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Police Use of Force and Officer Injuries: Comparing Conducted Energy Devices (CEDs) to Hands- and Weapon-Based Tactics

Eugene A. Paoline, III[1], William Terrill[2], and Jason R. Ingram[3]

Abstract

The widespread adoption of conducted energy devices (CEDs) across American police departments over the last decade has been mired in public controversy. It is generally accepted, from a police perspective, that CEDs are safer for officers who can use the weapon at a greater distance, avoiding much of the harm associated with close physical struggles with citizens. Research has generally supported the notion that aggregate levels of officer injuries are reduced following the implementation of CEDs. Unfortunately, multivariate examinations that, in varying degrees, have attempted to compare CED applications to other forms of force (while controlling for rival causal factors) have yet to produce the same consistent results as the pre- and post-CED adoption studies. The current research adds to recent multivariate inquiries by using data collected as part of a national multiagency use of force project to assess the independent effect of CEDs on officer injuries. Based on a series of multivariate models, our results generally find evidence of increased benefits (i.e., lower probability of officer injury) of CEDs when used by themselves. By contrast, in some instances when CEDs were used in combination with other forms of force, there was an increased probability of officer injury. The implications of these findings for police researchers and practitioners are considered.

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One of the mantras in policing is that officers should be safe on the streets (Herbert, 1998). A primary source of officer danger and subsequent injury are citizens, especially those that physically resist during police encounters. While we tend to focus on police use of force against citizens, the reciprocal violence between citizens and officers has been documented as far back as the seminal field work of William Westley (1970) in the 1950s. Even though the majority of police injuries sustained during encounters with citizens are often not serious in nature, they can have a detrimental impact on police agencies (e.g., manpower loss, workers compensation, medical costs, etc.) and individual police officers (e.g., loss of control in encounters, lower morale, etc.; Kaminski & Sorensen, 1995).

In making arrests and dealing with citizens who fight and resist the police, officers are permitted to apply a variety of physical and weapon-based tactics. One such weapon is a conducted energy device (CED). While CEDs have been in operation across American police agencies since the late 1970s, their popularity has increased dramatically (Vilke & Chan, 2007). At the same time, CEDs have been at the center of public controversy, driven largely by concerns over citizen safety (White & Ready, 2009). On the other hand, police agencies generally perceive CEDs as a safe alternative to other means of control in terms of reducing police injuries, as officers can use them at greater distances than hands-on tactics, prevent longer physical struggles, and do not have to worry about potential contamination to themselves (like that of chemical sprays; Adang & Mensink, 2004). While individual police agency reports illustrating reductions in officer injuries following the adoption of CEDs (pre- and post-analyses) have been heavily criticized for their weak research designs (Adams & Jennison, 2007), recent social science research has confirmed the benefits of CEDs, suggesting that aggregate levels of officer injuries are reduced in post-adoption time periods (Lin & Jones, 2010; MacDonald, Kaminski, & Smith, 2009; Taylor & Woods, 2010). Unfortunately, consistent empirical evidence from multivariate examinations has yet to be provided that clearly demonstrates that CEDs decrease the likelihood of police injuries although if one picked up a national police newsletter (either practitioner or funding based) one would read nearly unequivocally that CEDs reduce injuries to police compared to all other less lethal options.

Based on data collected as part of a national multiagency use of force project, the current study aims to add to the burgeoning area of research on CEDs and police officer injuries. In doing so, we seek to clarify the true independent effect of CEDs by assessing instances when they are used alone (compared to other forms of force) as well as when they are used in conjunction with other forms of force. Our analyses also systematically incorporate statistical controls (e.g., citizen resistance as well as other citizen and officer factors) allowing for a clearer picture of the relationship between CEDs and injuries to police.

We begin with a discussion of CEDs as a recent widespread addition to the use of force spectrum. Next, we review studies that assess the relationship between CEDs and officer injuries, which is followed by a discussion of how the current empirical inquiry addresses the limitations of this previous work. Following an explanation of the methodology, we present a series of multivariate analytical models that explore the impact of CEDs, compared to other forms of force, on injuries to police officers. Finally, the implications of these findings for police researchers and practitioners are considered.

Conducted Energy Devices (CEDs)

A comparatively recent addition to the use of force spectrum has been conducted energy devices (CEDs). CEDs, of which TASER® (Thomas A. Swift Electrical Rifle) and *Stinger* are the two most popular manufacturers, produce an electrical charge of up to 50,000 volts, operating in one of two primary ways (Vilke & Chan, 2007). The most common deployment of a CED is the firing of the handgun-like weapon from distances up to 25 feet from the subject where two steel probes/barbs/darts are propelled and attach to the body (via a wire) to disperse an electrical current for approximately 5 seconds (The U.S. Government Accountability Office, 2005). This approach is designed to incapacitate an individual by overriding his or her central nervous system, as it creates a feeling that all of one's "muscles are contracting at once" (Vilke & Chan, 2007, p. 349). An alternate deployment method is the "drive stun" approach where the weapon is placed directly against the subject in a stunning manner (Bozeman et al., 2009). Whereas the probed method is intended to fully incapacitate the individual in gaining compliance, created largely by the transmission of the electrical current across the distance of the two probes, the less powerful drive stun approach, with its contacts much closer in length, operates as more of a pain compliance tactic (Adams & Jennison, 2007; Donnelly et al., 2002).

The popularity of CEDs among the law enforcement community has grown immensely over the past 10 years. As a primary police weapon, batons have essentially been replaced by CEDs (Terrill & Paoline III, 2006). In fact, the National Institute of Justice (2008) recently reported that approximately 11,500 police departments are using CEDs, with roughly 260,000 being issued to officers on the street. Moreover, in a national survey of police agencies, as part of the research project from the current study, roughly 80% of the responding 662 agencies reported that they were currently using CEDs (Terrill, Paoline III, & Ingram, 2012).

Despite their widespread adoption and popularity, CEDs have also been engulfed in public controversy that has polarized opinion between the potential for injuries/deaths to citizens (White & Ready, 2009) versus the enhanced safety for police officers (Vilke & Chan, 2007; U.S. Government Accountability Office, 2005). Efforts to empirically inform both sides of the debate have suffered from some well-documented shortcomings (Adams & Jennison, 2007; Kaminski, 2009; White & Ready, 2010). Unfortunately, we also find that examinations of CEDs and injuries often fail to devote

the detail and attention needed to tease out the independent effects on either side, instead choosing to provide analyses of officers along with suspects.

CED and Officer Injury Research

A great deal of what is "known" about the effects of CEDs on officer injuries is based on reports from individual police departments that have been compiled from CED manufacturers (e.g., TASER International, 2009). Most of these reports illustrate the percentage of officer injuries after the agency implemented CEDs. Cumulatively, these findings reveal that when departments introduce CEDs, there is generally a reduction in officer injuries. While the results appear impressive, the science behind the work has been questioned. As Adams and Jennison (2007) conclude, "Unfortunately, most of these statistics derive from weak research designs that reduce confidence in the validity of results" (p. 461). Such claims have helped generate a handful of independent empirical inquiries, designed to present a clearer picture of the impact between CEDs and officer injuries.

One of the recent empirical additions to understanding the relationship between CEDs and officer injuries focuses on statistically modeling (e.g., time series) injuries during uniform time periods before and after the adoption of CEDs. This work goes beyond simply eyeballing injury frequencies from one year to the next in departments that employ CEDs, allowing for a more scientific examination of implementation effects.

MacDonald et al. (2009), using data collected from the Orlando Police Department (OPD) and the Austin Police Department (APD), examined the average monthly incidence of officer injuries during pre- and post-CED adoption. Based on a time-series analysis, the researchers found, over a 108-month period in Orlando and a 60-month period in Austin, that officer injury averages decreased by 62% (in OPD) and 25% (in APD) following CED implementation.

Lin and Jones (2010), relying on use of force incidents over a 5-year period from the Washington State Patrol (WSP), also examined changes in officer injuries following the implementation of electronic control devices (ECDs; a synonym for CEDs). Their approach compared the number of worker compensation claims between sworn (i.e., commissioned WSP officers) and nonsworn (i.e., noncommissioned employees) personnel following ECD adoption. Based on the findings that nonsworn personnel rates of injuries remained constant, while sworn personnel claims for all injuries reduced following ECD adoption, the researchers reported that ECDs reduced officer workplace injuries.

In a similar vein, Taylor and Woods (2010) compared seven police agencies with CEDs to six that did not use them to examine the impact of CED implementation on officer injuries. Using logistic regression, the researchers' analytic models contained an interaction term to measure whether the agency deployed a CED multiplied by the time period (i.e., before or after CEDs were adopted). The authors found that agencies

that were issued CEDs had fewer officer injuries (and injuries that needed medical attention) in the post-period than agencies that did not carry CEDs.

Cumulatively, this line of research finds that when police departments issue CEDs (across various time periods) officer injuries are reduced. While this work is grounded in better analytical techniques, it paints an incomplete picture. That is, these studies do not allow for comprehensive comparisons to other types of force or control for additional theoretically relevant casual factors (i.e., other than time) of officer injuries.[1] Other CED research has attempted to address these concerns by constructing multivariate officer injury models.

The Police Executive Research Forum (PERF; 2009) conducted a series of multivariate analyses designed to assess the relationship between CEDs and officer injuries based on a 13-agency data set (7 agencies with and 6 without CEDs).[2] In their initial analysis of the seven departments that were issued 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 examined with only three suspect-based controls (i.e., race, gender, and age). In their force comparisons, the researchers found the greatest impact on reducing the odds of officer injury for no weapons (i.e., hands-on tactics) followed by CEDs and chemical sprays. Further analyses that combined agencies with and without CEDs (i.e., 10 total) resulted in a few additional statistical controls (i.e., suspect physical aggression and weapon dummy variables), but resulted in the *loss* of comparing different categories of force. These latter analyses revealed, like Taylor and Woods (2010), that agencies with CEDs had a reduced probability of officers being injured and needing medical attention than those that did not issue CEDs.

MacDonald et al. (2009) also conducted multivariate analyses that examined CEDs and officer injuries using data from 12 police departments. In their most inclusive analytical model, the authors included three dichotomous force measures (i.e., CEDs, OC spray, and physical force, which included all other weapons and hands-on tactics), but only three statistical controls (i.e., suspect age, race, and resistance). The researchers found that hands-on force and OC spray resulted in an increased probability of officer injury, while CEDs had no statistical impact.

Finally, Smith et al. (2007) examined use of force data from Richland County Sheriff's Department (RCSD) and the Miami-Dade Police Department (MDPD), with separate analytical models for each agency. Although the variables differed across the two statistical models, the researchers did control for citizen resistance with a series of dummy variables (i.e., passive, defensive, and active) and a multiplicative interaction term (i.e., hard hands and active resistance) for RCSD, while an ordinal citizen resistance variable and a multiplicative interaction term (i.e., hard hands and any suspect resistance) was used for MDPD. In addition, Smith et al. (2007) controlled for six other types of force (i.e., soft hands, hard hands, chemical spray, baton, canine, and firearm) in the RCSD model, and three other types of force (i.e., soft hands, hard hands, and canine) in the MDPD model. Finally, the researchers accounted for situational factors (i.e., number of resistant citizens, deputies, and witnesses) in RCSD,

while in the MDPD model they accounted for citizen (i.e., race, age, sex, and impairment) and officer (i.e., race) factors. In terms of the relationship between CEDs and officer injuries, the authors found that there was no statistical relationship in RCSD, while for MDPD there was a negative relationship, as CEDs were associated with a reduced probability of officer injury.

In summary, an examination of extant CED officer injury research reveals a few interesting conclusions. First, pre- and post-implementation studies generally support the notion that aggregate levels of officer injuries are reduced after CEDs are introduced. Second, once multivariate models are employed, that allow for comparisons across other forms of force and additional statistical controls, the findings are much less clear and conclusive. That is, in some instances CEDs are associated with a lower probability of officer injury and in some cases there is no statistical relationship. Third, even among the studies that account for other types of force, we find, in varying degrees, that these measures do not adequately tease out the pure influence of that given form of force. For example, in some cases physical force is included with the CED deployment measure (and vice versa), which masks the true impact of the given type of force on the officer injury. Moreover, we find that previous research has not adequately (and consistently) controlled for other theoretically relevant causal factors of injuries, such as citizen resistance and other citizen and officer-based measures. Finally, we find a general reluctance to directly compare and test CED weapons against other forms of force beyond one reference category. In the end, while recent multivariate analyses have begun to statistically model the influence of CEDs on injuries to officers, more refinement is needed, which may help produce more consistent results.

The Current Inquiry

In addressing the limitations of previous CED officer injury studies, the current independent empirical inquiry uses data collected as part of a national multiagency use of force study. In examining the influence of CED use on injuries to officers, our analyses are drawn from more than 12,000 use-of-force incidents across six agencies. Similar to previous multivariate examinations, we focus our attention on the probability of officer injury versus the more rare event (which often does not allow enough cases for multivariate analyses)—serious injury.[3] The present study is based on a series of analytical models that clearly isolate CED cases and compare them to instances when officers use hands-on tactics and other weapon types. These analyses also control for levels of citizens resistance, which is an important causal factor of injuries as well as additional citizen- and officer-based measures.

Method

Data

The data for the current inquiry are drawn from the *Assessing Police Use of Force Policy and Outcomes* project, a National Institute of Justice (NIJ) funded study designed to look at a host of use of force issues (e.g., reporting mechanisms, officer

Table 1. Project Sites

	Columbus	Charlotte-Mecklenburg	Portland	Albuquerque	Colorado Springs	St. Petersburg	Fort Wayne	Knoxville
Agency characteristics								
Total No. of sworn officers	1,819	1,638	989	986	669	520	457	382
No. of officers/1,000 pop.	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 pop.	78.8	79.8	65.5	66.9	49.5	76.6	43.6	81.8

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 more than 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 2 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.[4] Third, mid- to large-sized agencies were selected to ensure a sufficient number of force incidents.[5] 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 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% Knoxville. In all, structurally, these eight agencies provide a snapshot of policing across mid- to large municipal departments.

On 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 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.[6] 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 six of the eight Phase 2 agencies and merged into a master SPSS datafile.[7] Albuquerque did not capture officer injuries as part of their use of force reporting system and, unlike the other agencies that provided CEDs to patrol officers, Fort Wayne only issued CEDs to emergency response team officers. Thus these two agencies are excluded from the analyses. Each of the remaining 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, which serves as the unit of analysis.[8] The threshold for reportable force involved any hands-on physical force above handcuffing/simple restraint as well as the use of any weapon.[9]

Officer injury. Our primary dependent variable is officer injury, which is measured dichotomously (no injury/injury). Each of the included study sites' use-of-force reporting system asked officers to indicate whether they were injured. There was no explicit direction in the policy guidelines to designate the criteria individual officers were to apply to determine injury. According to queries with officials across the sites, each officer was provided the discretionary power to determine injury, based on his or her assessment. Thus the injuries analyzed as part of this inquiry are considered injuries by police personnel, as opposed to a determination made by the authors.

Force measures. To ensure that force types are comparable across agencies, common measures of force were created and divided into hands-on and weapon-based measures. Hands-on weaponless tactics include firm grips/escorts (e.g., grabbing, holding, 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, leg sweeps to the ground), and empty hand/leg strikes (e.g., punching, kicking). Weapon-based tactics include handheld chemical spray (e.g., Oleoresin Capsicum), baton (e.g., expandable ASP), conducted energy devices (CED; e.g., TASER), munitions (e.g., beanbag), canines, and firearms.[10]

After splitting force tactics into hands-on and weapons-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 none* variable was then split into two subvariables. First, a *hands-only* variable was created to indicate those cases where the officer only used some form of hands-on force. Second, a *weapons-only* variable was created to indicate those cases where the officer only used a weapon (other than a CED).[11]

The importance of these variable splits should not be understated as they allow us to address one of the primary deficiencies of past studies by isolating and teasing out the influence of CEDs on officer injuries. Moreover, these specific measures of force allow one to properly assess the relative impact of each on officer injuries. 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., CED cases vs. those where no CED was used, CED cases vs. those where only hands-on tactics were used, and CED cases vs. those where only another type of weapon was used).

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 on 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., those variables collected by the study agencies), we are able to include nine control measures (i.e., citizen resistance, sex, age, alcohol/drug, weapon, officer sex, race, experience, and site).

In relation to the citizen-based variables, resistance serves as a key control as presumably the more aggressive a citizen is toward an officer, the greater the likelihood of injury (Terrill, 2001). As such, we first measured resistance ordinally (used in the analyses presented in Table 4). Failure to comply includes both passive (i.e., citizen 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, pull away from officer's grasp). Physical aggressive resistance includes a citizen either attempting or actually attacking or striking an officer (e.g., lunging toward the police, striking police with hands, fists, kicks). Finally, deadly resistance includes attempts or actual attacks that could cause death. In addition to this ordinal measure of resistance, we also use a dichotomous measure of physical resistance (defensive/aggressive), which is used in the analyses presented in Table 5.

Citizen sex, age, alcohol/drug use, and weapon possession are also included as controls. Varying forms of these measures have been included in previous examinations regarding officer injuries (e.g., MacDonald et al., 2009; PERF, 2009; Smith

et al., 2007) as well as broader use of force research (Terrill & Mastrofski, 2002).[12] Three primary officer-based characteristics are also included that have been part of previous empirical studies of police behavior in general (Riksheim & Chermak, 1993), the use of force (Paoline III & Terrill, 2007; Worden, 1996), and CEDs and officer injuries (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 in injuries to officers. Finally, site is included to account for potential confounding agency effects. Given that there are six departments in the analyses, five dichotomous variables are included in the models with Columbus (having the most cases) serving as the reference category.

Analyses and Findings

We examine the relationship between CEDs and officer injuries in two primary ways. In our first set of analyses we take an inclusive approach by examining all cases across the six cities. Here we rely on an ordinal measure of citizen resistance (our key control measure), positing that the more aggressive a citizen is toward an officer, the greater the likelihood of injury. In the second set of analyses, we restrict the number of cases to those where a citizen engaged in some form of physical resistance (i.e., defensive or aggressive). Based on results from our national survey of police agencies (Terrill et al., 2012) regarding use of force policies, we found that few agencies permit officers to use a CED on citizens who only passively or verbally resist police control (i.e., failure to comply), and few agencies that restrict CED use to deadly force situations. Thus most agencies, including the six examined here, primarily permit the use of CEDs when officers are faced with physically resistant citizens. Restricting cases in this manner (i.e., the second set of analysis) allows for a more conservative test of the relationship between CEDs and officer injuries. Hence, if similar findings are uncovered in both sets of analyses, we can have greater confidence as to the robustness of the effects.

Table 2 provides an overview of model variable coding descriptions, means, and standard deviations of model variables. When considering the total number of cases across the six cities, officers reported being injured 9.9% of the time (1,236 of 12,455 force cases).[13] When the number of cases are restricted to those involving physical resistance the percentage increases slightly to 11.6% (1,126 of 9,679 cases).

As presented in Table 3, when all cases are considered, officers were injured 5.0% of the time (37 of 735 encounters) when using a CED only, 14.2% of the time (222 of 1,567 encounters) when using a CED with some other form of force, and 9.6% of the time (977 of 10,153 encounters) when no CED was used. When cases are restricted to physical resistance cases, officers were injured 5.7% of the time (35 of 610 encounters) when using a CED only, 14.8% of the time (205 of 1,384 encounters) when using a CED with some other form of force, and 11.5% of the time (886 of 7,685 encounters) when no CED was used. For cases not involving a CED, further examination shows that the percentage of officer injury when using only hands-on force ranges from

Table 2. Variable Coding and Descriptive Statistics

Variable	Coding description	All forms of citizen resistance included		Only physical citizen resistance included	
		Mean	*SD*	Mean	*SD*
Dependent					
Officer injury	1 = *Injury*, 0 = *no injury*	.10	.29	.12	.32
Independent					
CED-only	1 = *CED only*, 0 = *all other*	.06	.23	.06	.24
CED with other force	1 = *CED with other force*, 0 = *all other*	.13	.33	.14	.35
CED none	1 = *CED none*, 0 = *all other*	.82	.38	.79	.40
Hands only	1 = *Hands only*, 0 = *all other*	.60	.49	.62	.49
Other than hands only	1 = *Non–hands only*, 0 = *all other*	.21	.41	.17	.38
Weapon only	1 = *Weapon only*, 0 = *all other*	.06	.24	.04	.19
Other than weapon only	1 = *Non–weapon only*, 0 = *all other*	.75	.43	.76	.43
Citizen resistance	4 = *Deadly*, 3 = *physical aggressive*, 2 = *physical defensive*, 1 = *failure to comply*, 0 = *none*	2.13	.81	—	—
Citizen aggressive resistance	1 = *Physical aggressive*, 0 = *physical defensive*	—	—	.43	.50
Citizen sex	1 = *Male*, 0 = *female*	.84	.36	.84	.37
Citizen age	Years (7-84)	29.85	11.08	29.69	10.98
Citizen alcohol/drug	1 = *Alcohol/drug*, 0 = *other*	.29	.45	.31	.46
Citizen weapon	1 = *Citizen weapon*, 0 = *other*	.07	.25	.06	.23
Officer sex	1 = *Male*, 0 = *female*	.94	.24	.94	.24
Officer race	1 = *White*, 0 = *non-White*	.89	.31	.89	.31
Officer experience	Years (0-36)	7.53	5.78	7.35	5.78
Colorado Springs	1 = *Colorado Springs*, 0 = *other*	.06	.23	.07	.25
Portland	1 = *Portland*, 0 = *other*	.17	.37	.15	.36
St. Petersburg	1 = *St. Petersburg*, 0 = *other*	.14	.34	.14	.35
Knoxville	1 = *Knoxville*, 0 = *other*	.07	.26	.09	.28
Charlotte-Mecklenburg	1 = *Charlotte-Mecklenburg*, 0 = *other*	.11	.30	.13	.34
Columbus	1 = *Columbus*, 0 = *other*	.45	.50	.42	.49

10.4% to 11.8%. Thus officers are more than twice as likely to report being injured when using hands-on tactics compared to cases where they rely solely on a CED. Conversely, officers report being injured less often (2.2 to 4.3%) when relying solely on another type of weapon besides a CED (e.g., chemical spray, baton).[14]

To allow for an assessment of independent effects, we then estimated a series of logistic regression models comparing cases when officers used a CED (both by itself

Table 3. Officer Injury by Force Type

Variable	All forms of citizen resistance included			Only physical citizen resistance included		
	Number of cases	Number of injuries	Percentage of injuries	Number of cases	Number of injuries	Percentage of injuries
Force						
CED only	735	37	5.0	610	35	5.7
CED with other force	1,567	222	14.2	1,384	205	14.8
CED none	10,153	977	9.6	7,685	886	11.5
Hands only	7,481	776	10.4	6,002	711	11.8
Other than hands only	2,672	201	7.5	1,683	175	10.4
Weapon only	805	18	2.2	351	15	4.3
Other than weapon only	9,348	959	10.3	7,334	871	11.9

and with other forms of force) to those when no CED was used. This was then broken down even further by comparing cases when officers used a CED (both by itself and with other forms of force) to those when officers relied solely on hands-on force tactics as well as cases when officers relied solely on another type of weapon.[15]

We begin with Table 4, Model 1 where we estimated the effects of CED only and CED with other force on officer 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 department). This base model is the most straightforward manner in which to assess the probability of CED use on officer injuries. As illustrated, both of the CED variables are statistically significant, but in opposite directions. That is, officers were *less* likely to be injured in cases where they used a CED as the only form of force, but *more* likely to be injured in cases where they used a CED with another form of force.

With respect to the control variables, as posited, officers were significantly more likely to be injured as the level of citizen resistance increases (over two and half times more likely). Moreover, officers in each of the cities were more likely to report being injured compared to officers in Columbus (the reference category). Conversely, officers were less likely to be injured when citizens displayed signs of alcohol or drug use. With a few exceptions, these control variable effects were prevalent in many of the subsequent models.

While Model 1 demonstrates CED effects when compared to a broadly classified reference category (i.e., CED none), we also wanted to compare instances where officers used a CED to those instances where they specifically used either hands-on tactics or another type of weapon. Thus Model 2 uses hands only as the reference category, which permits a direct comparison between instances where officers used a CED (both by itself and with other forms of force) to those cases where officers only used hands-on force. As shown, officers were significantly less likely to be injured when using a

Table 4. Logistic Regression Models of Officer Injury: Including All Forms of Citizen Resistance (N = 11,733)

	Model 1			Model 2			Model 3		
	Reference: No CED			Reference: No CED Hands only			Reference: No CED Weapon only		
	B	*SE*	O.R.	*B*	*SE*	O.R.	*B*	*SE*	O.R.
Force									
CED only	–1.093	.189	0.34**	–1.174	.190	0.31**	.290	.331	1.34
CED with other force	.181	.085	1.20*	.102	.088	1.11	1.597	.288	4.94**
Other than hands only	—	—	—	–.299	.089	0.74**	—	—	—
Other than weapons only	—	—	—	—	—	—	1.468	.280	4.34**
Control									
Citizen resistance	.969	.049	2.64**	.978	.049	2.66**	.979	.049	2.66**
Citizen sex	.141	.088	1.15	.161	.088	1.18	.156	.088	1.17
Citizen age	–.005	.003	0.99	–.006	.003	0.99	–.006	.003	0.99*
Citizen alcohol/drug	–.361	.080	0.70**	–.363	.080	0.70**	–.373	.080	0.69**
Citizen weapon	–.204	.124	0.82	–.169	.125	0.85	–.167	.124	0.85
Officer sex	–.232	.120	0.79	–.236	.120	0.79*	–.230	.121	0.79
Officer race	.152	.104	1.16	.149	.104	1.16	.138	.104	1.15
Officer experience	.004	.005	1.01	.005	.005	1.01	.006	.005	1.01
Colorado Springs	.997	.143	2.71**	1.020	.143	2.77**	1.100	.144	3.00**
Portland	.446	.105	1.56**	.496	.106	1.64**	.463	.106	1.59**
St. Petersburg	.540	.103	1.72**	.569	.103	1.77**	.535	.103	1.71**
Knoxville	.490	.111	1.63**	.489	.111	1.63**	.487	.111	1.63**
Charlotte-Mecklenburg	.520	.103	1.68**	.535	.103	1.71**	.548	.103	1.73**
Constant	–4.556	.229	.01**	–4.549	.230	.01**	–6.025	.364	0.01**
Pseudo *R*-squared		.050			.051			.053	
Model chi-square		597.079**			608.877**			638.720**	

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

CED only in relation to hands only, while there was no difference in injury when a CED was used along with other forms of force. Furthermore, Model 3 uses weapons only (non-CED) as the reference category, which permits a direct comparison between instances where officers used a CED (both by itself and with other forms of force) to those cases where officers only used another type of weapon beyond a CED. The results show that there is no difference in the likelihood of officer injury between using a CED only versus any other type of weapon, although there is a greatly increased risk of injury if a CED is used with some other form of force (odds ratio 4.94).

In our second set of analyses (Table 5), we restricted the number of cases to those where a citizen engaged in some form of physical resistance (i.e., defensive or aggressive). Once again we estimated three models. In Model 1 we compare the effects of officers using a CED (both by itself and with other forms of force) to those when no

CED was used, which serves as the reference category. Similar to results from the earlier inclusive model, officers were less likely to be injured when using a CED only in comparison to cases where no CED was used; however, cases where officers used a CED along another form of force resulted in no difference in injury probability compared to instances when no CED was used. This same finding holds in Model 2, when the hands-only variable serves as the reference category. When cases involving a CED-only are compared to cases where officers only use some other weapon type (Model 3) there is no statistical difference in injury probability although there is a greatly increased risk of injury if a CED is used with some other form of force (odds ratio 3.40).

Conclusion

The aim of this article was to add to the burgeoning area of empirical inquiry on the potential relationship between CEDs and officer injuries. In doing so, a number of important findings were uncovered. First, officers experienced a significantly lower probability of injury when using a CED only compared to instances when no CED was used. However, if officers ended up using a CED along with some other type of force, the reduced likelihood of injury dissipated and, in some cases, increased (i.e., resulted in an enhanced risk of injury) as evidenced in Table 4, Model 1. Second, when CED-only cases were compared directly to cases involving hands-only tactics, we again found a reduced likelihood of officer injury. Thus, all else being equal, if an officer is trying to decide whether to use a CED or go hands-on, our findings show there is a benefit to using a CED (at least in terms of officer injury) so long as no other force is used along with the CED. Third, the probability of officer injury was similar when comparing cases where a CED was used alone to those cases where another weapon was used alone. That is, there was no enhanced benefit to using a CED by itself in relation to another weapon type by itself. Nonetheless, it is important to note, as illustrated earlier (note 15), that a large majority of hands-on and weapons-only cases involved soft hand tactics and chemical spray, respectively. Thus we have greater confidence that the use of a CED compared to a soft hand tactic (rather than a hard hand tactic) is less likely to be associated with an officer injury. Similarly, we have greater confidence that the use of a CED and chemical spray (rather than other impact weapons) yield a similar injury probability. Finally, if officers ended up using a CED along with another form of force, the risk of injury was greatly enhanced (nearly four to five times more likely) compared to using another type of weapon (e.g., chemical spray, baton).

Discussion

The findings of the current study have implications for both police administrators and researchers when viewed from an officer safety perspective. A strength of the study is that it directly compares the use of CEDs against multiple alternative force options

Table 5. Logistic Regression Models of Officer Injury: Restricting Citizen Resistance to Physical (N = 9,372)

	Model 1			Model 2			Model 3		
	Reference: No CED			Reference: No CED hands only			Reference: No CED weapon only		
	B	*SE*	O.R.	*B*	*SE*	O.R.	*B*	*SE*	O.R.
Force									
CED only	–1.086	.196	0.34**	–1.157	.197	0.31**	–0.027	.334	0.97
CED with other force	.139	.089	1.15	0.069	.092	1.07	1.224	.289	3.40**
Other than hands only	—	—	—	–0.273	.094	0.76**	—	—	—
Other than weapons only	—	—	—	—	—	—	1.121	.280	3.06**
Control									
Citizen aggressive resistance	1.017	.069	2.76**	1.033	.069	2.81**	1.020	.069	2.77**
Citizen sex	0.140	.091	1.15	0.158	.092	1.17	0.150	.091	1.16
Citizen age	–0.004	.003	0.99	–0.004	.003	0.99	–0.005	.003	0.99
Citizen alcohol/drug	–0.396	.083	0.67**	–0.399	.083	0.67**	–0.401	.083	0.67**
Citizen weapon	–0.046	.139	0.95	–0.023	.139	0.97	–0.047	.139	0.95
Officer sex	–0.231	.124	0.79	–0.232	.125	0.79	–0.227	.125	0.79
Officer race	0.191	.109	1.21	0.190	.109	1.20	0.181	.109	1.19
Officer experience	0.006	.006	1.01	0.006	.006	1.01	0.007	.006	1.01
Colorado Springs	1.008	.148	2.74**	1.031	.148	2.80**	1.087	.150	2.96**
Portland	0.457	.111	1.57**	0.503	.112	1.65**	0.473	.111	1.60**
St. Petersburg	0.525	.110	1.69*	0.553	.110	1.73*	0.518	.110	1.67*
Knoxville	0.455	.117	1.57**	0.457	.117	1.57**	0.455	.117	1.57**
Charlotte-Mecklenburg	0.533	.106	1.70**	0.546	.106	1.72**	0.548	.106	1.73**
Constant	–2.720	0.203	0.07**	–2.699	0.204	0.14**	–3.813	0.343	0.02**
Pseudo *R*-squared		.066			.068			.070	
Model chi-square		323.258**			332.069**			345.088**	

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

in terms of the likelihood of officer injury. The findings show that officers were less likely to be injured when using a CED by itself compared to instances where no CED was used, or when only hands-on tactics were used. These specific findings highlight the potential benefits of CEDs in certain instances. However, the use of CEDs was not found to lead to lower risk of officer injuries when compared to cases where other types of weapons were used, suggesting that CED usage should not necessarily be advocated at the expense of alternative weapon-based tactics.

The results also indicate that when officers used a CED in combination with other force options, there was some elevated risk of being injured. Although this type of force could not be further parsed out for empirical modeling (see note 11), a further look at this category sheds additional insight into the nature of these encounters. Recall from Table 3 that there were 222 injuries (i.e., approximately 14%) for the CED with other force category. A closer examination of these cases (not presented in Table 3) revealed that a large majority of these injuries were the result of the use of CEDs in combination with hands-only tactics. In these types of encounters, the results could be interpreted in one of two ways. First, officers may have chosen to rely on CEDs early on and then had to move to hands-on tactics, which could be an indication that CEDs were initially ineffective at controlling the suspect. On the other hand, officers may have chosen to go hands-on early on in the encounter and then had to resort to using CEDs. This could indicate that CEDs had to ultimately be relied on to gain control of the suspect, and perhaps there would have been an added benefit (e.g., reduced chance of officer injuries) of using CEDs earlier during the encounter.

Future research could examine these potential issues by focusing on how the effectiveness of CEDs (e.g., White & Ready, 2010) in force encounters affect officer injuries. Moreover, while beyond the scope of the current study, past research has also identified factors that are associated with effectiveness, such as officer proximity to the suspect and whether CED probes struck the intended target (White & Ready, 2010). Applied to the current inquiry, if officers relied on CEDs when in close proximity to suspects while foregoing other close range tactics, CEDs may have been ineffective and could have increased the likelihood of officer injuries. Conversely, resorting to CEDs in close range encounters, in lieu of hands-on tactics, might decrease the likelihood of officer injuries. Examination of such possibilities in future studies may provide specific information that could be useful for use of force training programs.

The results of this research also have implications for theoretical frameworks of police behavior that utilize independent variables from different levels of explanation (i.e., situational, individual, organizational, and community; Snipes & Maguire, 2007). More directly, the ability to decipher the force option(s) that lead to a higher (or lower) probability of injury to the officer offers an additional situational factor to consider in explanations of the use of force. Injury probability assessments could work to compliment previously noted situational "threats to safety," which tend to focus on grave danger/injury (e.g., presence of a weapon; Terrill, 2001). As such, there could be a lower level evaluation by officers in terms of whether or not to use force as well as which option to utilize (e.g., wrestling a suspect to the ground vs. the use of a CED).

While this study sheds light on the impact of CEDs on officer injuries, compared to other forms of force and controlling for rival causal factors, it is not without limitations. The data are based on official police records, and as a result, are self-reports. Moreover, we are limited to the information captured on the use of force reporting forms. This affected the ability to capture information on injuries beyond mere presence (i.e., injury/no injury), as departments did not systematically document the type and severity of officer injuries. Additionally, the current study could only incorporate control measures that were captured on the official reports. While every effort was made to gather as much information as possible either electronically or through the coding of paper copies, there were certain factors found by prior research to be associated with the nature of force usage and officer injuries that could not be incorporated in the present inquiry. Most notably, suspect race, height, and weight could not be reliably captured across departments and, therefore, were not included.

Future research might address these limitations by incorporating alternative data collection strategies, beyond official records, into the study of CEDs and officer injuries. For example, interviews could be conducted with officers to determine the presence, type, and severity of injuries sustained from force encounters. This approach could provide a better understanding of the nature and extent of officer injuries, and could serve to qualitatively describe the serious injuries encountered by officers that were not analyzed in the multivariate models presented in the current study. Observational research could also be conducted to collect additional factors (e.g., whether the injury was preventable, the psychological impact of the injury on officer attitudes and behaviors, etc.) that are not available from official forms. Observational approaches conducted by independent parties could also serve to verify officers' own accounts of force encounters.

Collectively, the results of this study also illustrate that CED usage is not a panacea for eliminating the risk of officer injuries. The results did show that injuries were reduced when CEDs were used alone compared to hands-only tactics. However, use of CEDs were no more likely to reduce the risk of officer injury when compared to other weapon tactics, while sometimes increasing the risk of injury when used in combination with other force options. In this regard, the results have implications for police administrators that mirror those provided by prior research on CEDs and citizen injuries. Just as these studies have cautioned against the overuse of CEDs against citizens (e.g., PERF, 2009; Smith et al., 2007), the current findings suggest that officers should not overrely on CEDs at the expense of other viable (and appropriate) force options, particularly other weapon-based tactics. Although descriptive results indicated that officers used CEDs at a rate similar to other weapon-based tactics (both were approximately 20%), and at a much lower rate than hands-on tactics, the potential for overreliance on CEDs was a concern voiced anecdotally by some police supervisors across the study departments. With respect to officer safety, the findings highlight the importance of both considering and being skilled at the full range of force options available to officers.

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Notes

1. The one exception was Taylor and Woods (2010) who controlled for whether the agencies were issued CEDs and suspect race, age, and gender. The researchers did not control for other types of force, officer factors, or citizen resistance.
2. This was the same data set that Taylor and Woods (2010) utilized to assess pre- and post-CED implementation effects.
3. While Smith et al. (2007) and MacDonald et al. (2009) did not analyze officer injury severity, PERF (2009) attempted to model them in terms of "hospitalization" and "serious injuries," which produced just one statistically significant predictor across six separate analyses (i.e., physically resistant suspects increased the probability of officers being hospitalized). In a latter analysis of PERF data, Taylor and Woods (2010), correcting for nested errors, also found one statistically significant predictor of police hospitalization and serious injury (i.e., encounters with White suspects decreased the probability of officer hospitalization). In both analyses of PERF data, no use of force variables were statistically related to either police hospitalization or serious injury.
4. The overarching goal of the *Assessing Police Use of Force Policy 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 officer injuries as a collective whole.
5. While larger type agencies were included in the study (i.e., Charlotte-Mecklenburg and Columbus), a deliberate attempt was made to avoid the "largest" U.S. 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).
6. The exact two-year study period varied per agency, with a range of December 2004 to April 2008.
7. 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 only maintained 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.

8. Importantly, each individual officer involved in using force on each individual suspect filed a force report indicating the actions he or she faced from the suspect, the type of force he or she used, and any resulting injury to him or herself. Thus, if an officer used force on multiple suspects, multiple force reports were filed and analyzed since different forms of resistance, force, and injury may have occurred. Similarly, if multiple officers used force on one suspect, multiple reports were filed and analyzed.
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 only used 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. If officers filed reports where "only" simple restraint and/or the drawing of a firearm were documented, we excluded these from our analyses to ensure we had a consistent and comparable threshold.
10. Each of these includes actual use. That is, an officer had to deploy a CED either through the drive stun or probe mode to be coded as use. Simply drawing the weapon and/or threatening a citizen did not get counted as use.
11. We considered parsing the hands and weapons only variables further (e.g., chemical spray only or impact weapon only), but the number of injuries simply became too small for any sort of meaningful analyses. For example, there were but nine cases of officer injuries involving chemical spray only. Similarly, there were only nine cases of officer injuries involving an impact weapon only.
12. Citizen race, which has been found to be a predictor of officer use of force but not in examinations of CEDs and officer injuries, 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 citizen weight (as well as height) may affect officer injury as well. Unfortunately, we did not have a consistent measure of these variables to include them in our models.
13. Comparatively, Smith et al. (2007) found that 10% of officers were injured in Richland County, while 17% of officers were injured in Miami-Dade; PERF (2009) reported officers being injured 8.3% of the time in their post-CED-only sites; and MacDonald et al. (2009) reported officers being injured 13.8% of the time.
14. Data limitations preclude any sort of meaningful analysis with respect to serious injuries (i.e., due to lack of variation). First, officers did not list the type of injury received or simply labeled it as "other" in nearly 40% of the cases. Second, of the 766 cases where the officer specified the injury type, 97.8% were listed as abrasions, bruises, or lacerations (with no indication as to the seriousness of these). Failure to document the extent of abrasions, bruises, and lacerations has been noted by researchers as an impediment to constructing a seriousness injury scale (Terrill & Paoline, 2012). Furthermore, there were just 17 cases involving broken bones, a usually agreed upon classification of injury seriousness (none of which occurred when officers used a CED-only, while four occurred when a CED was used along with another form of force).
15. A large majority (86.7%) of hands-on force cases involved soft hand tactics (e.g., grabbing, pushing) as opposed to hard hand tactics (e.g., punching, hitting). Similarly, a large

majority (75.0%) of non-CED weapons cases involved chemical spray (e.g., Oleoresin Capsicum) as opposed to other impact weapons (e.g., baton, beanbag).

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