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Research for Practice



The Effectiveness and Safety of Pepper Spray

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Findings and conclusions of the research reported here are those of the authors and do not reflect the official position or policies of the U.S. Department of Justice.

The North Carolina study discussed in this report, "An Evaluation of Oleoresin Capsicum (O.C.) Use by Law Enforcement Agencies: Impact on Injuries to Officers and Suspects," by J. Michael Bowling and Monica Gaines, was supported by NIJ under award number 1997-LB-VX-K018.

The in-custody deaths study discussed in this report, "Deaths in Police Confrontation When Oleoresin Capsicum is Used," by Charles S. Petty, was supported by NIJ under purchase order number 2001-M7-56.

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ABOUT THIS REPORT

This report presents the findings from two recent unpublished NIJ-funded studies that used different methodologies to test pepper spray's safety and effectiveness. One study looked at officer and suspect injuries in three North Carolina police jurisdictions before and after pepper spray was introduced. The other examined the deaths of 63 suspects held in custody after pepper spray was used in their arrest.

What did the researchers find?

- The North Carolina study found that the number of injuries to police officers and suspects declined after pepper spray was introduced. Complaints that the police used excessive force also declined.
- The study of in-custody deaths concluded that pepper spray contributed to death in two of the 63 cases, both involving people with asthma. In the other cases, the researcher concluded that death was caused by the arrestee's drug use, disease, positional asphyxia, or a combination of these factors.


What were the studies' limitations?

- In the North Carolina study, procedures for identifying officer and suspect injuries differed considerably from agency to agency and within each agency over time, which limited the extent of the conclusions that could be drawn.
- The number of in-custody deaths in which pepper spray was used in the arrest process is very low, which makes identification of trends difficult.
- Each arrest situation is unique; it is virtually impossible to collect enough nearly identical arrest scenarios with and without pepper spray in the field to conduct a quantitative study.

Who should read these studies?

Law enforcement policy-makers and practitioners, defense and prosecution attorneys involved in pepper spray cases, and medical examiners.

The Effectiveness and Safety of Pepper Spray



Pepper spray, or oleoresin capsicum (OC), is used by law enforcement and corrections agencies across the United States to help subdue and arrest dangerous, combative, violent, or uncooperative subjects in a wide variety of scenarios. Though generally assumed to be safe and effective, the consequences of the use of OC, as with any use of force, can never be predicted with certainty. The need for reassurance on these points remains. This Research for Practice summarizes the results of two unpublished NIJ-funded studies on the safety and effectiveness of pepper spray in real-life arrests and compares them with previous studies. The goal: to expand the scope of knowledge on this complex subject.

One study looked at officer and subject injuries in three North Carolina police jurisdictions before and after pepper spray was introduced. The other examined 63 incidents nationwide in which people were sprayed with OC in the arrest process and later died in custody.

The North Carolina study found that the number of injuries to police officers and suspects decreased after pepper spray was introduced. Complaints that the police used excessive force also declined.

The study of in-custody deaths, which follows a similar study conducted in 1994,¹ concluded that exposure to pepper spray was a contributing cause of death in 2 of the 63 fatalities, and both cases involved people with asthma. In the other 61 cases, death was judged to have resulted from the arrestee's use of drugs, disease, positional asphyxiation (which may occur when subjects are placed in a prone position, typically handcuffed behind the back, in which breathing becomes more difficult), or a combination of these factors.

These findings complement those of another recent experiment that used healthy volunteers who inhaled pepper spray and were then placed in a sitting position or handcuffed in a prone position. The volunteers exhibited

no breathing difficulties in either position.

The North Carolina study

Claims of pepper spray's effectiveness were tested in a 2-year study conducted by a multidisciplinary team of investigators at the University of North Carolina's Injury Prevention Research Center in Chapel Hill, North Carolina. This research sought to assess whether the introduction of pepper spray had reduced the number of—

- Injuries to police officers from assaults.
- Injuries to suspects from police use of force.
- Excessive force complaints against the police.

The records of three North Carolina police departments—the Charlotte-Mecklenburg Police Department (CMPD), the Winston-Salem Police Department (WSPD), and the North Carolina State Highway Patrol (SHP)—were compared for the periods before and after the introduction of pepper spray by each agency. SHP was the first of the three to introduce pepper spray in January 1993. WSPD

and CMPD followed suit in April 1993 and January 1995, respectively.

Data sources

Officer injuries. All information on the use of force by Charlotte-Mecklenburg officers (including injuries to officers and suspects) came from the CMPD Use of Force Database. Information on injuries to Winston-Salem officers and suspects was taken from the Injury Database, 1990–1998. Information on State Highway Patrol officer injuries came from their Worker's Compensation and Medical Only Claims files. Records in which the injury resulted from a motor vehicle crash or actions unrelated to an arrest were excluded. Researchers applied statistical methods to determine whether observed declines in the number of injuries after the introduction of pepper spray were significant enough to be attributed to its use.

Injuries to suspects.

Suspect injury data were available from the Charlotte-Mecklenburg and Winston-Salem police departments. No information was available for injuries to suspects

arrested by the State Highway Patrol.

Excessive force complaints.

Although data on excessive force complaints were collected from all sites, only the State Highway Patrol had data going back far enough to analyze statistically.

Results

Officer injuries. In Charlotte, monthly counts of injured officers declined steadily from 1991 to 1998 (see exhibit 1). This decline began

before pepper spray was introduced and continued at roughly the same rate afterward. Before pepper spray was introduced in Winston-Salem, there were two upward trends in monthly counts of officers injured, the first ending in August 1991 and the second in December 1992. After pepper spray was introduced, officer injuries declined, followed by an increase, then a relatively stable period of low counts beginning in December 1995 (see exhibit 2).

Exhibit 1. Charlotte: Officer injuries

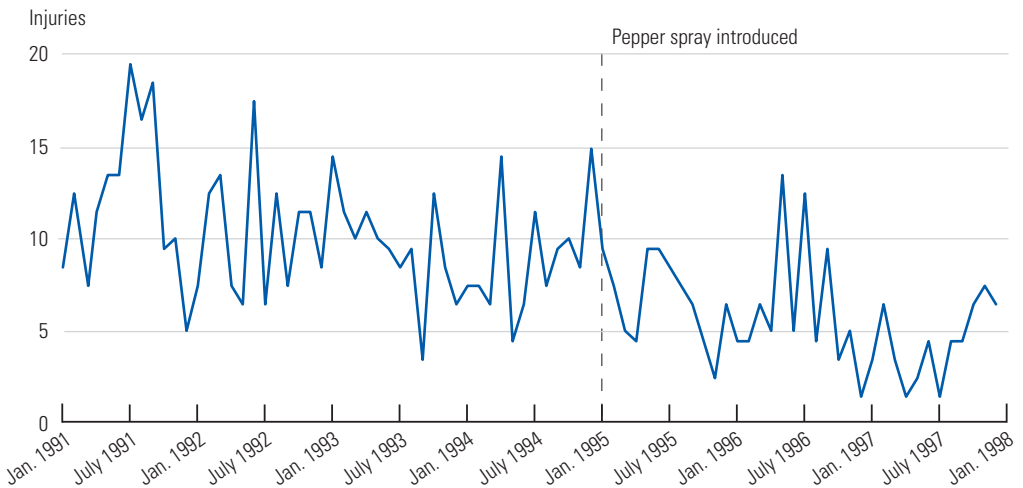


Exhibit 2. Winston-Salem: Officer injuries

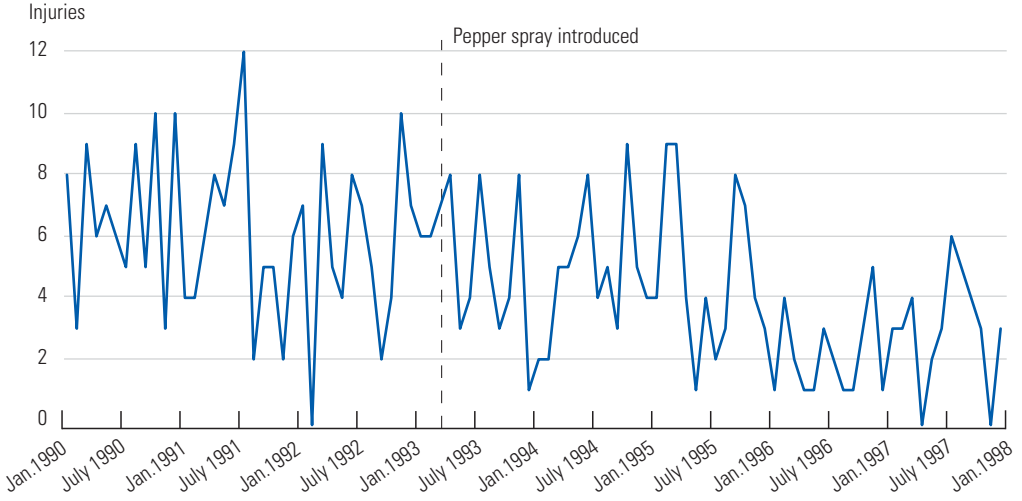
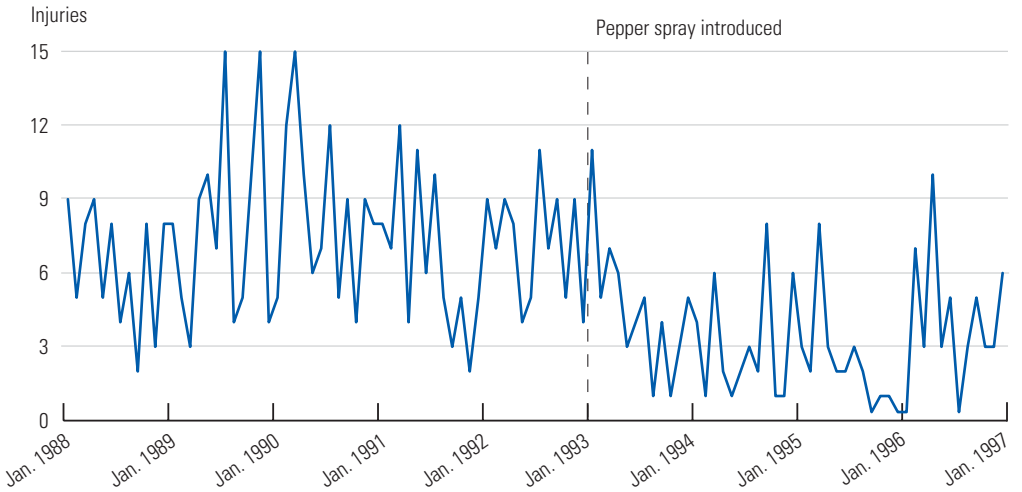


Exhibit 3. State Highway Patrol: Officer injuries



The monthly count of injured State Highway Patrol officers, however, shows a substantial decline that corresponds with the implementation of pepper spray. In 1992, 87 officers were injured, whereas only 58 were injured in 1993, a 33-percent decline over a 1-year period (see exhibit 3).

Suspect injuries. Monthly counts of suspects injured by CMPD officers began falling after the introduction of pepper spray (see exhibit 4). In Winston-Salem, on the other hand, monthly counts of

suspects injured by WSPD officers had already been declining before pepper spray was introduced (see exhibit 5).

Excessive force complaints.

Ninety-four excessive force complaints were filed against State Highway Patrol officers from 1975 to 1998, peaking in 1992—the year before pepper spray was issued. Complaints dropped sharply after the introduction of pepper spray (see exhibit 6).

Thus, the data suggest relationships between the use of

Exhibit 4. Charlotte: Suspect injuries

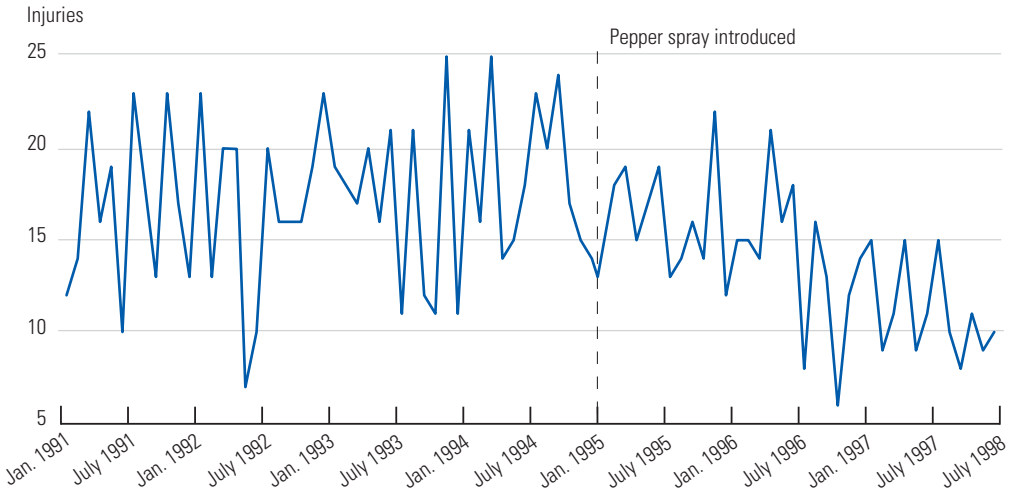


Exhibit 5. Winston-Salem: Suspect injuries

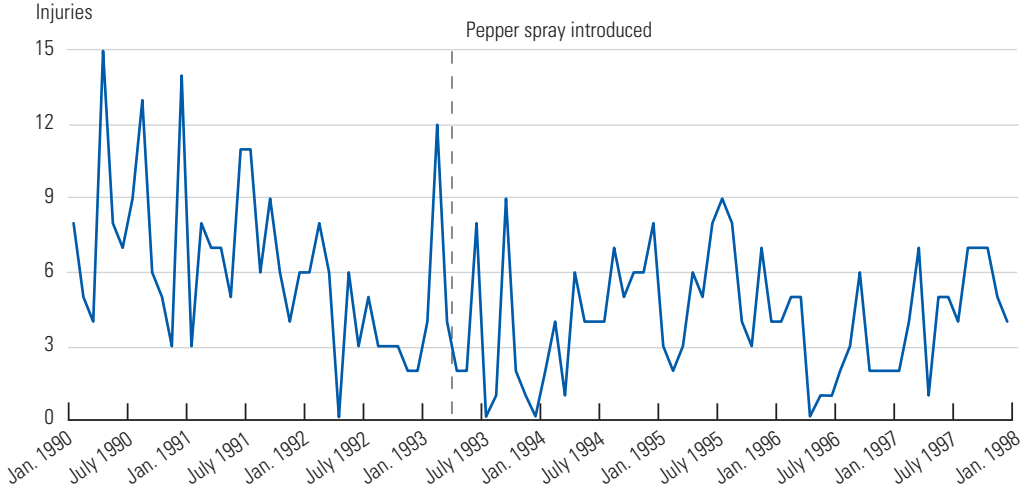
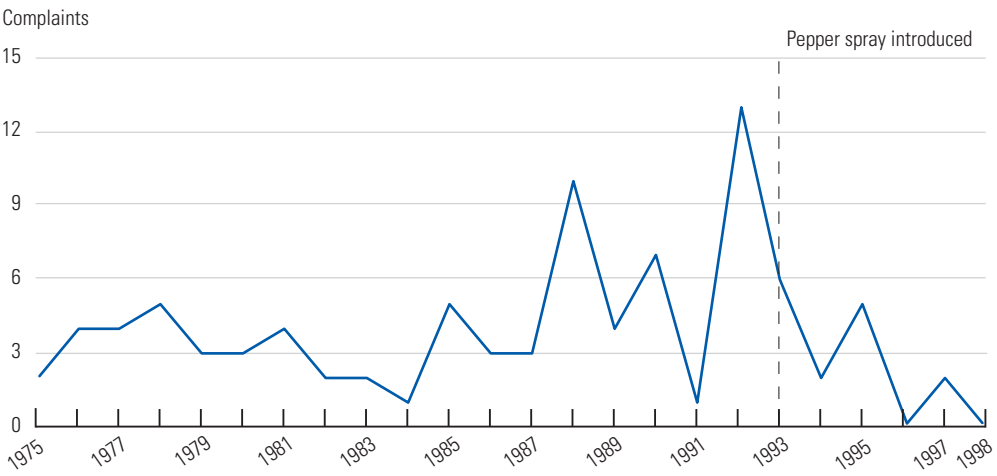


Exhibit 6. State Highway Patrol: Excessive force complaints



pepper spray and declines in the number of State Highway Patrol officer injuries, suspect injuries in Charlotte, and excessive use-of-force complaints against SHP officers. Although pepper spray could have contributed to declines in officer injuries in Charlotte and Winston-Salem and suspect injuries in Winston-Salem, the available data were not sufficient to support those claims. A 1998 study, however, indicated that the introduction of pepper spray reduced the number of assaults on police significantly in the Baltimore County (Maryland) Police Department.²

Study limitations. Due to differences among the study's data sources, only a limited number of conclusions could be drawn. The procedure for identifying officer and suspect injuries differed considerably from agency to agency and within each agency over time. The availability of data at each site differed, depending on the level of computer use and the sophistication of programming and software. The systems in place at the State Highway Patrol and in Winston-Salem in the early 1990s required officers to

describe the circumstances leading up to injuries. Thus, determination of the number of injuries depended on the officer's recall of the incident and the degree of detail in his narrative report.

Moreover, injuries captured in one system might have been overlooked in others. The State Highway Patrol included only those injuries for which officers had filed Worker's Compensation claims, whereas cases identified in Winston-Salem and Charlotte were not limited to those requiring medical attention or loss of work.

The in-custody deaths study

Early on, as pepper spray use began to spread, questions arose as to its safety, especially after several exposed arrestees died in custody. A professor of forensic sciences and pathology at the University of Texas, Southwestern Medical Center, recently conducted a study of 73 cases of in-custody deaths following pepper spray use to determine the role, if any, played by pepper spray.

For each case, the author collected reports from law enforcement sources, emergency medical technicians, emergency room personnel, coroners and medical examiners, and toxicologists. Analysis of police reports of the confrontation was combined with the more quantifiable autopsy findings and, finally, with numerically precise toxicological data. The author believes that information from each of these sources is necessary to have the maximum confidence in the cause of death.

The author did not always agree with the cause of death listed by the autopsy surgeon or medicolegal officer. In some of these cases, he had more or different information than was available to the certifying official at the time an opinion was given on the cause of death.

Classifying the cases

Of the 73 reported cases of in-custody deaths allegedly involving pepper spray, 10 were excluded from the study. Three cases were excluded because investigation showed that pepper spray had not been used. Another seven were excluded because insufficient

details were included in the case reports.

The remaining 63 cases were broken down into four subsets (see exhibit 7):

- Clear cut—cases in which the cause of death was clear and well-founded.
- Combined effects—cases in which the cause of death could be attributed to two or more factors working together.
- Outliers—cases that defied categorization.
- Asthma—cases in which compromised air passages to the lungs were found at autopsy.

Clear-cut cases. In 12 of the 23 cases included in the clear-cut category, drugs alone were determined to be the cause of death. In another four cases, death was attributed to drugs and heart disease. In the remaining seven cases, the author attributed death to positional asphyxia, which can occur when subjects are placed in a position in which they cannot use the muscles that move air in and out of their lungs. When a subject is made to lie face down, hands cuffed behind, pressure

on the abdomen forces the abdominal contents up against the diaphragm, making it harder to breathe. This situation is exacerbated when the subject is obese. Weights applied to the back, such as an arresting officer placing his weight on the subject’s shoulder-blade area, also interfere with a suspect’s ability to breathe (in one case reported in this study, a sofa was placed on the subject to help control him). Pepper spray was ruled out as a direct or contributing cause in all of these deaths.

Combined effects. In these cases, drugs and disease combined with the confrontational situation to such a degree that it was impossible to isolate a single cause of death. In 23 cases, death was attributed to a combination of the confrontational situation and drugs. In five cases, death was attributed to the confrontational situation and the effects of disease. In another four cases, all three factors contributed to death. Again, pepper spray was ruled out as a cause or contributing factor in these deaths.

Outlier cases. Other weapons or health issues were involved in the deaths

Exhibit 7. In-custody death cases

Category	Number of cases
Category I: Clear cut	23
IA: Drugs alone	12
IB: Drugs and disease	4
IC: Positional asphyxia	7
Category II: Combined effects	32
IIA: Confrontational situation + drugs	23
IIB: Confrontational situation + disease	5
IIC: Confrontational situation + drugs and disease	4
Category III: Outliers (uncategorizable)	6
Category IV: Asthma	2
Total cases examined in study	63

and were likely the main cause of death.

Asthma. In the two cases involving asthma, death was attributed to the disease. In one case, details of the confrontation with law enforcement were not available, but the autopsy found signs of preexisting asthma, and the medical examiner certified the death as asthma precipitated by the use of pepper spray. In the other case, signs of asthma were not found, but the autopsy revealed airway damage that could have made the subject susceptible to bronchial spasms triggered by inhaled

pepper spray. The autopsy surgeon listed OC and disease as the cause of death.

Pepper spray was used more times in this case than in any other, but according to police officers, it was ineffective. The subject, who was obese, was handcuffed behind his back and placed in a face-down position when being transported. The difficulty of breathing in this position may have been compounded by the damage already done to his airways. In this case, the confrontational situation could have caused or contributed to death.

Was pepper spray the cause of death?

For pepper spray to cause death, it would have to make breathing difficult by closing or narrowing the bronchial tubes. The subject would have to struggle to both inhale and exhale. These effects would be noticeable shortly after the application of pepper spray. Yet, except for the two cases in which the subjects were classified as asthmatics, comments regarding breathing (other than “ceased breathing”) were found in only five case reports, none of which referred to a struggle to

breathe. In none of these cases did death immediately follow pepper spray application. For these reasons, the study concluded that pepper spray was not the direct or sole cause of death in these five cases.

Lessons and observations

In addition to concluding that pepper spray did not cause or contribute to death in 61 out of 63 cases, the author viewed pepper spray as a relatively innocuous force option, ranking at the low end of the “escalation of force” scale. Although pepper spray was reported by arresting officers to be effective in only 20 percent of the cases studied, all confrontations examined in the present study were distinguished by the fact that they ended in the subject’s death.

A 1999 study that examined 690 incidents of pepper spray use concluded that pepper spray was effective 85 percent of the time, according to the broadest definition of the term “effectiveness.”³ None of the arrestees in these incidents died in custody. Other studies have reported lower and higher effectiveness rates, but effectiveness

is a subjective term and its definition varies across studies. The 1999 study found that the effectiveness rate reported by officers was significantly reduced when subjects exposed to pepper spray appeared to be on drugs (about 13 percent of the incidents). In the in-custody death study, toxicological data showed that 39 of 63 subjects (62 percent) had some level of drugs in their body. This apparent large difference in drug use and varying interpretations of what constitutes effectiveness may explain some of the differences in effectiveness rates reported in the two studies.

The current study also concluded that, despite some skepticism as to its existence,⁴ positional asphyxia is real and can (and does) cause death. Although pepper spray was not found to be effective in any of the cases of positional asphyxia examined in this study, its precise role in these cases could not be determined. The results of a recent experiment that tested the effect of pepper spray on drug-free, healthy volunteers, by itself and when combined with positional restraint, are discussed below.

Pepper spray and positional restraint

In another study, medical researchers at the University of California–San Diego measured the effects of pepper spray on breathing and other health parameters, particularly when combined with positional restraint.⁵ Subjects (34 recruits from a law enforcement training academy) were exposed to pepper spray and a placebo spray and then placed in a sitting position or handcuffed in the “hogtie” or “hobble” position.

The study found that pepper spray inhalation alone does not pose a significant risk for respiratory compromise or asphyxiation, even when combined with positional restraint. Researchers found no evidence that OC exposure resulted in any additional change in respiratory function in the restraint position. In both the OC and placebo groups, pulmonary function was restricted in the restraint position, but measurements remained within the normal range. Moreover, there were no statistical differences between the OC and placebo groups relative to these declines.

Pepper spray did, however, result in an increase in blood pressure of 10 to 15 percent, perhaps due to the discomfort and pain associated with it. The clinical implications of this finding are unknown.

This study had several limitations:

- Conditions that occur in the field are impossible to replicate in the laboratory.
- The effects of prolonged sprays and repeated exposures were not studied.
- All of the subjects were cadets at the local police academy and were generally healthy.
- Subjects wore goggles to reduce pepper spray exposure to the eyes, which causes irritation and pain. (The purpose of the study was to measure acute effects of inhalation).
- Restrained subjects were placed on a medical examination table rather than on a hard surface, as often occurs in the field.
- The study did not investigate the long-term effects of pepper spray exposure or the potential for complications from chronic occupational exposure to it.

Practical implications

In-custody deaths occurred before pepper spray was introduced and still occur today in cases not involving pepper spray. Determining the risks of pepper spray in arrest situations is complicated by two facts:

- The number of in-custody deaths in which pepper spray was used in the arrest process is very low.
- Every situation in which a suspect resists arrest is unique; it is impossible to collect enough useful data on nearly identical documented arrest scenarios with and without the use of pepper spray.

The studies cited in this report do not and cannot prove that pepper spray will never be a contributing factor in the death of a subject resisting arrest. In the in-custody death study summarized here, the evidence led the author to believe that, except for two cases, the deaths could be explained as being caused by the struggle with officers and the presence of drugs or alcohol (or both) even if OC had not been used.

The clinical study of subjects exposed to pepper spray and placed under positional restraint, even hogtied, strongly indicates that these conditions alone are unlikely to produce any significant risk to subjects. That study, however, was performed on healthy subjects who were not on drugs or obese. They had not fought with officers or subjected themselves to other physiological or psychological stress that could have compromised their health. These complicating conditions, often found in the field, cannot be replicated in a laboratory. Thus, there can be no definitive clinical determination of the risk of pepper spray use in all arrest circumstances.

The North Carolina study provided results that, in some instances, supported the general belief that the use of pepper spray will reduce injuries to police officers and suspects and excessive force complaints against police. Limitations in the data, however, made it impossible to draw conclusions on all three effectiveness measures at all three study sites.

The in-custody death study noted that pepper spray was

reported to be effective in only about 20 percent of the incidents. This rate is much lower than that found in a 1999 study of arrests involving pepper spray, which examined a large number of incidents in which no deaths occurred. The subjects in the in-custody death study had a much higher rate of drug use, however, and there is evidence that pepper spray is less effective on subjects who are on drugs. A possible implication of these observations is that officers may want to move quickly to another force option if subjects appear to be on drugs and seem unaffected by a blast of pepper spray that clearly hit them in the face. Doing so could reduce risks to officers from continually aggressive subjects.

The results of all studies discussed in this Research for Practice seem to confirm that pepper spray is a reasonably safe and effective tool for law enforcement officers to use when confronting uncooperative or combative subjects; they provide no reason to stop using this important less-than-lethal weapon. Other studies continue to be conducted on pepper spray, however, and this will not be the last word on the subject.

Additional reading

Kaminski, Robert J., Steven M. Edwards, and James W. Johnson, "Assessing the Incapacitative Effects of Pepper Spray During Resistive Encounters With Police," *Policing: An International Journal of Police Strategies and Management* 22 (1) (1999): 7–29.

Kaminski, Robert J., Steven M. Edwards, and James W. Johnson, "The Deterrent Effects of Oleoresin Capsicum on Assaults Against Police: Testing the Velcro-Effect Hypothesis," *Police Quarterly* 1 (2) (1998): 1–20.

National Law Enforcement Technology Center, "Positional Asphyxia—Sudden Death," *National Law Enforcement Technology Center Bulletin*, Washington, DC: U.S. Department of Justice, National Institute of Justice, June 1995.

Notes

1. Granfield, John, Jami Onnen, and Charles S. Petty, "Pepper Spray and

In-Custody Deaths," Executive Brief: Science and Technology, International Association of Chiefs of Police and National Institute of Justice, March 1994.

2. Kaminski, Robert J., Steven M. Edwards, and James W. Johnson, "The Deterrent Effects of Oleoresin Capsicum on Assaults Against Police: Testing the Velcro-Effect Hypothesis," *Police Quarterly* 1 (2) (1998): 1–20.

3. Kaminski, Robert J., Steven M. Edwards, and James W. Johnson, "Assessing the Incapacitative Effects of Pepper Spray During Resistive Encounters With Police," *Policing: An International Journal of Police Strategies and Management* 22 (1) (1999): 7–29.

4. Much of this skepticism resulted from a case in which a forensic pathologist answered that he could not prove, in the case in question, that death resulted from positional asphyxia. (See *Price v. County of San Diego* 990F Supp 130.)

5. More information on this study can be found in Chan, Theodore C., et al., *Pepper Spray's Effects on a Suspect's Ability to Breathe*, Research in Brief, Washington, DC: U.S. Department of Justice, National Institute of Justice, December 2001, NCJ 188069.

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