aggressive means of apprehending suspects, the use of LLWs can reduce the likelihood of such lawsuits and avoid their negative consequences. Although rare, Figure 5 shows the number of police officers convicted of serious criminal offenses related to their firearm discharge.

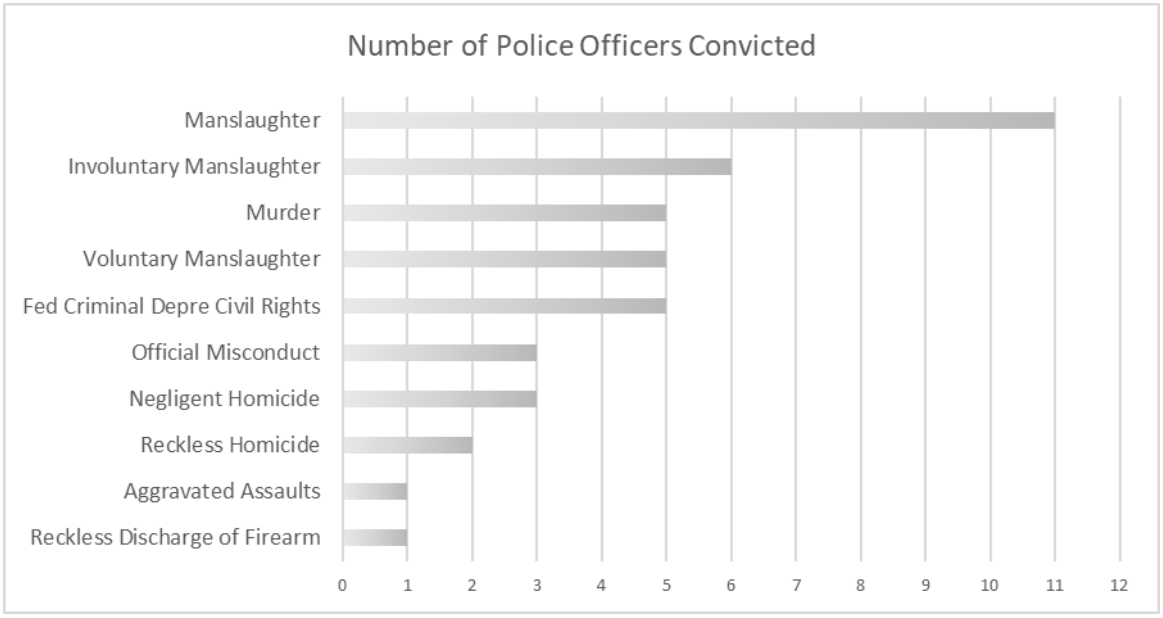

Figure 3. Number of Police Officers Convicted Between 2005 and 2020 (Adapted from Statista, 2020).

3.5. Disadvantages

Deploying alternative weapons technologies in police and military police operations does have some drawbacks. Less-lethal ammunition can still cause serious harm, including lasting injury, impairment, or death if handled improperly. Rubber bullets and beanbag rounds, for instance, can cause severe injuries if shot at close range or if they strike a vulnerable body region such as the head or neck. In addition, they may not be as effective as conventional firearms in stopping an individual, and their employment may not be appropriate in all circumstances.

4. Case Study: Alternative Ballistics

While much has been written about conducted energy devices, such as Tasers and other LLWs, there is a new technology that has not yet been recognized on a widespread basis. Alternative Ballistics Corporation, located in Las Vegas, Nevada, and San Diego, California, has a new product aptly named "The Alternative," which represents the "newest less-lethal impact munition available to the law enforcement community, which protects officers and saves lives in ways that were, until now, not possible with existing options" (Alternative Ballistics, 2023). This section provides a case study of this new technology and its potential use cases. This case study is not an endorsement of this product or its company's services, and its results do not constitute an implied or expressed recommendation or endorsement. This company's product was selected in this case study because limited research has been performed on this product, while there is ample data available to perform the required analysis.

Unlike a Taser, The Alternative is a patented lightweight and affordable optional docking that mounts on top of a gun (Figure 5). The unit is made of a proprietary alloy that allows a fired bullet to embed itself inside the projectile as it is propelled forward to the target. Once The Alternative is attached, the officer's existing service weapon is quickly converted into an LLW. The bullet's velocity is slowed down to 1/5 of its original speed. It hence reduces the kinetic energy significantly, while the larger surface area of The Alternative's alloy projectile ball disperses the contact force, also contributing to making the bullet less lethal. The Alternative essentially acts as an airbag for the bullet while maintaining its blunt impact force to subdue a suspect and is accurate up to 35 feet with a circular error probable (CEP) inside of a 6-inch diameter (Alternative Ballistics, 2023). The device works with commonly used law enforcement firearms (Glocks 17, 19, 45, Glocks 22 and 23 [pre-Gen5 series], Smith & Weston M&P, CZ-P10, Sig Sauers P-229 and P-320) and is compatible with 9mm- and .40-caliber ammunition. This is a single-shot LLW placed on top of a conventional lethal weapon. Without changing equipment, the officer can fire lethal subsequent shots if needed, using the same weapon, saving time in urgent and critical situations.

Some basic technical specifications available on the company's website and marketing collateral based on the manufacturer's tests (The Alternative – Technical Specs Sheet, accessed 2023) indicate that using a Speer Gold Dot 180 Grain 40 S&W GDHP ammunition, the muzzle speed without The Alternative is 1,025 fps (feet per second) with 420 ft/lbs muzzle energy (Ammunition Depot, 2023) compared to 237 fps and 95.7 ft/lbs at 21 feet when fired with The Alternative. When fired using the Speer Gold Dot 9mm +P/GDHP 124 Grain ammunition, the ammunition of choice for law enforcement worldwide, the muzzle velocity is 1,220 fps with 410 ft/lbs versus firing with The Alternative attached whereby the muzzle velocity reduces to 220 fps with 77.5 ft/lbs at 21 feet. These test results indicate a reduction between 75% and 85% in velocity and impact force, depending on the ammunition used and the impact distance measured. With the smaller 9mm caliber, the manufacturer's tests found that there is a 0.0% probability of cardiac arrest and 1.16% probability of severe lung injury when the suspect is wearing a t-shirt (this reduces to 0.98% if the suspect is wearing a jacket). The probability of "mostly moderate" injury based on the Abbreviated Injury Scale (AIS, which ranges from 1 for a minor injury to 6 for fatality) with a sternum fracture or fracture of two ribs is 22.90% (suspect wearing a medium-thickness jacket) and 35.73% (suspect wearing a t-shirt). The corresponding AIS score is 2+, which carries only up to a 2% probability of death. While all less-lethal munition impacts carry an inherent probability of death, even the use of Tasers and pepper spray can result in death. The goal is to reduce the probability of fatalities.

In order to determine what some law enforcement officials think about this technology, we engaged in a discussion with retired Sheriff A. J. Louderback, a senior tactical advisor to the National Sheriffs' Association. From his point of view:

The credentialing of this product has been extensive, using independent companies such as National Technical Systems ("NTS") at their NIJ-accredited Chesapeake Ballistics Lab. In a rapidly changing world, less lethal products will be more in demand by Law Enforcement than ever before. It is my belief that Alternative Ballistics deserves a place in the less lethal world. Another tool for Law Enforcement belts that may save lives. The National Sheriffs' Association is encouraged to accept my recommendation for full use of this product for this nation's Sheriffs. In my role as Senior Tactical Advisor, I believe that this product will fill a unique role as a belt-mounted, less-lethal device that is quickly deployed with the ability to respond with lethal force if necessary.

In a comprehensive analytical study on the performance and probability of injury of The Alternative, based on testing conducted by both NTS and Wayne State University (2022), Rob Kinsler of Sydor Technologies concluded that:

The user should keep in mind that there are other risks that need to be considered when evaluating less-lethal options. If The Alternative was reconfigured so that the risk to a lightly clothed individual was not as injurious, then they run into the issue of it not being injurious enough to even garner the attention of someone who is heavily clothed. The goal in the development of The Alternative was to come up with a solution that straddled the delicate line between being too injurious and not injurious enough in all situations. As mentioned, the user needs to evaluate what are acceptable risks. What level of injury is acceptable for a less lethal solution compared to the option of a potentially lethal solution? This analysis was done for shots aimed at the frontal torso of individuals that could potentially cause a thoracic skeletal injury. It does not evaluate shots to the head or to frangible organs such as the liver or spleen. Impacts from The Alternative have a probability of fracturing one or more ribs. Medical attention will most likely be needed after an impact. (Sydor Technologies, 2022)

Figure 4. "The Alternative" (Source: www.alternativeballistics.com).

The following illustrates simple use cases where nonlethal weapons such as The Alternative might be appropriate, as opposed to using conventional lethal sidearms.

4.1. Use Case I: Domestic Violence

A 911 call was placed for potential domestic violence in a normally quiet suburban neighborhood. Emergency dispatch requested two patrol cars to investigate with code 273-D. When officers arrived on the scene, they saw a man brandishing a baseball bat and a young woman with bruises on her hand and some blood on the side of her dress. The woman had a red mark on her right cheek, her lips were trembling, and her face was wet with smeared makeup. The man looked intoxicated, with red eyes, rosy cheeks, and slurred speech. Although motor function was impaired, the man was belligerent and seemed to have lowered inhibitions. When the officers approached, the man

seemed to grow more agitated. The officers had their hands on their service weapons with holsters unlatched. The officers ordered the man to drop the baseball bat. The man refused, and the woman came rushing to his side, trying to intervene. Because the woman might end up in the line of fire, this may be an example where LLWs can and should be employed if necessary.

4.2. Use Case II: Mental Health and a Homeless Person

A homeless person usually sleeps in parks or alleys, on sidewalks, or in other public locations and can sometimes erect temporary shelters by using boxes or clothing material. Many cities and municipalities have attempted to outlaw such behavior and encourage the homeless to seek city-provided shelters. Officers were dispatched to a new construction area where there was a report from nearby residents that a homeless individual was roaming the neighborhood looking at front porches for delivered packages and was spending his nights on the porches of some model homes. The person of interest likely violated the city's ordinance on erecting obstructions in private spaces and possible misdemeanor petty theft. When officers approached to remove him from the premises and look through some unopened delivery boxes, the suspect pulled out a pen knife. The suspect probably suffers from chronic mental illness and is not completely aware of his actions. This is another example where police officers need to apprehend the suspect in order to keep the neighborhood safe while needing to be cautious and protect themselves. The nonlethal alternative might be appropriate in such a situation.

4.3. Use Case III: Navy and Marine Personnel on Liberty

Military police (MP) officers were on duty in the area. MPs are charged with enforcing military laws and regulations, responding to emergencies, conducting force protection and anti-terrorism, and performing investigations and security at bases and around the world. Sometimes, MPs patrol the local restaurants and bars where military personnel visit. On one occasion, a Navy ship is at a local port, and some of its sailors are on shore leave for the day. As is customary for the first day, the sailors are in uniform and easily identified. Several of the sailors were intoxicated and acting disorderly. A fight soon broke out. MPs responding to the scene decided to break up the fight and issue warnings to the sailors when a few of them became belligerent and challenged the officers to a fistfight with broken bottles. The nonlethal alternative might again be appropriate.

5. The Value of Less-Lethal Weapons: An Analytical Approach

The Thurgood Marshall Institute identified 167 publicly announced settlements that led to policy changes and over $2,246,987,900 in compensation for victims. Their NPF database contains detailed settlements by individuals and settlements linked to internal police department misbehavior (National Police Funding Database, 2023).

Although there is no assurance that the deployment of LLWs will always prevent death or serious injury, both occurrences are dramatically decreased with their use. It is considered that neither the officer nor the agency will be held accountable for civil or criminal action if it can be demonstrated that the officer behaved within the limits of his or her official duties and prescribed protocols. Through adequate training and the use of LLWs, the amount of money paid out to victims and their families due to the reckless actions of police officers in lethal force situations will be greatly decreased (Cox, 2005).

When one considers the numerous negative social consequences of police shootings in addition to the personal ones, such as race riots, widespread antipathy toward the police in minority communities, and substantial awards as a result of civil lawsuits, the price for ignoring the use of LLWs appears excessively high (Geis and Binder, 1990).

Recent examples involving the use of less deadly force, such as Tasers, chemical sprays, and projectiles, highlight both the prevalence of such force and the potential for its abuse. These cases also demonstrate the

substantial financial risk municipalities face when their police personnel employ excessive force and bring attention to the significance of developing an effective policy for the use of less-lethal force.

5.1. Return on Investment for "The Alternative"

To compute the quantitative return on investment or ROI (Π) on the value of acquiring, training, and implementing The Alternative, we make the following assumptions. The total monetary benefits from potential costs saved $f(\pi_i)$ comes from the probability distribution of the frequency Φ_p^f and severity Φ_l^x. There were 11,195 police-related shootings over the last 10 years, averaging 1,120 cases annually, with an average population of 360 million in the United States during that period. Further, we assume 0.311 cases per 100K population with an average lawsuit of $25 million (with a minimum of $5 million). We run a Monte Carlo stochastic simulation of 100,000 to 1,000,000 trials using a Poisson distribution ϕ_p for the frequency and lognormal ϕ_l as well as triangular distributions for the severity of an outcome if it does occur. That is, we have:

$$\Pi = \frac{f(\pi_i) - \sum \omega(\chi_1 + \chi_2 + \chi_3)}{\sum \omega(\chi_1 + \chi_2 + \chi_3)} \tag{1}$$

Where: $f(\pi_i) = \Phi_p^f \times \Phi_l^x$, $\phi_p(x) = \frac{e^{-\lambda}\lambda^x}{x!}$ for x and $\lambda > 0$, $\phi_l(x) = \frac{1}{x\sqrt{2\pi}\, ln(\sigma)} e^{\frac{-[ln(x)-ln(\mu)]^2}{2[ln(\sigma)]^2}}$ for $x > 0$; $\mu > 0$ and $\sigma > 0$.

The total cost is the sum of the individual costs χ_i for The Alternative, holster, and certification, multiplied by the number of units required per police officer, ω. The national average statistics show approximately 2 to 3.4 police officers per 1,000 population in the United States, where annually, an average of three units per officer would suffice. Supposing that The Alternative prorated cost averages $600 per officer (e.g., a box of 5 units may cost $200 plus $400 training and certification; these are only example averages used in the model while the actual cost may vary) ($\chi_1 + \chi_2 + \chi_3$), we estimate that based on our stochastic analysis, the ROI is between 980% and 1,629% with a 95% statistical confidence after performing Monte Carlo simulation (Figure 7).

In other words, for every $1 spent on acquiring, equipping, and training an officer to use The Alternative, the shadow return or value is between $10 and $17. That is, for a small city or suburb with a population of 10,000, the total expenses would be approximately $10,000 per year for the equipment and certification. For a slightly larger town with a 100,000 populace, the expected value impact is $7.7 million in legal exposure with a 3% probability of occurrence. Although the probability of any incident of this magnitude happening is remote, when it does occur, the impact is significant in the community.

The legal and financial exposures are equally significant. The $10,000 can be seen as an insurance policy against any collateral damage. A similar analogy would be that of home insurance against fire hazards. The typical home has between 0.03% and 0.05% probability of a fire with an average insurance cost of $1,000 to $1,500 depending on location, size, and year it was built, among other things. One hopes that the insurance is never claimed, but it is there in the event of a worst-case scenario. The same can be said about The Alternative. One hopes that unnecessary loss of life will not occur, but, at the very least, The Alternative less-lethal device can help mitigate the risks.

These computations are based only on quantitative measures and do not include qualitative benefits such as the reduction of reputation risk, decrease in risks of riots and civil unrest, and the decrease in the erosion of trust and goodwill of the police department. The value of these risk mitigations is incalculable. And the most valuable impact of all is the possibility of preventing unnecessary loss of life. Even if the $10,000 implementation cost can prevent the collateral death of one young child, one would surmise that the benefit is infinitely greater and

incalculable.

Figure 9 provides a scenario analysis based on the simulated ROI results for various cities with different population sizes (1,000 to 10 million) and the corresponding average pro-rated annual cost per officer (equipment acquisition, spares, training, and certification). For example, with The Alternative priced at $600 per officer, a 10,000-person city with an average of 3.4 officers per 1,000 population, equipping these 34 officers will return an average of 1,730% in ROI. The larger the city, the lower the average number of officers per 1,000 population because the total number of officers will increase substantially, and there is a decrease in marginal ratio, meaning that the ROI increases (i.e., 1,730% increases to 3,011% from a 10,000 town to a large metropolis of 10 million). In addition, the more expensive the less lethal equipment, the lower the ROI. For example, a high-energy discharge weapon, peripherals, and training that costs $2,500 per officer may only yield a 46% ROI in a 10,000-person town.

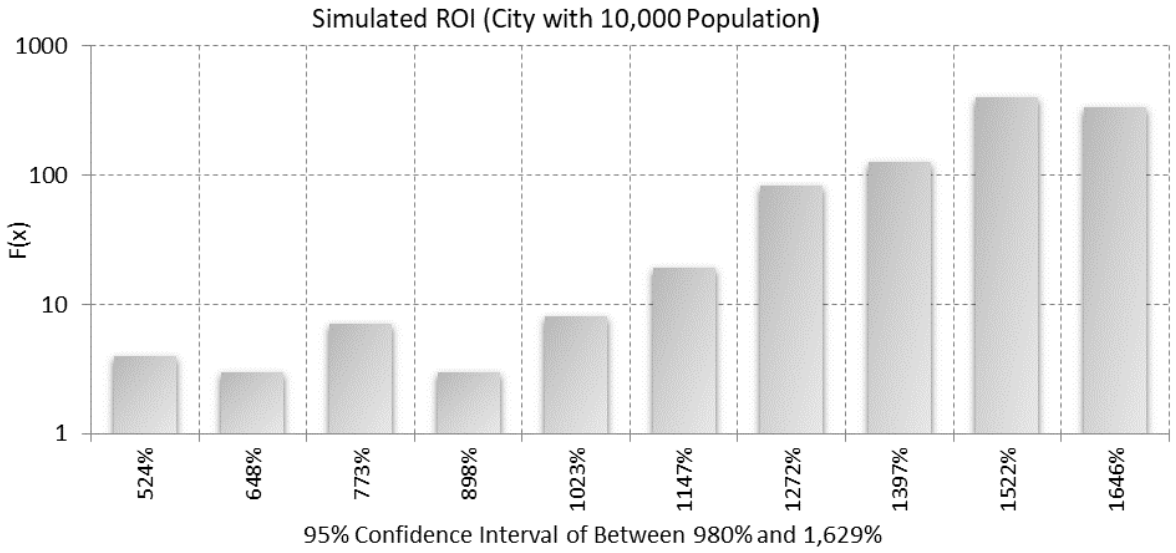

Figure 5. Return on Investment.

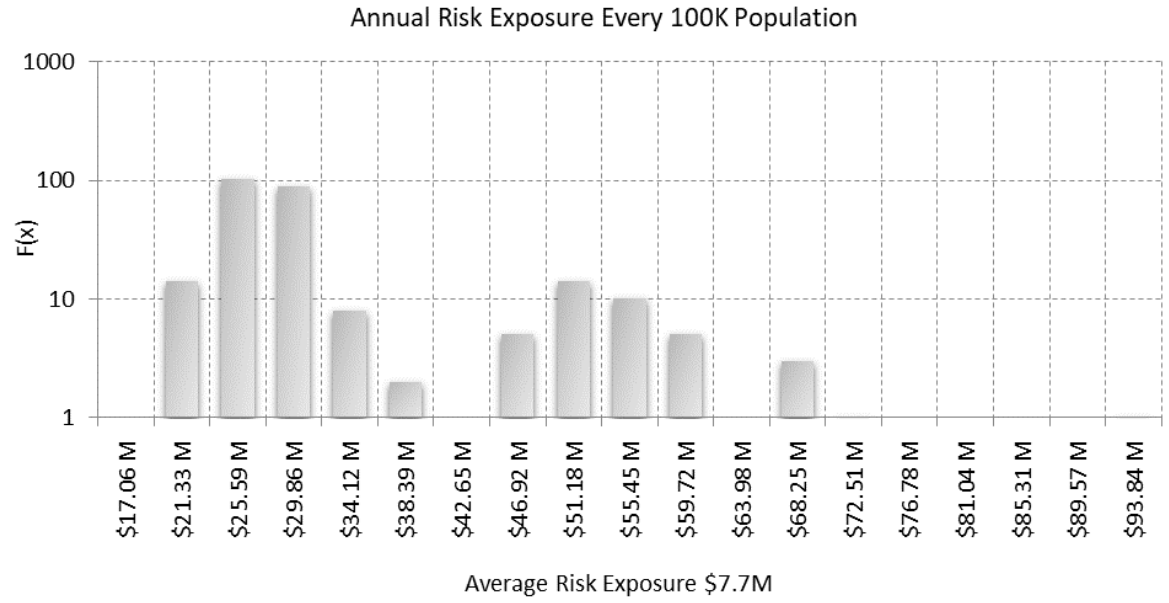

Figure 6. Average Annual Risk Exposure for Every 100K Population.

Table 3. ROI Scenario Analysis.

Officer/1K Population	Unit Cost/ Population	$50	$75	$100	$150	$200	$300	$500	$1,000	$1,500	$2,500
3.4	1,000	7220%	4780%	3560%	2340%	1730%	1120%	632%	266%	144%	46%
3.4	10,000	7220%	4780%	3560%	2340%	1730%	1120%	632%	266%	144%	46%
2.8	30,000	8789%	5826%	4344%	2863%	2122%	1381%	789%	344%	196%	78%
2.8	50,000	8789%	5826%	4344%	2863%	2122%	1381%	789%	344%	196%	78%
2.8	100,000	8789%	5826%	4344%	2863%	2122%	1381%	789%	344%	196%	78%
2.3	300,000	10721%	7114%	5311%	3507%	2605%	1704%	982%	441%	261%	116%
2.3	500,000	10721%	7114%	5311%	3507%	2605%	1704%	982%	441%	261%	116%
2.3	1,000,000	10721%	7114%	5311%	3507%	2605%	1704%	982%	441%	261%	116%
2.3	3,000,000	10721%	7114%	5311%	3507%	2605%	1704%	982%	441%	261%	116%
2.0	5,000,000	12344%	8196%	6122%	4048%	3011%	1974%	1144%	522%	315%	149%
2.0	10,000,000	12344%	8196%	6122%	4048%	3011%	1974%	1144%	522%	315%	149%

6. Key Conclusions

The use of LLWs, such as alternative projectile technologies and Tasers, in law enforcement and military policing operations is a feasible alternative to conventional firearms. The proper use of these weapons decreases collateral damage, reputational risk, and the number of unnecessary deaths caused by fatal gunshot wounds. In addition, their utilization can reduce wrongful death-related litigation and the police officer's or federal agent's criminal liability. The risk exposure of wrongful death lawsuits averages $7.7M for every 10K population. The acquisition, training, and implementation of The Alternative, a velocity-reducing projectile, ranges between 980% and 1,629%, with a 95% statistical confidence in return on investment. The quantifiable benefits alone justify The Alternative's acquisition and implementation, while many additional incalculable intangible benefits exist.

The American Civil Liberties Union believes that implementing policy recommendations for limiting the use of less-lethal force by police officers will benefit both the police and the broader population. The people will be protected against the excessive use of less lethal force. The police will be provided with much-needed direction concerning its use. Lastly, governments can reduce the risk of compensating those against whom less-lethal force was unlawfully employed (ACLU, 2015). For police enforcement, LLWs have become an absolute necessity. One need only consider the number of people involved in altercations when LLWs were utilized to comprehend how drastically things would change if only fatal force were available in those instances. In fact, it may be said that departments that do not equip their police with LLWs are negligent in safeguarding the public.

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Conflict of interest

All the authors claim that the manuscript is completely original. The authors also declare no conflict of interest.

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