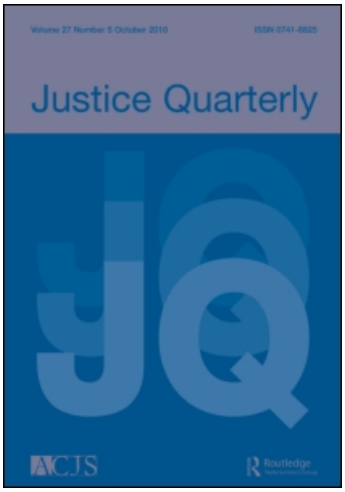

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Conducted Energy Devices (CEDs) and Citizen Injuries: The Shocking Empirical Reality[1]

William Terrill and Eugene A. Paoline III

As one of the contemporary additions to the use of force spectrum, conducted energy devices (CEDs) have been surrounded by controversy. Such concerns have fueled a number of studies, many of which have attempted to examine the relationship between CEDs and citizen injuries. This limited body of research, however, has produced inconsistent results and suffers from a number of documented drawbacks. Drawing on data collected as part of a national multi-agency use of force project, the current study analyzes nearly 14,000 use-of-force incidents across seven agencies, over 2,600 of which involve a CED, to assess the potential impact of CEDs on citizen injuries. In doing so, a series of multivariate statistical models are employed that isolate CED cases and compare them to a number of both hands-on and weapon-based tactics. Unlike previous research, which often highlights the beneficial aspects of CEDs in relation to injuries, our findings generally show an increased risk between the use of CEDs and citizen injuries. As such, more research is needed before deriving any conclusions as to the "safeness" of CEDs, especially in relation to the choice between using a CED or an alternative means of dispute resolution (either hands-on physical force or another weapon).

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Introduction

The right to use coercive force is a defining feature of the police occupation (Bittner, 1970). However, the manner in which this right is applied has always sparked much debate, the majority of which has focused on excessive and deadly use of force (Worden, 1996). More recently, concerns have centered around the use of conducted energy devices (CEDs) (Kaminski, 2009; White & Ready, 2010).[2] Proponents of CEDs herald these weapons for their perceived ability to quickly, safely, and fully incapacitate citizens, while opponents question their effectiveness and, more importantly, their safety (Adams & Jennison, 2007). These opposing perspectives have worked to fuel a series of CED studies.

While there are a number of studies that have concluded that serious injury to citizens, a rare event in and of itself, is not attributable to CED use, we currently lack a clear understanding as to the extent to which CEDs affect the probability of citizen injury (MacDonald, Kaminski, & Smith, 2009). Beyond an almost exclusive focus on serious injury, early CED research has been stymied by a number of limitations (e.g., lack of independent inquiry, descriptive analytical approaches, small sample sizes, generalizability concerns, failure to adequately isolate the independent effect of the CED, and the absence of theoretically relevant statistical controls) (Adams & Jennison, 2007; Kaminski, 2009). More recent inquiries have alleviated many of these shortcomings, but they too have failed to adequately tease out the relationship between CED use and other types of force, and/or control for other causal factors in explaining citizen injuries. These more recent studies have also found mixed results regarding injuries to citizens.

Using data collected from a national multi-agency use of force project, the current inquiry seeks to further clarify the relationship between CEDs and citizen injuries. Our primary focus is on whether a citizen is injured, as opposed to the extent of injury, given the infrequency with which the latter occurs. However, we also conduct a secondary supplemental analysis to assess the severity of citizen injuries and determine if the findings are similar to our findings from the primary analyses. Unlike prior studies, we employ a series of multivariate models that assess the role of CEDs when used alone as well as when used in combination with other types of force. In doing so, we compare CED usage to a number of other types of force that officers utilize while controlling for citizen resistance and additional theoretically relevant variables.

2. CEDs, the current most popular versions of which are *TASER*® (Thomas A. Swift Electric Rifle) and, to a lesser extent, *Stinger* disperse an electrical charge of up to 50,000 volts and can be deployed in either a probe or a drive stun mode (Vilke & Chan, 2007).

Police Use of Force and Legitimacy

As agents of social control, the police are authorized to use coercion over citizens. It is no surprise then that researchers have been interested in exploring this area of inquiry over the past half century. Even though prior research establishes that police use of force occurs rarely (Adams, 1996), the social significance of this unique occupational power is expressed in each application. When the police abuse their coercive power or when injuries result from the use of force tactics, there are potentially damaging social consequences. In essence, there is a balancing act between the utilization of coercion in performing the duties as a police officer and maintaining public trust as legitimate criminal justice agents.

As Tyler (1990, 2004) theorizes, when citizens perceive legal authorities as legitimate, they are generally more likely to obey the law, comply during police encounters, and cooperate as victims and witnesses in helping to control crime. As such, it is in the best interest of the police to preserve this public image, since compromised legitimacy could result in citizens deciding not to follow societal rules, resisting and fighting with police during encounters, and not assisting police when asked about crime. Moreover, legitimacy is manifested not only by first-hand experiences that citizens have with the police, but vicariously through others as well (i.e., relatives, friends, and the media) (Brunson, 2007; Gau & Brunson, 2010). In this sense, establishing, maintaining, and diminishing legitimacy in the eyes of the public, during use of force situations, is based on both direct and indirect sources. This does not mean that police cannot (or should not) use force on citizens. Procedurally, the public may understand that coercion is a necessary part of the police response, but if citizens are receiving injuries at a high rate (or unexpectedly) in the process, it can certainly work to erode public trust. Given the recent controversy and media attention to CEDs (Ready, White, & Fisher, 2008; White & Ready, 2009), rivaled only by examples of excessive and deadly force, this application of force is certainly a critical, and potential damaging, arena for police legitimacy.

The CED Controversy

CEDs have been a part of the weaponry available to the police since the late 1970s, although their widespread adoption has increased dramatically over the past decade (Vilke & Chan, 2007). A recent study by the National Institute of Justice (NIJ) (2008) reported that roughly 11,500 law enforcement agencies currently have CEDs, with approximately 260,000 in operation across these agencies. Given the large number of agencies utilizing CEDs, it is evident that these weapons are not a passing fad. However, the current popularity of CEDs has come with controversy over the potential negative outcomes associated with the weapon (Kaminski, 2009).

CEDs have been heralded for their increased ability to fully incapacitate suspects, as opposed to a single area noted for other less lethal weapons that police use (Vilke & Chan, 2007). Moreover, CEDs can be used at a greater distance than other less lethal weapons, while also potentially avoiding "hands-on" and ground-fighting tactics, which may have the increased potential for injuries (US Government Accountability Office, 2005). Thus, from a pro-CED perspective, CEDs are perceived as safer, injury-wise, for officers who do not have to engage in close force tactics with resisting citizens, while also safer for citizens who do not have to be engaged by police in longer physical struggles or the use of other types of weapons (e.g., batons). However, critics question the pro-CED argument, especially with respect to citizen injuries. Citizen advocacy groups (e.g., Amnesty International and the American Civil Liberties Union), have lobbied against the use of these weapons, citing examples of serious injuries and deaths as a result of forceful encounters that have included the use of CEDs (Adams & Jennison, 2007; White & Ready, 2009). In short, the controversy surrounding CEDs focuses on the interplay between their ability to incapacitate individuals and the injuries that may result from their use.

Prior CED and Citizen Injury Examinations

As a burgeoning area of police use of force inquiry, examinations of CEDs have explored a variety of topics including their overall effectiveness (Lin & Jones, 2010; Ready et al., 2008; White & Ready, 2007, 2010), the ethical considerations of these weapons (Kleinig, 2007), their influence on other types of force usage (Sousa, Ready, & Ault, 2010), their portrayal in the media (Ready et al., 2008, White & Ready, 2009), policy, procedure, and training concerns (Alpert & Dunham, 2010; Bunker, 2009; PERF, 2005; US Government Accountability Office, 2005), and their impact on officer injuries (Lin & Jones, 2010; MacDonald et al., 2009; PERF, 2009; Smith, Kaminski, Rojek, Alpert, & Mathis, 2007). While the aforementioned topics have been part of previous CED inquiries, the greatest amount of attention has been paid to the weapon's impact on citizen injuries.

Based, in part, from the competing concerns of advocacy groups (e.g., Amnesty International, American Civil Liberties Union, TASER International), there have been a number of medical studies that have examined a variety of serious internal and external injuries (e.g., heart, muscle, head, etc.) as well as deaths associated with CEDs (Bozeman et al., 2009; Ho, Miner, Lakireddy, Bultman, & Heegaard, 2006; Lakkireddy et al., 2006; Levine, Sloane, Chan, Dunford, & Vilke, 2007; Nanthakumar et al., 2006; Strote & Hutson, 2006; Vilke et al., 2007).[3] A recent comprehensive panel of 80 medical experts, police practitioners, and social scientists, convened by the NIJ (2008, p. 3), summed up the current state of knowledge by explaining that there is no conclusive evidence of

3. For excellent reviews of this research, see Kaminski (2009) and Vilke and Chan (2007).

direct effects of CEDs on serious injuries and deaths, although CED "darts may cause puncture wounds or burns."

The initial studies on the impact of CEDs on citizen injuries suffer from a few central drawbacks. First, from a research standpoint, the work done by advocacy groups has been driven by a heated debate where there is a vested interest in the results. Moreover, these examinations have been descriptive in nature, usually designed to illustrate variation in injuries associated with CED usage (Schlosberg, 2005; Amnesty International, 2004, 2006; Jenkinson, Neeson, & Bleetman, 2006; TASER International, 2009). A second primary limitation of early CED research is the heavy focus on serious injuries and deaths. While not minimizing the importance of severe injuries and deaths to citizens, such instances are extremely rare events as the "typical" injury from the use of force encounters are less serious in nature (e.g., bruises, abrasions, and lacerations) (PERF, 2009; Smith et al., 2007; Terrill & Paoline, 2009). As social scientists interested in explaining variation, focusing on the exception tends to push the field toward getting caught up in the advocacy group debate. Third, early CED research has suffered from small sample sizes, which constrains the ability to utilize a number of multivariate statistical tests, while also raising generalizability concerns (Ho et al., 2006; Levine et al., 2007; Strote & Hutson, 2006; Vilke et al., 2007). Fourth, earlier research has failed to adequately isolate the independent influence of the CED on citizen injury. This includes controlling for other theoretically relevant factors, while also clearly separating various types of force when used individually or in conjunction with another tactic or weapon.

Recent empirical examinations of CEDs and citizen injuries have addressed several of the limitations from earlier studies. In doing so, researchers have now begun to focus on whether or not CEDs contribute to any injury, rather than just a serious injury. We find also that this work has utilized better multivariate models that, in varying degrees, compare different types of force and control for other theoretically relevant causes of citizen injuries.

Smith et al. (2007) examined 1,080 use-of-force incidents from Richland County Sheriff's Department (RCSD) and the Miami-Dade Police Department (MDPD), running a separate statistical model for each agency. They relied on between three and seven dichotomous force variables (i.e., CEDs, soft hands, hard hands, chemical spray, baton, canine, and firearm) in their models as well as up to six control measures. The findings showed that the probability of citizen injury as a result of CED use was statistically lower in MDPD, but not in RCSD. The authors also examined injury seriousness among MDPD force incidents, with an ordered three category measure, where they found that CEDs were associated with fewer severe injuries.

MacDonald et al. (2009) examined the relationship between CEDs and citizen injuries using data from 12 police agencies. In each of their multivariate models they included three dichotomous force measures (CEDs, chemical spray, and physical force including all other weapons and hands-on tactics) and a varying number of controls. Their most inclusive model consisted of 12,508 cases with

four control variables.[4] The findings indicated that chemical spray had the greatest impact on reducing the odds of a suspect injury, followed by CEDs.

Lin and Jones (2010), utilizing 708 use-of-force incidents from the Washington State Patrol (WSP), also examined the probability of citizen injury as a result of electronic control devices (ECDs) (a synonym for CEDs). The researchers dichotomized their force variable to include instances where ECDs were used versus all other force applications that did not involve an electronic weapon, and incorporated six control variables. They found that the impact of ECDs on citizen injuries was mixed. That is, the authors noted that in one year ECD deployments were statistically less likely to result in citizen injuries, while in the following year they were statistically more likely to result in citizen injuries.

PERF (2009), relying on a series of analyses from a 13-agency dataset (seven agencies with and six agencies without CEDs), also examined CEDs' impact on citizen injuries. In an introductory multivariate analysis of the seven agencies that employed CEDs, five categories of force (i.e., CED only, baton only, chemical spray only, hands-on only, and multiple weapons or weapons other than CED, baton, and chemical spray) were included along with three statistical controls. The researchers found the greatest reduction of citizen injury for chemical spray, while CEDs (when used alone) were associated with an increased probability of citizen injury (*p* value .06). In terms of injury seriousness, the authors found no statistical relationship between CED use and the probability of severe injuries (broken bones, stab wounds, gun shots), although they did find that CEDs increased the odds of suspects requiring medical attention (*p* value .05) and hospitalization (*p* value .00). Additional analyses of the 13 combined sites (i.e., CED and non-CED agencies) revealed that the odds of a citizen being injured, needing medical attention, or hospitalization were lower in the agencies that used CEDs versus those that did not. Overall, despite their broader interpretation as to the benefits of CEDs, in terms of citizen injuries, the safety of CEDs remains in question.

Recently, Taylor and Woods (2010) published part of the results from the PERF (2009) study that compared agencies with CEDs to those that did not allocate CEDs, but not the results from the same study that compared CED sites only. The results indicated that the probability of citizens being injured in agencies with and without CEDs was actually similar, with no statistical distinction. However, in terms of seriousness, the authors found that CED sites reported a reduced probability of citizen severe injury, need for medical attention, and hospitalization.

In assessing prior CED citizen injury research as a whole, several issues emerge. First, the relationship between CEDs and citizen injuries is unclear, as the findings are mixed across studies. Second, researchers are utilizing a variety of analytical models which, in varying degrees, do not adequately

4. In an additional time-series analysis, MacDonald et al. (2009) isolated the Orlando Police Department (OPD) and the Austin Police Department (APD) for an examination of citizen injuries before and after CED implementation. Over a 108-month period in Orlando and a 60-month period in Austin, the researchers found that citizen injury averages decreased by 53% (in OPD) and 30% (in APD) following CED implementation.

account for the types of force being used. That is, cases where officers used physical force sometimes include CED deployment measures as well, and vice versa, making it difficult to identify the true effect of either of these forms of force on citizen injuries. These analytical models also do not sufficiently control for additional injury explanatory factors (e.g., citizen resistance, other citizen factors, and officer characteristics). Another concern is how researchers have compared CED use to other types of force. More specifically, researchers have limited the degree to which CEDs are tested against other types of force beyond but one simple reference category. In effect, failure to specifically and directly test the effect of CED applications to specific types of force, that are isolated and independent, clouds the potential true relationship between CED usage and injuries.

The Current Inquiry

In addressing concerns from these previous studies, the current independent empirical inquiry utilizes data collected as part of a national multi-agency use of force study. We analyze nearly 14,000 use of force incidents across seven agencies, over 2,600 of which involve a CED, to assess the potential impact of CEDs on citizen injuries. In doing so, a series of multivariate statistical models are employed that isolate CED cases and compare them to a number of both hands-on and weapon-based tactics. Furthermore, we account for levels of citizen resistance, a key explanatory factor for injuries, as well as additional citizen and officer-based control measures.

Methodology

Data

The data for the current inquiry are drawn from the *Assessing Police Use of Force Policies and Outcomes* project, a NIJ federally funded study designed to look at a host of use of force issues (e.g., reporting mechanisms, officer perceptions of force, degree of force usage, injuries, complaints, lawsuits). The initial phase of this project consisted of researchers surveying a nationally representative sample of over 600 police agencies. Eight agencies were then selected for deeper exploration as part of the second phase of the project and include Columbus, Ohio; Charlotte-Mecklenburg, North Carolina; Portland, Oregon; Albuquerque, New Mexico; Colorado Springs, Colorado; St. Petersburg, Florida; Knoxville, Tennessee; and Fort Wayne, Indiana.

The selection of phase two agencies was based on several criteria. First, agencies must have engaged in the regular reporting of force via officer use of force reports, which offers the most promising means of collecting large amounts of data in the most efficient manner. Second, agencies must have had

a consistent use of force policy and reporting procedure for two consecutive years, and some degree of policy variation across departments.[5] Third, mid-to-large-sized agencies were selected to ensure a sufficient number of force incidents.[6] Finally, jurisdictions must have been reasonably comparable from a socioeconomic perspective (e.g., unemployment, poverty, crime rates).

Table 1 lists the eight study sites and how they compare across a multitude of factors. With respect to sworn officers, while the total number varies between 1,819 in Columbus and 382 in Knoxville, when the number of sworn officers per 1,000 population is considered, the range is just from 2.48 in Columbus to 1.79 in Colorado Springs. Several of the cities are particularly similar in size, and many of the socioeconomic indicators are relatively closely situated. For example, percent unemployed is tightly grouped between 3.1 in Colorado Springs and 4.5 in Portland. We tend to see a little more variation on some other measures. For instance, poverty rates range from 6.1% in Colorado Springs to 14.4% in Knoxville. In all, structurally, these eight agencies provide a snapshot of policing across mid-to-large municipal departments.

Upon securing agreements with police administrators, researchers conducted multiple site visits over the course of two years at each of the eight agencies in procuring a variety of police data. Besides the use of force data, project staff collected citizen complaint and civil litigation data, as well as accompanying sources of information (e.g., organizational charts, rosters, policy manuals), retrospectively for 24 months.[7] Furthermore, a survey to patrol officers was administered to assess their views on the impact of the agency's force policy on decision-making. Finally, a series of informal interviews were conducted with officials at the middle and upper management levels to glean information on organizational practices, operational procedures, and protocols.

Model variables

The measures used in the analyses are taken from the use of force reporting forms of seven of the eight phase two agencies and merged into a master SPSS datafile.[8] Unlike the other agencies, which provided CEDs to patrol officers,

5. The overarching goal of *Assessing Police Use of Force Policies and Outcomes* project was to examine policy variation with respect to how and why officers use force broadly, while the current inquiry examines the connection between CED use and citizen injuries as a collective whole.

6. While larger type agencies were included in the study (i.e., Charlotte-Mecklenburg and Columbus), a deliberate attempt was made to avoid the "largest" US agencies (e.g., New York, Los Angeles, etc.) to enhance generalizability (e.g., just 17 agencies serve a population of one million or greater, Hickman & Reaves, 2006).

7. The exact two-year study period varied per agency, with a range of December 2004 to April 2008.

8. Some of the agencies coded nearly all data electronically (i.e., Portland, Charlotte-Mecklenburg, and Columbus), others had some sort of combination between electronic data and paper copies (i.e., Albuquerque and St. Petersburg), and yet others maintained only paper copies (i.e., Colorado Springs, Fort Wayne, and Knoxville). As such, any variables, not electronically maintained, were coded from hard copies and entered into the master database.

Table 1 Study sites

	Columbus	Charlotte-Mecklenburg	Portland	Albuquerque	Colorado Springs	St. Petersburg	Fort Wayne	Knoxville
Agency characteristics								
Total number of Sworn Officers	1,819	1,638	989	986	669	520	457	382
Number of officers/ 1,000 population	2.48	2.23	1.84	1.92	1.79	2.10	1.84	2.09
City characteristics								
Population	733,203	733,291	538,133	513,124	374,112	248,069	248,423	182,337
% Non-White	32.0	36.0	22.1	28.4	19.3	28.6	24.5	20.3
% Female headed	9.3	7.6	6.3	8.0	7.1	7.9	9.8	8.0
% Below poverty	10.8	6.6	8.5	10.0	6.1	9.2	9.6	14.4
% Unemployed	3.5	3.7	4.5	3.8	3.1	3.2	4.3	3.9
Part I crimes/1,000 population	78.8	79.8	65.5	66.9	49.5	76.6	43.6	81.8

Fort Wayne issued only CEDs to emergency response team officers and are thus excluded from the analysis. All agencies had similar reporting mechanisms with respect to force reporting. More directly, each officer using force was required to file a use of force report form. The threshold for reportable force involved any hands-on physical force above handcuffing/ simple restraint, as well as the use of any weapon.[9]

Citizen injury

Our primary dependent variable is any citizen injury, which is measured dichotomously (no injury/injury). All of the study sites contained a section on their use of force reporting form asking officers to indicate whether the citizen was injured. There was little to no direction in the policy guidelines to designate the criteria individual officers were to apply to determine whether a citizen was injured other than the officer's perception of injury or complaint of injury by the citizen.[10] According to queries with officials across the sites, each officer using force was provided the discretionary power to determine injury, based on his/her assessment, as to whether the force he/she used caused such.[11] Thus, the injuries analyzed as part of this inquiry are considered injuries by police personnel, as opposed to a determination made by the authors.

We also examine injury severity in a secondary analysis using two ordinal dependent measures. The first involves a measure of injury type (no injury, bruises/abrasions, lacerations, broken bones),[12] while the second involves a

9. Agencies also captured when officers used simple restraint (e.g., firm grip) and drawing a firearm, so long as the threshold for a reportable force action was met. For example, if an officer used only a firm grip or drew a firearm, a force report was not required. However, if an officer used a CED and also used a firm grip, a force report was required. Across the seven sites approximately 350 force reports were filed by officers where only simple restraint and/or the drawing of a firearm was documented; these were excluded from our analyses to ensure we had a consistent and comparable threshold.

10. Only three departments made some specific mention of injury either in their policy or use of force reporting form. Portland officers were instructed that a physical injury involves "impairment of physical condition or substantial pain." Albuquerque asked officers if citizens suffered a "visible/ obvious injury" or "complaint of injury." Columbus identified a minor injury as one that "does not require transport to a medical facility" and a serious injury as one that "requires transport to a medical facility."

11. Importantly, each officer was to assess the impact that his/her force had on injury. Thus, if two officers used force on one citizen, with officer one using an arm bar and officer two using a baton, and the citizen sustained a bruise from the baton strike, officer one was to report no injury in his/ her report, while officer two was to report an injury in his/her report.

12. Of course, any approach to measuring seriousness based on injury type is open to debate since there is no agreed upon definition of such. For example, we conservatively placed lacerations in the moderate category, given the potential for blood being drawn, and hence more serious than bruises. However, one could also argue that not all lacerations are the same (e.g., a small cut being less serious than a 20-stitch wound), although we are unable to make this distinction in the data. Taking it one step further, one may argue that a broken finger is less serious than a deep bone bruise or 20-stitch laceration. Hence, given the potential variability in constructing our first measure, we incorporate a second ordinal dependent variable involving hospitalization.

measure of hospitalization (no injury, injury but no transport to a hospital, and injury with transport to a hospital). Colorado Springs and Albuquerque did not require officers to indicate the type of injury a citizen received (and thus these two agencies are excluded from the injury type analysis), although both of these departments, as well as the remaining agencies, did require officers to note whether the citizen was taken to a medical facility for an injury evaluation.

Force measures

The primary independent variables involve the types of force reported by officers. To ensure that force types are comparable across agencies, common measures of force were created across each of the cities and divided into hands-on and weapon-based measures. Hands-on weaponless tactics include firm grips/escorts (e.g., grabbing, holding, and guiding a citizen), control maneuvers involving physical manipulation (e.g., wrestling with a citizen), pressure point techniques (e.g., wristlock), takedowns (e.g., pushing, shoving, and leg sweeps to the ground), and empty hand/leg strikes (e.g., punching, kicking). Weapon-based tactics include hand-held chemical spray (e.g., Oleoresin Capsicum), baton (e.g., expandable ASP), CEDs (e.g., TASER), munitions (e.g., beanbag), canines, and firearms.[13]

After splitting force tactics into hands-on and weapon-based tactics, we then created three primary dichotomized variables (i.e., CED only, CED with other force, and CED none). The *CED only* variable involves those cases where an officer used no other force except for a CED. The *CED with other force* measure involves those cases where an officer used a CED along with any other type of force (either hands, weapon, or both). The third primary measure, *CED none*, involves those cases where an officer did not use a CED.

Once the three primary variables were created, the CED with other force and CED none variables were further divided. The *CED with other force* variable was separated into three sub-variables: CED with hands (cases where an officer deployed his/her CED and used some type of hands-on force, but no other type of weapon), CED with weapons (cases where an officer deployed his/her CED and used some other type of weapon as well, but no hands-on force), and CED with hands and weapons (cases where an officer deployed his/her CED, and used both hands-on force and another weapon).

The *CED none* variable was then split into a series of sub-variables. First, a hands only variable was created to indicate those cases where the officer used only some form of hands-on force. This was broken down even further into a soft hands only variable (i.e., cases where the officer used only some form of soft-hand force), and a hard hands only variable (i.e., cases where the officer

13. Each of these includes actual use. That is, an officer had to deploy a CED through either the drive stun or the probe mode to be coded as use. Simply drawing the weapon and/or threatening a citizen did not get counted as use.

used only some form of hard-hand force).[14] Second, a weapons only variable was created to indicate those cases where the officer used only a weapon (other than a CED). This was broken down even further into a chemical spray only variable (i.e., cases where the officer used only hand-held chemical spray), and an impact only variable (i.e., cases where the officer used only a weapon other than a CED or hand-held chemical spray, such as a baton, bean bag, canine, and firearm).

The importance of these variable splits should not be understated as they allow us to address one of the primary deficiencies of past studies—isolating and teasing out the influence of CEDs on citizen injuries. Moreover, these specific measures of force allow one to properly assess the relative impact of each on citizen injuries for equally appropriate tactics and weapons. Given the lack of agreement among police practitioners and researchers as to which types of force are directly comparable, in relation to the type of citizen resistance encountered, these measures (and subsequent analytical models) allow for a variety of comparison options (e.g., CEDs versus chemical spray, CED versus hard hands, CED versus impact weapons).

Control measures

A number of variables are included in our statistical models as controls. Precisely what measures should be included to offer a properly specified model, however, is not entirely clear from prior research. That is, a universally agreed upon set of variables has yet to emerge from this growing body of literature. Control measures used in previous research appear to be limited to what is available within existing data structures given the study at hand. While our analyses are constrained within the same type of data availability framework (i.e., limited to those variables collected by the study agencies), we are able to include nine control measures (i.e., citizen resistance, sex, age, alcohol/drug, weapon, as well as officer sex, race, experience, and department).

In relation to the citizen-based variables, resistance serves as a key control and is measured ordinally, given that one may reasonably posit that the probability of a citizen being injured is enhanced as the degree of their aggressiveness increases.[15] Failure to comply includes both passive (i.e., citizen

14. Soft hands include firm grips/escorts, control maneuvers, pressure point techniques, and takedowns, while hard hands include empty hand/leg strikes.

15. Citizen resistance is an indicator (along with alcohol/drug impairment and weapon possession below) of how threatening a situation is and serves as a primary factor in determining how aggressive an officer may be in controlling the encounter. Besides our ordinal measure, we also employed four dichotomous measures of resistance (i.e., failure to comply, physical defensive, physical aggressive, and deadly). See Section "Analyses and Findings" for further description and findings.

behaviors that were unresponsive to police verbal communication or direction) and verbal resistance (i.e., citizen verbally rejecting police verbal communication or direction). Physical defensive resistance includes a citizen's attempt to evade police attempts at control (e.g., attempts to leave the scene, flee, hide from detection, and pull away from officer's grasp). Physical aggressive resistance includes the citizen either attempting or actually attacking or striking an officer (e.g., lunging toward the police, striking police with hands, fists, and kicks). Finally, deadly resistance includes attempts or actual attacks that could cause death.

Additionally, citizen sex, age, alcohol/drug use, and weapon possession are included as controls. Varying forms of these measures have been included in previous examinations regarding citizen injuries (e.g., Lin & Jones, 2010; MacDonald et al., 2009; PERF, 2009; Smith et al., 2007) as well as broader use of force research (Terrill and Mastrofski, 2002).[16] Three primary officer-based characteristics also are included that have been part of previous empirical studies of police behavior in general (Riksheim & Chermak, 1993), the use of force (Paoline & Terrill, 2007; Worden, 1996), and CEDs and citizen injuries (Lin & Jones, 2010; Smith et al., 2007). More specifically, we accounted for officer sex, race, and experience in the event that these factors are related to individual-level differences in the application of CEDs and potentially resulting injuries to citizens. Finally, site is included to account for potential confounding agency effects. Given that there are seven departments in the study, six dichotomous variables are included in the models with Columbus (having the most cases) serving as the reference category. Table 2 provides an overview of model variable coding descriptions, means, and standard deviations for the force and control measures.

Analyses and Findings

In total, officers reported a citizen injury in 4,447 of 13,913 (31.9%) use of force cases.[17] As illustrated in Table 3, citizens were injured 41.2% of the time (322 of 781 encounters) when officers used a CED only, 47.0% of the time (858 of 1,826 encounters) when officers used a CED with some other form of force, and 28.9% of the time (3,267 of 11,306 encounters) when no CED was used. As a result, from a bivariate standpoint, citizens were significantly more likely to be injured

16. Citizen race, which has often been included in previous use of force research, is excluded from our analyses given data limitations (i.e., not captured across all the study agencies). Furthermore, White and Ready (2010) found citizen weight to be a predictor of CED "effectiveness." One may also reasonably posit that weight (as well as height) may impact injury as well. Unfortunately, we did not have a consistent measure of these variables in order to include them in our models.

17. Comparatively, Smith et al. (2007) found that 17% of citizens were injured in Richland County, while 56% of citizens were injured in Miami-Dade; PERF (2009)-reported citizens being injured 22% of the time in their CED only sites; and MacDonald et al. (2009) reported citizens being injured 39% of the time.

Table 2 Variable coding and descriptive statistics

Variable	Coding description	Mean	S.D.
Dependent			
Citizen injury—any	1 = Injury and 0 = no injury	.32	.46
Citizen injury—injury type	3 = Broken bones, 2 = lacerations, 1 = bruises/abrasions, and 0 = no injury	.40	.76
Citizen injury—hospitalization	2 = Injury hospitalization, 1=injury no hospitalization, and 0 = no injury	.45	.71
Force			
CED only	1 = CED only and 0 = all other	.05	.23
CED with other force	1 = CED with other force and 0=all other	.13	.33
CED with hands	1 = CED with hands-on force and 0 = all other	.11	.31
CED with weapons	1 = CED with weapons 0 = all other	.01	.07
CED with hands and weapon	1 = CED with hands and Weapon and 0 = all other	.02	.13
CED none	1 = CED none and 0 = all other	.81	.39
Hands only	1 = Hands only and 0 = all other	.59	.49
Other than hands only	1 = Non-Hands only and 0 = all other	.22	.41
Soft Hands Only	1 = Soft only and 0 = all other	.50	.50
Other than Soft Hands Only	1 = Non-Soft only and 0 = all other	.31	.46
Hard Hands Only	1 = Hard only and 0 = all other	.01	.11
Other than Hard Hands Only	1 = Non-Hard only and 0 = all other	.80	.40
Weapon Only	1 = Weapon only and 0 = all other	.06	.24
Other than Weapon Only	1 = Non-Weapon only and 0 = all other	.75	.43
Chemical Only	1 = Chemical only and 0 = all other	.05	.20
Other than Chemical Only	1 = Non-Chemical only and 0 = all other	.77	.42
Impact Only	1 = Other weapon only and 0 = all other	.02	.12
Other than Impact Only	1 = Non-Other weapon only and 0 = all other	.80	.40
Control			
Citizen resistance	4 = Deadly, 3 = physical aggressive, 2 = physical defensive, 1 = failure to comply, and 0 = none	2.17	.79
Citizen sex	1 = Male and 0 = female	.84	.36
Citizen age	Years (7–84)	29.91	11.02
Citizen alcohol/drug	1 = Alcohol/drug and 0 = other	.32	.46
Citizen weapon	1 = Citizen weapon and 0 = other	.07	.26
Officer sex	1 = Male and 0 = female	.94	.24
Officer race	1 = White and 0 = non-white	.86	.34
Officer experience	Years (0–36)	7.27	5.73
Colorado Springs	1 = Colorado Springs and 0 = other	.05	.22
Portland	1 = Portland and 0 = other	.15	.35
Albuquerque	1 = Albuquerque and 0 = other	.10	.30
St. Petersburg	1 = St. Petersburg and 0 = other	.12	.32
Knoxville	1 = Knoxville and 0 = other	.07	.24
Charlotte-Mecklenburg	1 = Charlotte-Mecklenburg and 0 = other	.10	.29
Columbus	1 = Columbus and 0 = other	.41	.49

Table 3 Any citizen injury by force type

Variable	Number of cases	Number of injuries	Percentage of injuries
Force			
CED only	781	322	41.2
CED with other force	1,826	858	47.0
CED with hands	1,506	692	45.9
CED with weapons	82	39	47.6
CED with hands and weapon	238	127	53.4
CED none	11,306	3,267	28.9
Hands only	8,199	2,475	30.2
Other than hands only	3,107	792	25.5
Soft hands only	6,998	1,949	27.9
Other than soft hands only	4,308	1,318	30.6
Hard hands only	195	71	36.4
Other than hard hands only	11,111	3,196	28.8
Weapon only	880	203	23.1
Other than weapon only	10,426	3,064	29.4
Chemical only	638	54	8.5
Other than chemical only	10,668	3,213	30.1
Impact only	229	147	64.2
Other than impact only	11,077	3,120	28.2

in cases involving a CED compared to those cases when no CED was used (χ^2 = 269.290, p < . 001).[18]

Further examination shows that the injury percentage for those encounters involving a CED ranges from 41.2% to 53.4%, with CED used by itself on the low end, and CED used in conjunction with hands-on and another weapon at the high end. For cases not involving a CED, the percentage ranges from 8.5% to 64.2% (across 12 different measures of no CED use), with chemical spray only (e.g., Oleoresin Capsicum) on the low end and impact only on the high end.[19] Overall, instances where an officer used a CED were more likely to result in a citizen injury when compared to instances where an officer chose to use some other form of force (either hands, another weapon, or a combination of the two), with the exception of impact only force.

18. One anonymous reviewer noted the possibility of whether a department's policy toward transport to a medical facility post CED deployment may affect an officer's reporting of injury. None of the agencies had a policy requiring transport to a medical facility after CED deployment, although all agencies advised officers to assess if a suspect should be transported to a medical facility depending on the nature of the CED injury. Much of the same cautionary language used for CEDs is also present for chemical spray and baton usage. In fact, in six of the eight agencies the cautionary language in the policy for chemical spray is more voluminous than for CED.

19. While the percentage for chemical spray injuries may initially seem somewhat low, it does not vary substantially from prior studies. MacDonald et al. (2009) reported 22.1%, Smith et al. (2007) 10.0%, and PERF (2009) 7.6%. Clearly, officers do not often report injuries when using chemical sprays—perhaps, as one reviewer noted, because they do not consider tearing/blurring of the eyes or a burning sensation as an injury.

While there is a connection between CED use and citizen injuries from a bivariate standpoint, it does not allow for an assessment of independent effects. For instance, it is quite possible that other factors, such as citizen resistance, may attenuate the CED/injury relationship. As a result, we estimated a series of logistic regression models centering around three areas of inquiry: (1) the effects of CED use (both by itself and with other forms of force) compared to a broad based reference category that includes all other forms of force (Table 4); (2) the effects of CED usage in comparison to hands-on force (Table 5); and (3) the effects of CED usage in comparison to instances when officers used some sort of weapon other than a CED (Table 6).

Table 4 Logistic regression models of any citizen injury (N = 13,128) CED only and CED with other force combined and expanded: compared to CED none

	Model 1			Model 2		
	CED and other force combined			CED and other force expanded		
	Reference: CED None			Reference: CED None		
	B	SE	OR	*B*	SE	OR
Force						
CED only	.521	.087	1.68**	.521	.087	1.68**
CED with other force	.638	.057	1.89**			
CED with hands				.608	.062	1.83**
CED with weapons				.650	.254	1.91**
CED with hands & weapons				.834	.145	2.30**
Control						
Citizen resistance	.311	.027	1.36**	.311	.027	1.36**
Citizen sex	.600	.062	1.82**	.600	.062	1.82**
Citizen age	.013	.002	1.01**	.013	.002	1.01**
Citizen alcohol/drug	.316	.050	1.37**	.317	.050	1.37**
Citizen weapon	.315	.076	1.37**	.309	.076	1.36**
Officer sex	.156	.086	1.16	.156	.086	1.16
Officer race	.118	.061	1.12	.118	.061	1.12
Officer experience	−.005	.004	.99	−.005	.004	.99
Colorado Springs	−.051	.098	.95	−.050	.098	.95
Portland	−.392	.069	.67**	−.399	.069	.67**
Albuquerque	−.512	.077	.59**	−.512	.077	.59**
St. Petersburg	−.879	.077	.41**	−.878	.077	.41**
Knoxville	.441	.078	1.55**	.440	.078	1.55**
Charlotte-Mecklenburg	1.697	.074	5.44**	1.692	.074	5.43**
Constant	−2.775	.144	.06**	−2.772	.144	.06**
Pseudo *R*-square		.134			.134	
Model Chi-Square		1882.944**			1885.128**	

*$p < .05$.
**$p < .01$.

Table 5 Logistic regression models of any citizen injury (*N* =13,128). CED only and CED with other force: compared to CED none (hands only, soft hands only, hard hands only)

	Model 1			Model 2			Model 3		
	Reference: hands only			Reference: soft only			Reference: hard only		
	B	SE	OR	*B*	SE	OR	*B*	SE	OR
Force									
CED only	.506	.088	1.65**	.614	.089	1.84**	.181	.177	1.19
CED with other force	.622	.059	1.86**	.730	.062	2.07**	.290	.168	1.33
Other than hands only	−.106	.054	.94						
Other than soft hands only				.208	.049	1.23**			
Other than hard hands only							−.357	.162	.70
Control									
Citizen resistance	.312	.027	1.36**	.302	.027	1.35**	.310	.027	1.36**
Citizen sex	.603	.062	1.82**	.573	.062	1.77**	.594	.062	1.81**
Citizen age	.013	.002	1.01**	.013	.002	1.01**	.013	.002	1.01**
Citizen alcohol/drug	.316	.050	1.37**	.314	.050	1.36**	.316	.050	1.37**
Citizen weapon	.322	.076	1.38**	.287	.076	1.33**	.312	.076	1.36**
Officer sex	.155	.086	1.16	.158	.086	1.17	.159	.086	1.17
Officer race	.118	.061	1.12	.118	.061	1.12	.119	.061	1.12
Officer experience	−.005	.004	.99	−.006	.004	.99	−.005	.004	.99
Colorado Springs	−.047	.098	.95	−.093	.098	.91	−.081	.099	.92
Portland	−.381	.069	.68**	−.443	.070	.64**	−.392	.069	.67**
Albuquerque	−.503	.078	.60**	−.561	.078	.57**	−.508	.077	.60**
St. Petersburg	−.873	.077	.41**	−.902	.077	.40**	−.876	.077	.41**
Knoxville	.442	.078	1.55**	.424	.078	1.52**	.441	.078	1.55**
Charlotte-Mecklenburg	1.698	.074	5.46**	1.678	.075	5.35**	1.699	.074	5.46**
Constant	−2.766	.144	.06**	− 2.793	.144	.06**	− 2.420	.216	.08**
Pseudo R Square		.134			.135			.134	
Model Chi-Square		1884.012**			1900.998**			1887.670**	

**$p < .01$.

Table 6 Logistic regression models of any citizen injury (N = 13,128). CED only and CED with other force: compared to CED none (weapons only, chemical only, and impact only)

	Model 1			Model 2			Model 3		
	Reference: weapons only			Reference: chemical only			Reference: impact only		
	B	SE	O.R.	*B*	SE	O.R.	*B*	SE	O.R.
Force									
CED only	.283	.128	1.32*	1.114	.174	3.04**	−.899	.187	.40**
CED with other force	.396	.112	1.48**	1.243	.164	3.46**	−.778	.175	.46**
Other than weapons only	−.256	.101	.77*						
Other than chemical only				.620	.157	1.85**			
Other than impact only							−1.448	.169	.23**
Control									
Citizen resistance	.314	.027	1.36**	.308	.027	1.36**	.316	.028	1.37**
Citizen sex	.597	.062	1.81**	.599	.062	1.82**	.581	.062	1.78**
Citizen age	.013	.002	1.01**	.012	.002	1.01**	.013	.002	1.01**
Citizen alcohol/drug	.320	.050	1.37**	.319	.050	1.37**	.349	.051	1.41**
Citizen weapon	.310	.076	1.36**	.313	.076	1.36**	.281	.076	1.32**
Officer sex	.157	.086	1.17	.152	.086	1.16	.147	.086	1.15
Officer race	.121	.061	1.12	.108	.061	1.11	.106	.061	1.12
Officer experience	−.006	.004	.99	−.005	.004	.99	−.007	.004	.99
Colorado Springs	−.069	.098	.93	−.023	.098	.97	−.083	.098	.92
Portland	−.395	.069	.67**	−.403	.069	.66**	−.447	.069	.63**
Albuquerque	−.519	.077	.59**	−.519	.077	.59**	−.579	.078	.56**
St. Petersburg	−.876	.077	.41**	−.890	.077	.41**	−.896	.077	.40**
Knoxville	.441	.078	1.55**	.428	.078	1.53**	.403	.078	1.49**
Charlotte-Mecklenburg	1.690	.074	5.42**	1.677	.074	5.34**	1.636	.075	5.13**
Constant	−2.537	.172	.07**	−3.347	.207	.03**	−1.293	.224	.27**
Pseudo R-Square		.134			.135			.139	
Model Chi-Square		1889.170**			1900.410**			1960.200**	

*p < .05.
**p < .01.

We begin with Table 4, Model 1, where we estimate the effects of CED only and CED with other force on citizen injury, using the CED none variable as the reference category while controlling for other potential effects (i.e., citizen resistance, sex, age, alcohol/drug, weapon; officer sex, race, experience, and departments). This base model is the most straightforward manner in which to assess the probability of CED use on citizen injuries. As illustrated, both of the CED variables are statistically significant at the $p < .01$ level.[20] Examination of the odds ratio (OR) column shows citizens are 68% more likely to be injured in cases where officers use a CED as the only form of force and 89% more likely to be injured in cases where officers use a CED with another form of force. With the exception of the officer-based variables (i.e., sex, race, and experience) and Colorado Springs, each of the remaining control variables demonstrates a relationship to injuries. Specifically, citizens engaged in higher levels of citizen resistance,[21] were male, older, under the influence of alcohol or drugs, and had a weapon were more likely to sustain an injury, as were cases occurring in Knoxville and Charlotte-Mecklenburg; conversely, cases occurring in Portland, Albuquerque, and St. Petersburg were less likely to result in a citizen injury compared to the reference category (i.e., Columbus). These control variable effects were prevalent also in the subsequent models presented in the following text.

The second model presented in Table 4 breaks the CED with other force variable into three sub-variables (CED with hands, CED with weapons, and CED with hands and weapons) as described in the above-described methodology. This allows one to examine the potential varying effects that other types of force officers use in tandem with a CED have on citizen injuries. All three of these measures are statistically significant. Compared to the cases where officers did not use a CED, encounters where an officer used a CED with hands-on force increased citizen injury by 83%, encounters involving the use of a CED with another weapon increased citizen injury by 91%, and encounters involving the use of a CED in combination with both hands-on and another weapon more than doubled the probability of a citizen being injured.

While the statistical models presented in Table 4 demonstrate CED effects when compared to a broadly classified reference category (i.e., CED none), we also wanted to compare instances when officers used a CED to those instances

20. Given the nested nature of the data (individual cases clustered within agencies), all models were estimated also using a robust variance estimator (i.e., Huber-White Sandwich). The resulting effects or changes in standard errors were minuscule, while all of the significant effects reported in Tables 4–7 remained.

21. We also estimated the model with four dichotomous citizen resistance measures (failure to comply, physical defensive, physical aggressive, and deadly) as opposed to the ordinal measure presented here. The failure to comply variable was not statistically significant, while the physical defensive, physical aggressive, and deadly resistance variables were statistically significant in the expected direction (i.e., more likely to result in injury). Importantly, the reported CED effects (when used alone, as well as when used with other force) remained regardless of the resistance measures used. Given this finding, we rely on the ordinal measure of citizen resistance for all models.

when officers used specific types of hands-on or weapon-based force. In other words, we wanted to know the probability of citizen injury when an officer used a CED in comparison to those cases when an officer used some form of hands-on force (Table 5) as well as the probability of citizen injury when an officer used a CED in comparison to those cases when an officer used some other weapon (Table 6).

The first model presented in Table 5 uses hands only as the reference category. This permits a direct comparison between instances when officers *only* used a CED to those cases where officers *only* used hands-on force.[22] As shown, citizen injuries were 65% more likely when officers used a CED only in relation to hands only. The probability increases to 86% when a CED is used along with other forms of force. To determine if the "type" of hands-on tactics matters, we also estimated models using soft and hard hands only as the reference categories. The soft-hand model presented in Model 2 shows that the probability of citizen injury increases to 84% when officers used a CED only compared to using soft-hand force only, and 107% when officers used a CED with other forms of force compared to using soft-hand force only. The hard-hand model presented in Model 3 shows there is no statistical difference between CED cases and hard hands only cases (i.e., the probability of injury is similar).

A similar strategy is employed in Table 6, but comparing CED cases to instances when officers used other types of weapons. Model 1 uses weapons only (non-CED) as the reference category and shows citizen injuries were 32% more likely when officers used a CED by itself and increases to 48% when a CED is used along with other forms of force. To determine if the type of weapon matters, we also estimated models comparing CED use to those cases when only hand-held chemical spray was used as well as those cases when impact forms of force were used (e.g., baton, bean bag, canine, and firearm). The chemical spray model is presented in Model 2 and shows that citizens are more than three times more likely to be injured when officers use a CED compared to chemical spray. However, when CEDs are compared to impact weapons only (i.e., cases that did not involve a CED or chemical spray) the effects are reversed (Model 3). That is, citizens are significantly less likely to be injured when officers use a CED compared to an impact weapon (e.g., baton, canine, and munitions).

Secondary Supplemental Analyses

In addition to the primary analyses presented above involving any citizen injury, we also estimated the same multivariate base model depicted in Table 4, Model 1, with each of our two injury severity dependent measures (i.e., injury type and hospitalization). Table 7 presents the results of these models. As illustrated,

22. Given the results shown in Table 4, Model 2 with respect to CED use in tandem with all other forms of force being significantly related to citizen injuries, the models presented in Tables 5–7 collapse CED with other force back into one measure as was done in Table 4, Model 1.

Table 7 Ordinal regression models of citizen injury severity. CED only and CED with other force: compared to CED none

	Model 1			Model 2		
	Injury type			Hospital		
	Reference: CED none			Reference: CED none		
	B	SE	*p*	*B*	SE	*p*
Force						
CED only	1.040	.101	.000	.615	.081	.000
CED with other force	.951	.063	.000	.735	.054	.000
Control						
Citizen resistance	.355	.031	.000	.315	.027	.000
Citizen sex	.691	.072	.000	.582	.060	.000
Citizen age	.014	.002	.000	.014	.002	.000
Citizen alcohol/drug	.456	.058	.000	.304	.047	.000
Citizen weapon	.433	.086	.000	.299	.071	.000
Officer sex	.281	.104	.007	.128	.082	.119
Officer race	.109	.076	.150	.121	.059	.040
Officer experience	−.005	.004	.247	−.005	.003	.171
Portland	−.679	.076	.000	−.330	.067	.000
St. Petersburg	−1.049	.084	.000	−.804	.076	.000
Knoxville	.470	.078	.000	.841	.072	.000
Charlotte-Mecklenburg	1.371	.071	.000	1.792	.065	.000
Colorado Springs				.196	.093	.034
Albuquerque				−.376	.075	.000

Table 7 (*Continued*)

	Model 1			Model 2		
	Injury type			Hospital		
	Reference: CED none			Reference: CED none		
	B	SE	*p*	*B*	SE	*p*
Intercept 1	−.743	.231	.001	−1.255	.265	.000
Intercept 2	.332	.230	.150	.120	.264	.648
Intercept 3	4.296	.274	.000			
-2 Log likelihood		13924.029	.000		18583.273	.000
Model Chi-Square		1935.839	.000		2306.260	.000
Pseudo R Square		.170			.161	
N		10,390			13,128	

citizens were more likely to receive a more severe injury in cases where officers used a CED by itself as well as when a CED was used with some other form of force. These findings hold for both measures of severity (i.e., Models 1 and 2). Similar effects (not shown in Table format), in terms of direction and statistical significance, were uncovered when we estimated each of the other models (e.g., those mirroring models presented in Tables 5 and 6) using these two severity dependent variables, with three exceptions.

First, cases involving officers using a CED, both by itself and along with other force, were more likely to result in a more severe injury type compared to cases where officers used only hard-hand force. Recall in the any injury comparison (Table 5, Model 3) there was no significant injury difference found between these two forms of force. Second, there was no statistical difference in injury type when comparing CED usage cases (when used alone or with other force) to those cases involving impact weapon only cases. Recall in the any injury comparison (Table 6, Model 3) CEDs were associated with less injuries. Third, cases involving officers using a CED with another form of force were more likely to result in a more serious injury compared to hard-hand force only when using our hospitalization outcome measure. Recall in the any injury comparison (Table 5, Model 2) there was no significant injury difference found between these two forms of force. Overall, when seriousness is taken into account, within the context of the two different forms of severity presented here, the relationship between CEDs and citizen injuries becomes an even more pressing concern when considered along with the primary findings involving any citizen injury.

Given the multitude of analyses presented, Table 8 provides a summary assessment of the multivariate statistical findings for all three outcome measures. As shown, 33 of the 42 comparisons demonstrate that the use of a CED significantly increased citizen injuries. In five of the comparisons, no statistical difference in injuries was found. In the remaining four comparisons, CEDs decreased the probability of citizen injuries.

Table 8 CED and citizen injury statistical significance summary findings

	CED only			CED with other force		
Comparison	Any injury	Injury type	Hospital	Any injury	Injury type	Hospital
No CED	Increase	Increase	Increase	Increase	Increase	Increase
Hands only	Increase	Increase	Increase	Increase	Increase	Increase
Soft hands only	Increase	Increase	Increase	Increase	Increase	Increase
Hard hands only	Null	Increase	Null	Null	Increase	Increase
Weapon only	Increase	Increase	Increase	Increase	Increase	Increase
Chemical spray only	Increase	Increase	Increase	Increase	Increase	Increase
Impact only	Decrease	Null	Decrease	Decrease	Null	Decrease

Conclusion

The salience of the present inquiry emerges in light of advocacy claims concerning the use of CEDs and citizen injuries, but more importantly from the limited body of research that has produced inconsistent results and suffers from a number of documented drawbacks. In terms of our primary analyses involving any citizen injury, the findings show that CEDs were associated with a significantly higher probability of injury compared to cases when no CED was used. Additional analyses most often revealed an increased likelihood of citizen injury when comparing CEDs to varying forms of both hands-on physical force and other weapons. The only time we found a decreased probability associated with the use of CEDs was when we compared them to impact weapons; and the only time we found a similar injury risk was when comparing CEDs to hard-hand tactics. When varying forms of injury severity were examined, many of the same CED effects were uncovered, but in the form of more severe injuries.

In summary, the decision to use a CED over another form of force most often resulted in an elevated risk of citizen injury. While the current inquiry adds to a growing body of research, it is the first to report a fairly consistent increased risk between the use of CEDs and citizen injuries. As such, recent policy recommendations made by a number of researchers (MacDonald et al., 2009; PERF, 2009; Smith et al., 2007), as to how or when to use CEDs, are premature. More research is needed before deriving any conclusions as to the "safeness" of CEDs in terms of citizen injuries.[23]

Of course, the present study comes with its own set of limitations. Similar to volumes of prior use of force studies, the *Assessing Police Use of Force Policies and Outcomes* project relied on the use of official records collected cross-sectionally. While we did our best to capture available information by gathering both electronic and hard copies of all force incidents, and thus we were able to include a number of additional control measures in our models in comparison to previous studies, further refinement in this area is needed so as to more properly specify the relationship between CEDs and injuries. As previously noted, we were unable to include citizen race in our analyses, given that it was not captured in all use of force reporting across our study agencies. Additional situational variables, such as suspect height and weight, should also be explored which might contribute to more fully specified

23. While we would submit, given findings from the present study, that CEDs may most appropriately be placed at the level of hard-hand tactics (or between hard-hand tactics and the use of other impact weapons) within a force continuum structure, we would caution readers from over-generalizing based on results from one study. Moreover, there are additional factors policy-makers may want to consider before determining CED tactical placement (e.g., officer safety, effectiveness, citizen complaints, public sentiment, etc.). Furthermore, where CEDs are located within a force continuum is more complex than simply placing them either low or high since agency policies vary nationally (Terrill & Paoline, 2006). For example, hard-hand tactics are sometimes placed with soft-hand tactics, as well as any number of other weapon types (e.g., chemical spray, baton, etc.), and can be lower or higher depending on individual policy approaches.

analytic models.[24] In a related manner, two of the agencies also failed to document the type of injury a suspect sustained, which limited our ability to include these cases in the injury-type severity analysis.

By drawing on organizationally derived use of force records, we were also limited to the officers' accounts of the use of force encounter.[25] As a result, our lens into the nature of the force incident is gleaned solely through the eyes of the reporting officer, rather than a neutral third party with no stake in the outcome. Future research that can draw on observational research, in particular, would allow for a comparison of results using different methodologies to determine if similar findings are uncovered. Third-party observation, with a structured seriousness instrument, would allow for an assessment of injury severity among bruises, lacerations, and broken bones in a manner different from the two measures utilized in the current study. For example, one could measure not only the type of injury (e.g., bruise, laceration, and broken bone), but also the degree of severity within injury types. This would permit one to consider a superficial skin bruise differently than a deep bone bruise, a small cut differently than a 20-stitch laceration, and a broken finger differently than a broken leg. Such a methodology would also permit observers to "debrief" officers after force incidents in an attempt to offer more insight as to what constitutes an injury in the officer's view. Moreover, third-party observation might allow also for an examination of intrinsic (i.e., anticipated) and extrinsic (i.e., unanticipated) injuries caused by various forms of force. The present study was unable to account for the appropriateness of injuries that might be associated with each type of force (e.g., a bruise from a strike) versus those that were unexpected (e.g., a broken leg following a chemical spray deployment).

Discussion

The findings uncovered in the current inquiry suggest that CEDs, and the increased risk of injury associated with them, have the potential to threaten Tyler's (1990) notion of police legitimacy in the eyes of the public. This coupled with negative media attention surrounding CEDs (White & Ready, 2009) provide both direct and indirect sources of potential perceptions of public distrust in the police, which

24. Other limitations sometimes associated with cross-sectional research involve data collection over a single-time frame and the use of samples. While we do not measure change in behavior and outcomes over time, our data source included a population of all force incidents over a full two-year period, thereby making the present inquiry less sensitive to these issues.

25. With respect to citizen injury documentation, given that nearly all force incidents resulted in an arrest, external jail intake personnel serve as a second-level check and balance system. That is, arrested suspects are generally inspected for visible injuries for liability purposes (i.e., distinguishing between injuries caused by police versus jails) prior to being admitted to jail facilities. In terms of personal accountability, failure to document one's use of force or resulting citizen injury is far more damaging to the officer than the force applied, the resulting citizen injury, or complaint of injury.

may have implications for citizen cooperation.[26] We call on future researchers to further examine the connection between CEDs and citizen injuries. We believe the manner in which we have approached the present study can help move the debate forward and improve the rigor in which future studies are conceptualized and investigated. The trend toward examining all citizen injuries, as opposed to just serious injury or death, should continue given the rarity of severe injuries. Additional attempts to isolate the impact of CEDs on injuries, while comparing CEDs to a multitude of various alternative force options, also merit future attention. In practice, officers at the street level must decide on any number of force options when dealing with resistant citizens. As a result, analyses that *directly* compare CED injury effects to a variety of physical hands-on force, as well as a variety of other weapon options, are advantageous. Further, researchers should continue to more fully and properly attempt to specify appropriate theoretical relevant control variables in their statistical models. Finally, beyond citizen injuries, researchers should also examine officer injuries in a similarly comprehensive manner. To date, many of the same identified limitations associated with citizen injuries are also relevant to officer injuries.

While our findings diverge from those noted in MacDonald et al. (2009) and PERF (2009), two studies that data-wise most resemble ours (i.e., multiple agencies that employ CEDs, with large sample sizes), we are left wondering whether or not the difference is a function of our more comprehensive analytical models (i.e., multiple use of force comparisons and additional statistical controls), or the manner in which citizen injury has been operationalized. A citizen injury in both of these previous studies was not classified as a citizen injury (even when officers recorded it as one on the official use of force report), if it was the result of a penetrating barb (i.e., laceration) or a burn/abrasion from a drive stun approach. While many of these lacerations and burns/abrasions may not be severe, as are most police inflicted injuries, they still represent an injury. As such, researchers should acknowledge them if they are interested in answering the empirical question regarding whether or not an injury was caused to a citizen as a result of police use of force. How and when this decision was made by social scientists is unknown, but TASER International (2007) themselves, a major CED manufacturer, acknowledges (in print) these lacerations and burns/abrasions as injuries in their training protocol for police departments.[27]

26. The issue of CEDs and compromised public legitimacy can extend beyond resulting *physical* injuries sustained by citizens. Police use of CEDs can also produce social–psychological injuries that are not visible to citizens. For example, instances where lesser forms of force could have been reasonably used (but were not), or cases where the citizen did not actively fight with the police but CEDs were still applied, can damage the public credibility of the police as well. At this time, we can only speculate on this matter, as a direct test of Tyler's (1990) work would require researchers to concentrate on citizen accounts and perceptions of police CED usage over police documentation of these events. We thank an anonymous reviewer for this thought-provoking insight.

27. TASER International (2007, p. 3) notes, in their *Product Warnings-Law Enforcement* publication, instructive warnings regarding probe removal and skin wound treatment. For example, in dealing with probe removal, it states, "In most areas of the body, injuries or wounds caused by TASER probes will be minor. TASER probes have small barbs. There is a possible risk of probes causing injury to blood vessels." Further explanation is offered in relation to treating skin wounds, stating "TASER devices can cause skin irritation, small puncture wounds, friction abrasions, minor burns, etc. As with any injury of this type, in some circumstances infection(s) may occur."

Embedded in this overall decision to exclude some injuries that are caused by CEDs are a number of related concerns. First, as a researcher, if one is going to rely on officer accounts of the use of force incident via an official report (e.g., type of force, level of citizen resistance, citizen sex, race, age, intoxication/drug use, etc.), why change the officer's assessment of citizen injury? If the identical visible mark was made from a handcuffing technique on a resisting citizen (i.e., a cut) or from a fall on the pavement during a takedown (i.e., an abrasion), it would be classified as a citizen injury by the officer and coded as such by the researcher.

A second concern is the way in which some researchers have, in essence, changed the rules for assessing injuries caused by CEDs. One response that the authors of this manuscript heard from an audience member during a recent national conference is that "the probe laceration or drive stun burn/abrasion should not be counted as an injury because that is the intended purpose of the weapon." We disagree with this rationale wholeheartedly, as the intended purpose of the weapon is to incapacitate the individual with the electrical charge, and while the resulting injuries may be somewhat anticipated (i.e., not surprising)[28] they still represent an injury. Another response from a member at this conference was "if we count probe lacerations and drive stun burns/abrasions as injuries, then we would have an injury every time that a CED was effectively utilized." This overgeneralization is not practically nor empirically supported, as CEDs do not always result in such injuries and do not have to touch or penetrate one's skin to be effective. For example, heavy clothing that mediates the CED's electrical charge can prevent these injuries, although the citizen still does feel the impact of the weapon. Moreover, empirically, our results illustrate that a citizen injury did not result from every CED use. In fact, nearly 54.8% of the cases involving a CED did *not* result in an injury.

Finally, and perhaps, most perplexing is how citizen injury assessments also change based on *where* they occur. Both MacDonald et al. (2009) and PERF (2009) explain that they recoded officer classifications of citizen injuries from probe lacerations to "no injury" unless they occurred to unapproved targets (i.e., groin or face).[29] While this reclassification might be appropriate for a

28. The same could be said for baton strikes and firearm use. In this sense, as an anonymous reviewer pointed out, some police-inflicted injuries are intrinsic (i.e., associated with the weapon), while others are extrinsic (i.e., not expected). For example, probe lacerations from a CED would be characterized as intrinsic or associated with the weapon, while a broken arm produced from a fall down a flight of stairs, after a shock from a CED would represent an extrinsic injury. In the end, extrinsic injuries may be subject to more intense review from police officials. In this study, the data do not permit us to distinguish between these types of injuries.

29. The PERF reclassification appears to be incongruent with the way in which they operationally define injuries in their report. According to the authors, suspect injury was coded based on "any impairment of physical condition, or pain due to an officer's actions, including physical damage produced by the transfer of energy, such as kinetic, thermal, chemical, electric, and radiant energy"(2009, p. 51). Also, their reclassification was based on examinations of injury narratives, which "could not be done in all datasets" (2009, p. 48). As such, there appears to be instances in their data where probe lacerations were counted for some departments and not for others. How many departments (and CED cases) were included or excluded is unknown, as such information was not provided.

study devoted exclusively to injury severity, as a CED laceration could reasonably be regarded as more serious when applied to the face or genitals (over an arm or a leg), for a dichotomous classification of injury versus no injury this makes little sense. Thus, not only has the criterion changed for determining a citizen injury based on the weapon itself, but it has also changed depending on the part of the body that came in contact with the weapon.

As a research community, we should collectively decide how we are going to operationalize police-inflicted injuries as a result of CED usage, especially in light of the practical implications of our research. Given the relative infancy of this research area, now is the time to decide so that more informed decisions can be made with respect to the injurious nature of CEDs. If we continue to alter the criteria for assessing injuries based on the weapon itself, or where the weapon is applied, at what point does it stop? Would we, as researchers, change the threshold for determining police deadly use of force based on whether or not citizens were actually struck by the rounds (over discharging it, the current agreed upon standard), or depending on where one was struck (e.g., the mid section versus a limb), or based exclusively on resulting death?

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