Handheld Chemical Spray

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Definition

A handheld chemical spray is a personally carried aerosol or pressurized chemical-irritant device directed at an individual or small number of people at relatively close range to cause temporary ocular, respiratory, and sensory impairment and facilitate control.

This category includes oleoresin capsicum (OC/pepper spray), handheld CS or CN spray where used, and comparable personal-issue chemical-irritant formulations delivered as aerosol, stream, foam, or gel.

It excludes launcher-fired chemical projectiles, which are classified as Extended-Range Chemical Weapons; grenades, canisters, foggers, or other area-saturation systems, which are classified as Tear Gas; and chemical agents that are merely drawn, displayed, or threatened but not discharged.

This definition corresponds with the research dataset, where `I_CS` is coded when an officer discharges OC, pepper spray, Mace, or a similar chemical agent directly from a standard personal-issue canister at the decedent.

How It Is Designed to Work

Handheld chemical sprays are intended to create a rapid, temporary inflammatory and sensory effect that interferes with vision, breathing comfort, concentration, and coordinated aggressive behaviour without relying on blunt-force trauma or electrical incapacitation.

Oleoresin capsicum

OC spray is derived from capsicum compounds containing capsaicinoids, and its principal effects arise through activation of sensory nerve pathways associated with intense burning pain and neurogenic inflammation. Expected effects can include:

- intense burning of the eyes and skin;
- involuntary eye closure or difficulty keeping the eyes open;
- tearing;
- nasal discharge;
- coughing;
- burning of the mouth and throat;
- a subjective sensation of breathing difficulty;
- disorientation;

- anxiety or panic; and
- temporary reduction in the ability or willingness to continue aggressive behaviour.

Unlike a conducted energy weapon, OC does not reliably produce involuntary neuromuscular incapacitation. Its effectiveness depends on the person's physiologic response, behaviour, motivation, exposure quality, environmental conditions, and the officer's ability to place sufficient agent on or near the face.

Delivery matters

A handheld chemical spray must reach the intended target in sufficient concentration. Operational performance therefore depends on distance, wind, spray pattern, duration of discharge, target movement, whether the spray reaches the eyes and face, physical barriers such as glasses, masks, clothing, or helmets, environmental ventilation, and cross-contamination of officers or third parties. Because the mechanism is principally irritation rather than mechanical incapacitation, a person may remain physically capable of attacking, running, using a weapon, or otherwise resisting despite substantial discomfort.

Evidence of Effectiveness

Overall assessment

Handheld OC spray has one of the more favourable evidence profiles among commonly studied less-lethal police interventions. The strongest literature suggests that OC can reduce violent or aggressive behaviour, reduce officer and subject injury compared with some physical-force alternatives, deter some assaults against officers, and provide officers with a relatively low-injury means of attempting control. However, the evidence also shows that OC is not an instantaneous or universally reliable incapacitant, particularly in high-threat encounters.

Operational effectiveness

Bertilsson and colleagues (Bertilsson et al., 2017) examined 936 police OC deployments and found that violent behaviour was reduced in 93% of incidents. That headline figure is important, but the operational details are equally so. The authors found that effective operating distance was often less than 2 metres, that it commonly took approximately 3 to 5 seconds of spraying before effect was obtained, that moving subjects could be difficult to hit effectively, that collateral exposure occurred in 24% of incidents, and that approximately 90% of those collateral exposures involved other police officers.

Most importantly for an edged-weapon research project, the authors found that in 21% of incidents officers used OC at close range against persons armed with lethal weapons, placing themselves at substantial personal risk. The authors concluded that OC was a useful option for lower-threat situations but lacked important characteristics needed for safe and efficient management of high-threat armed encounters. A tool can be highly

effective in general police encounters while still being tactically inappropriate against an immediately dangerous armed person – that distinction is central to the evidence library.

Effectiveness is not the same as incapacitation

Brandl and Stroshine [(Brandl & Stroshine, 2017)] analyzed 504 use-of-force incidents involving OC spray or CEWs and specifically examined factors associated with weapon use and effectiveness. Their work is useful because it separates deployment from incapacitation: a chemical agent can influence behaviour without physically preventing continued action. For this reason, "OC worked" can mean several different things – the person stopped fighting, resistance decreased, officers were able to approach and restrain the person, the person voluntarily complied because of pain, the intervention prevented escalation to another force option, or the person was sufficiently impaired to permit control – and these outcomes should not be treated as equivalent to guaranteed physical incapacitation.

Injury-reduction effect

Morabito and Doerner [(Morabito & Doerner, 1997)] examined use-of-force reports from a municipal police department before and after policy changes governing OC deployment and found that OC use significantly reduced injuries to both officers and subjects. They also observed that officers were more likely to use OC when at a physical disadvantage relative to the subject, while OC use declined as subject violence increased – a pattern suggesting that field officers recognize that a chemical irritant has practical limitations as threat severity increases. MacDonald, Kaminski, and Smith [(MacDonald et al., 2009)] likewise found that less-lethal technologies can substantially reduce injury when used in place of physical force, although their strongest adjusted findings concerned conducted energy devices.

Deterrence of assaults against officers

Kaminski, Edwards, and Johnson [(Kaminski et al., 1998)] used an interrupted time-series design to examine assaults on officers before and after OC introduction in the Baltimore County Police Department and found a statistically significant reduction of approximately 3.2 assaults on officers per month following introduction of OC. This study is notable because it evaluates an organizational outcome rather than simply asking whether an individual sprayed subject was incapacitated, suggesting that OC may have value not only after resistance begins but as part of a force environment in which officers have an intermediate option available short of direct physical struggle.

What is missing

Despite a relatively strong evidence base, several questions remain incompletely answered. There is no universal probability that a single OC deployment will immediately incapacitate a resisting person, and effectiveness varies with spray placement, distance, wind, subject movement, formulation and delivery pattern, behavioural state, intoxication, pain tolerance, environmental factors, and how success is defined. The evidence is particularly weak for the question most relevant to this research project: what is the probability

that handheld chemical spray will stop an armed edged-weapon assault quickly enough to prevent the need for lethal force? Bertilsson et al. (Bertilsson et al., 2017) provide evidence suggesting caution rather than reassurance on that point.

Injury and Safety Evidence

Comparative injury risk

The strongest recent comparative synthesis is Nielsen et al. (Nielsen et al., 2025). Across 19 peer-reviewed studies of real-world police force, OC spray appeared to have the lowest subject-injury rate among the commonly studied modalities, and although the included studies were heterogeneous, the direction of the evidence was relatively consistent: OC was generally associated with less injury than the alternatives against which it was compared.

A more recent multi-agency analysis by Petersen and colleagues (Petersen et al., 2025) examined 2,348 use-of-force incidents from 17 large urban and metropolitan agencies and found, after controlling for officer, civilian, and situational characteristics, that chemical agents were predicted to result in hospitalization or death in approximately 4% of cases, compared with 13% for conducted energy devices, 16% for impact weapons, and 37% for police canines. These estimates should not be interpreted as universal probabilities for every OC deployment, but they reinforce the comparative conclusion that chemical agents are generally among the lower-injury force options.

Typical injury profile

Semple, Jenkins, and Bennell (Semple et al., 2021) reviewed 22 documents concerning injury and death proximate to OC deployment and found that OC was often effective and was generally associated with reduced odds of injury to both subjects and deployers. When OC-associated injuries occurred, they were usually relatively minor, with common acute effects including eye pain, conjunctival irritation, tearing, skin burning, coughing, nasal and throat irritation, transient breathing discomfort, and anxiety or panic. The central safety conclusion is therefore comparative rather than absolute: handheld OC spray usually produces substantial temporary discomfort but relatively little lasting physical injury.

Ocular injury

Watson, Stremel, and Westdorp (Watson et al., 1996) reviewed 81 emergency-department patients exposed to OC during law-enforcement encounters and found that ocular burning and redness were the most common findings. Seven patients had corneal abrasions and six experienced respiratory symptoms, but no patient required hospitalization because of OC toxicity. These findings support two simultaneous conclusions: serious toxicity is uncommon, and OC exposure is not medically trivial in every case. Direct close-range exposure, prolonged contamination, mechanical trauma from the spray stream or canister, contact lenses, and delayed decontamination can increase ocular risk.

Respiratory effects

Most healthy people experience temporary coughing, throat irritation, and subjective breathing difficulty rather than clinically dangerous respiratory compromise. Busker and van Helden (Busker & Van Helden, 1998) examined the toxicology and efficacy of pepper spray in connection with its consideration for Dutch policing, and their work supports a comparatively favourable toxicologic profile when OC is used under expected operational conditions. However, risk assessment becomes more uncertain for persons with asthma, chronic lung disease, acute respiratory distress, prolonged exposure, high-concentration exposure, exposure in confined environments, or simultaneous physiologic stress from struggle, restraint, intoxication, or other force.

Deaths temporally associated with OC use

Deaths have occurred following police incidents in which OC spray was deployed, but that does not establish that OC caused the death. Steffee and colleagues (Steffee et al., 1995) examined in-custody deaths associated temporally with pepper spray exposure and contributed foundational forensic evidence to the debate over whether OC was a primary lethal mechanism. Semple et al. (Semple et al., 2021) later reviewed the wider literature and found recurring themes in deaths proximate to OC deployment, including complex circumstances involving restraint, intoxication, agitation, underlying disease, and multiple concurrent stressors. The scientific problem is therefore one of causal attribution. A death occurring after OC exposure may involve the chemical agent, underlying disease, stimulant intoxication, extreme physiologic stress, positional or restraint-related impairment, other police force, trauma, or combinations of these factors. Current literature does not support characterizing routine OC exposure as a commonly lethal intervention, nor does it justify assuming that OC can never contribute to adverse outcomes.

Cross-Contamination and Environmental Risk

Collateral exposure is a defining operational limitation of handheld chemical spray. Bertilsson et al. (Bertilsson et al., 2017) found collateral contamination in 24% of deployments, with police officers accounting for approximately 90% of those affected. This matters tactically because cross-contamination can impair the deploying officer, cover officers, bystanders, victims, medical personnel, and other persons who must remain functional during the encounter.

Environmental conditions can significantly alter risk. Wind can carry spray away from the target, reduce effective dose, contaminate officers or bystanders, and make deployment unpredictable. In small or poorly ventilated environments, chemical concentration may persist and affect everyone present; although handheld spray is more targeted than tear gas, repeated or extensive spraying in an enclosed environment can begin to resemble area contamination rather than individual application. Officers must also anticipate that physical

control following successful spraying may expose them to residual chemical agent through contact with the subject, clothing, hair, or contaminated surfaces.

Decontamination and Aftercare

Because OC effects continue after the immediate force objective is achieved, post-deployment care forms part of the safety profile of the intervention. Generally relevant measures include moving the subject to fresh air where feasible, discontinuing exposure, allowing natural blinking and tearing, flushing affected areas when indicated, removing contaminated clothing when appropriate, monitoring respiratory status, obtaining medical assessment when symptoms are severe, atypical, or persistent, and avoiding unnecessary additional restraint that may worsen respiratory distress.

The legal significance of aftercare is illustrated by *LaLonde v. County of Riverside*, 204 F.3d 947 (9th Cir. 2000). The Ninth Circuit emphasized that once an arrestee had surrendered and was helpless, continued harmful effects of pepper spray could not simply be ignored, and the court specifically noted evidence that officers were trained to provide basic first aid after spraying but failed to do so. The safety question does not end when the canister stops discharging.

When Its Use May Be Appropriate

The evidence most strongly supports handheld chemical spray where officers need to control active resistance or violence but have enough tactical margin to tolerate a delayed or incomplete effect. Potentially appropriate circumstances can include:

- active physical resistance;
- assaultive behaviour that does not create an immediate lethal threat;
- preventing or interrupting a physical fight;
- avoiding a prolonged hands-on struggle;
- situations where officers are at a physical disadvantage;
- circumstances where direct impact force would be expected to produce greater injury; or
- attempts to gain control before escalating to a more injurious force modality.

Adang and Mensink (Adang & Mensink, 2004), drawing on Dutch police street trials, concluded that OC could be a genuine benefit where suspects were violent or possessed some forms of impact weapon, while cautioning against treating OC as a preferred response to mere verbal resistance. That distinction aligns closely with the broader evidence base.

When Its Use May Be Inappropriate

Verbal resistance or simple noncompliance

Adang and Mensink [Adang & Mensink, 2004] specifically questioned the reasonableness of using pepper spray as the preferred intervention against merely verbally resistant subjects. The relatively favourable medical profile of OC does not mean it is proportionate to every failure to comply with police direction.

Passive resistance

Where a person is stationary, nonviolent, poses no immediate threat, and can be arrested through less intrusive means, chemical irritation may create pain without providing a corresponding safety benefit. This principle is strongly reflected in U.S. case law.

Immediate lethal threat

The most important tactical contraindication for this research project is an armed subject who can inflict lethal injury before the chemical agent can reasonably be expected to work. Bertilsson et al. [Bertilsson et al., 2017] found common operational distances below 2 metres, delays of approximately 3 to 5 seconds before effect, and substantial risk when officers deployed OC against persons armed with lethal weapons, concluding that OC lacked key characteristics needed for safe management of high-threat armed encounters. A high overall effectiveness rate should not therefore be interpreted as evidence that handheld OC is a reliable stand-alone response to an immediately threatening edged weapon.

Dangerous positioning

Deployment may be inappropriate where temporary visual impairment or panic could itself create serious harm, including when the person is driving, operating machinery, at height, near fast-moving traffic, in deep water, or otherwise in a location where sudden disorientation could cause catastrophic injury.

Confined or poorly ventilated environments

Repeated spraying in confined environments can expose officers, third parties, and the subject to sustained chemical contamination, and the risk-benefit balance becomes less favourable when officers cannot reasonably ventilate the space or remove exposed persons.

Repeated spraying after control

Once meaningful resistance or threat has ended, additional spraying becomes increasingly difficult to justify. Repeated exposure should be treated as an additional application of force requiring an independent continuing justification.

Vulnerable respiratory presentation

Known asthma or respiratory disease does not necessarily make every OC deployment impermissible, but obvious breathing compromise should materially affect the risk assessment. Persistent or severe respiratory symptoms after deployment warrant prompt medical evaluation.

Relevance to Edged-Weapon Encounters

The general effectiveness and safety evidence for handheld chemical spray does not establish that it is appropriate for every edged-weapon encounter. The relevant question is whether officers can reasonably expect the irritant effect to influence the threat before the subject can cause serious injury, and whether they can safely manage delayed, partial, or failed effect.

Potential role

Handheld chemical spray may offer a comparatively low-injury opportunity to resolve an edged-weapon encounter where the subject is threatening or resistant but not yet able to immediately reach an officer or third party. Its potential value is greatest because successful OC deployment may impair vision, increase discomfort, reduce aggressive behaviour, interrupt concentration, and facilitate surrender or physical control without the greater injury burden associated with kinetic impact, canine, or firearm force. The existing field evidence supports this general harm-reduction potential, but it does not show that OC reliably incapacitates an armed person (Bertilsson et al., 2017; Brandl & Stroshine, 2017).

Conditions favouring deployment

Deployment is more plausible where officers have sufficient distance, containment, barriers or cover, time for chemical effects to develop, a clear spray path, limited cross-contamination risk, and another response available if the spray is ineffective. A stationary, contained, or otherwise tactically separated edged-weapon subject presents a different problem from a person already moving rapidly toward someone with the weapon.

Failure consequences

The central limitation is that OC produces irritation rather than mechanical incapacitation. Bertilsson et al. (Bertilsson et al., 2017) found that effective operating distance was often less than 2 metres and that meaningful effect commonly required several seconds, meaning a person may remain capable of advancing, stabbing, or otherwise using an edged weapon despite substantial pain and visual impairment. If deployment occurs within striking distance, unsuccessful or delayed effect may consume reaction time while placing the officer in greater danger.

Risk trade-off

For the subject, successful OC deployment generally carries a lower expected injury burden than most kinetic or lethal alternatives. For police and third parties, however, the key risk is under-response: choosing an

intervention whose effects may develop too slowly or incompletely for the threat presented. Handheld chemical spray is therefore most defensible in edged-weapon encounters where officers can safely tolerate incomplete or delayed effectiveness; it should not be treated as a reliable stand-alone response to an immediately advancing lethal threat.

U.S. Legal Considerations

Fourth Amendment framework

Police use of handheld chemical spray during an arrest or seizure is generally analyzed under the objective-reasonableness standard of *Graham v. Connor*. The central considerations include severity of the suspected offense, whether the person poses an immediate threat to officers or others, whether the person is actively resisting arrest or attempting to flee, and the totality of the circumstances surrounding the deployment. Federal courts commonly treat pepper spray as a meaningful or intermediate application of force, not as trivial physical contact.

Passive resistance and clearly established law

Headwaters Forest Defense v. County of Humboldt, 276 F.3d 1125 (9th Cir. 2002) is a foundational Ninth Circuit case. Officers applied pepper spray to nonviolent environmental protesters who had linked themselves together and refused orders to disengage, and the Ninth Circuit concluded that the use of pepper spray was excessive where the protesters posed no safety threat and officers had reasonable nonviolent alternatives available. The case is especially important for qualified-immunity analysis because it provided clear notice in the Ninth Circuit that pepper spray can constitute excessive force even where a person is disobeying police orders.

Minor offense, no threat, no active resistance

In *Young v. County of Los Angeles*, 655 F.3d 1156 (9th Cir. 2011), an officer pepper sprayed a man during a traffic-stop encounter and subsequently used a baton. The Ninth Circuit characterized pepper spray and baton blows as intermediate force capable of inflicting significant pain and, taking the facts in the plaintiff's favour, found the force excessive where the suspected offenses were minor, the subject posed no apparent threat, he was not actively resisting arrest or attempting to flee, and less intrusive options were available. The court also held that the relevant constitutional principles were sufficiently established to defeat qualified immunity.

Continued effects after surrender

LaLonde v. County of Riverside, 204 F.3d 947 (9th Cir. 2000) established an important principle regarding post-spray treatment. The court explained that while pepper spray may sometimes reasonably be used to bring an arrestee under control, continued use or an unjustified refusal to alleviate its harmful effects after the

subject has surrendered and become helpless can constitute excessive force. This makes decontamination and aftercare relevant not merely medically, but constitutionally.

Restrained and non-resisting subjects

Other federal circuits have reached similar conclusions regarding gratuitous pepper spray against restrained, non-resisting persons. The legal principle is strongest where the subject is handcuffed or otherwise controlled, no longer actively resists, poses no immediate safety threat, and is sprayed solely to punish, intimidate, or obtain unnecessary compliance.

Qualified immunity

Qualified-immunity analysis remains circuit- and fact-specific. However, longstanding precedent in several circuits provides substantial notice that chemical spray cannot be used gratuitously against a person who is non-threatening, restrained, or merely passively resistant when the governmental interest is minimal. Conversely, courts are more likely to find OC use reasonable where a person is actively assaultive, violently resisting, creating an immediate safety threat, or engaged in conduct that officers reasonably need to interrupt rapidly.

Ethical and Moral Considerations

Handheld chemical spray occupies an unusual position in the less-lethal continuum. It deliberately inflicts intense pain and temporary sensory impairment, yet compared with most physical-force options it produces relatively little lasting injury. That creates a strong harm-reduction argument, but not an unlimited justification.

Proportionality

The comparatively low injury rate of OC does not make pain morally insignificant. Using intense chemical irritation against a violent person to avoid baton strikes or prolonged grappling may substantially reduce total harm, while using the same intervention solely because a peaceful person refuses an instruction can impose considerable pain for relatively little safety benefit.

Necessity

OC is ethically strongest when it replaces a more harmful realistic alternative. Its justification is weaker when the realistic alternative is communication, waiting, containment, distance, additional officers, negotiation, or low-risk physical control.

Failure and escalation

Because OC does not physically prevent movement, officers should account for the consequences of failure before deployment. This is particularly important in edged-weapon encounters: if ineffective spray leaves an officer within striking distance of an armed person, the attempt may consume reaction time, close distance,

impair the officer through cross-contamination, and force rapid escalation to lethal force. A nominally lower-force option is not necessarily the lower-risk option when its use creates a worse tactical position.

Collateral exposure

The possibility of contaminating uninvolved people raises ethical concerns beyond the targeted subject. Officers must consider foreseeable effects on children, elderly persons, victims, hostages, bystanders, other officers, and medically vulnerable persons.

Punitive use

Chemical spray should not be used to punish disrespect, verbal defiance, or refusal to obey once no legitimate safety or control objective remains. The painful nature of the intervention makes retaliatory use especially problematic.

Aftercare

Because the intervention intentionally creates ongoing pain after deployment, officers retain an ethical responsibility to reasonably mitigate its effects once the need for force has ended.

Evidence Limitations

The OC literature is comparatively mature, but important limitations remain.

First, effectiveness is defined inconsistently. Studies may measure reduced aggression, incapacitation, successful arrest, avoidance of higher force, or officer perceptions of success.

Second, observational selection effects remain. Officers do not randomly choose OC during field encounters.

Third, formulations differ. Concentration, capsaicinoid content, carrier, spray pattern, and delivery systems vary between products and jurisdictions.

Fourth, environmental conditions are under-measured. Wind, ventilation, temperature, distance, and barriers can substantially change exposure.

Fifth, injury recording is inconsistent. Minor ocular or respiratory symptoms may be coded differently between agencies and medical systems.

Sixth, deaths are difficult to attribute causally. Fatal police encounters involving OC often include intoxication, restraint, physiologic stress, trauma, and other force modalities.

Seventh, high-threat encounters are not well represented by aggregate success rates. An intervention that reduces aggression in most ordinary deployments may remain unsuitable against a person capable of inflicting lethal injury within seconds.

Eighth, evidence on vulnerable populations is limited. Children, older adults, pregnant persons, and people with serious respiratory disease are not well represented in many operational studies.

Ninth, cross-contamination is operationally important but poorly integrated into most injury comparisons.

Tenth, product-specific research should not automatically be generalized to every handheld chemical formulation.

Bottom Line

Effectiveness

Moderate-to-strong evidence supports the conclusion that handheld OC spray reduces aggressive behaviour and can facilitate control. A large Swedish field study reported reduced violent behaviour in 93% of deployments, but effects commonly required several seconds and operational range was often under 2 metres.

Injury

Comparative real-world research consistently places handheld chemical agents among the least injurious commonly used police force modalities.

Serious injury/death

Serious direct injury appears uncommon. Ocular injury, respiratory complications, and other adverse effects can occur, though deaths proximate to OC deployment are usually medically and causally complex rather than attributable to the spray alone.

Comparative safety

OC appears less injurious than batons, police canines, and many forms of direct physical force, and may also carry lower injury risk than conducted energy weapons.

Tactical limitation

Handheld chemical spray should not be equated with reliable immediate incapacitation. Short operating distance, delayed effect, aiming difficulty, wind, and cross-contamination make it a poor stand-alone option against some immediately dangerous armed subjects.

Risk-benefit assessment

The strongest evidence supports handheld chemical spray as a low-injury intermediate-force option when sufficient time and distance exist for its effects to occur and when it can replace a more injurious physical intervention. Its weakest justification is against passive or merely verbal resistance, already-controlled persons, and high-threat armed subjects where a delayed or failed effect would expose officers or third parties to lethal harm.

Core Peer-Reviewed Evidence

1. Bertilsson, J., Petersson, U., Fredriksson, P. J., Magnusson, M., & Fransson, P. A. (2017)

Use of pepper spray in policing: retrospective study of situational characteristics and implications for violent situations.

Police Practice and Research, 18(4), 391–406.

DOI: 10.1080/15614263.2017.1288119

Priority: Essential / strongest direct operational-effectiveness study.

Contribution: Examined 936 real-world police pepper-spray incidents.

Key finding: Violent behaviour decreased in 93% of incidents.

Operational limitations: Effective range was often under 2 metres, effect commonly took 3–5 seconds, and collateral exposure occurred in 24% of incidents.

Critical finding for armed encounters: In 21% of incidents officers exposed themselves to substantial risk by using OC at close range against persons armed with lethal weapons.

Key value: Demonstrates the difference between high aggregate effectiveness and suitability for high-threat encounters.

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2. Nielsen, M., Munkholm, J., Banner, J., & Wingren, C. J. (2025)

Injury rates following conducted electrical weapons and other less-lethal force modalities in real-life police settings: a comparative literature review.

Forensic Science, Medicine and Pathology, 21, 1396–1406.

DOI: 10.1007/s12024-025-01020-9

Priority: Essential current comparative synthesis.

Contribution: Reviewed 19 peer-reviewed real-world studies comparing OC, CEW, baton, canine, and physical force.

Key finding: OC appeared to have the lowest subject-injury rate among the commonly studied force modalities.

Limitation: Considerable heterogeneity in injury definitions, study design, and police practice prevents precise universal risk estimates.

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3. Petersen, K., Koper, C. S., Taylor, B. G., Liu, W., & Sheridan-Johnson, J. (2025)
Less-Lethal Weapons and Civilian Injury in Police Use of Force Encounters: A Multi-agency Analysis.
Journal of Urban Health, 102(2), 389–399.
DOI: 10.1007/s11524-024-00940-1

Priority: Essential modern comparative field study.

Contribution: Analyzed 2,348 use-of-force incidents from 17 large urban and metropolitan law-enforcement agencies.

Key finding: Chemical agents were associated with substantially lower predicted risk of hospitalization or death than CEWs, impact weapons, or police canines.

Adjusted predicted hospitalization/death: Approximately 4% for chemical agents compared with 13% for CEWs, 16% for impact weapons, and 37% for canines.

Limitation: Chemical-agent categories may combine different products or deployment circumstances, and observational data cannot fully eliminate selection effects.

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4. Semple, T., Jenkins, B., & Bennell, C. (2021)
Injuries and deaths proximate to oleoresin capsicum spray deployment: A literature review.
The Police Journal: Theory, Practice and Principles, 94(2), 184–205.
DOI: 10.1177/0032258X20926873

Priority: Essential safety and mortality review.

Contribution: Reviewed 22 documents concerning injuries and deaths occurring proximate to OC deployment.

Key finding: OC was generally effective and associated with decreased odds of both subject and deployer injury; documented OC-related injuries were usually minor.

Key caution: Deaths following OC deployment commonly involved multiple confounding medical, behavioural, restraint, and intoxication factors.

Limitation: The underlying evidence base is heterogeneous and does not support simple causal conclusions about deaths proximate to deployment.

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5. Adang, O. M. J., & Mensink, J. (2004)

Pepper spray: An unreasonable response to suspect verbal resistance.
Policing: An International Journal of Police Strategies & Management, 27(2), 206–219.
DOI: 10.1108/13639510410536823

Priority: High / important policy and proportionality study.

Contribution: Examined street trials involving pepper spray in four Dutch police forces and compared results with existing safety and effectiveness research.

Key finding: OC could provide substantial benefit against violent subjects or some persons armed with impact weapons.

Critical policy finding: The authors argued that treating pepper spray as the preferred response to mere verbal resistance was unreasonable and potentially abusive.

Key value: Connects empirical effectiveness with proportionality rather than assuming that a comparatively safe weapon is appropriate at every resistance level.

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6. Kaminski, R. J., Edwards, S. M., & Johnson, J. W. (1998)

The Deterrent Effects of Oleoresin Capsicum On Assaults Against Police: Testing the Velcro-Effect Hypothesis.
Police Quarterly, 1(2), 1–20.
DOI: 10.1177/109861119800100201

Priority: High / important organizational-effectiveness study.

Contribution: Interrupted time-series evaluation of assaults on officers following OC introduction.

Key finding: OC introduction was associated with a statistically significant reduction of approximately 3.2 assaults on officers per month.

Strength: Quasi-experimental design evaluates broader organizational effects rather than relying solely on officer perceptions.

Limitation: Agency-level change cannot isolate the mechanism responsible for every observed reduction.

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7. Morabito, E. V., & Doerner, W. G. (1997)

Police use of less-than-lethal force: Oleoresin Capsicum (OC) spray.

Policing: An International Journal of Police Strategies & Management, 20(4), 680–697.

DOI: 10.1108/13639519710368099

Priority: Foundational field study.

Contribution: Examined municipal police use-of-force reports and changes in OC policy placement.

Key finding: OC use significantly reduced injuries to both officers and subjects.

Operational finding: Officers were more likely to use OC when physically disadvantaged relative to the subject, while use declined as subject violence increased.

Key value: Early evidence that OC can substitute for more injurious hands-on force while also revealing practical limits in highly violent encounters.

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8. Brandl, S. G., & Stroshine, M. S. (2017)

Oleoresin Capsicum Spray and TASERs: A Comparison of Factors Predicting Use and Effectiveness.

Criminal Justice Policy Review, 28(3), 279–306.

DOI: 10.1177/0887403415578732

Priority: High for operational effectiveness.

Contribution: Analyzed 504 use-of-force incidents involving OC spray or CEW deployment.

Key value: Directly examines factors associated with use and incapacitation effectiveness rather than assuming deployment equals success.

Strength: Provides a useful comparison between two widely deployed intermediate-force options.

Limitation: Single-department observational data.

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9. Watson, W. A., Stremel, K. R., & Westdorp, E. J. (1996)

Oleoresin Capsicum (CAP-STUN) Toxicity from Aerosol Exposure.

Annals of Pharmacotherapy, 30(7–8), 733–735.

DOI: 10.1177/106002809603000704

Priority: High supporting clinical-safety study.

Contribution: Reviewed 81 emergency-department patients following law-enforcement OC exposure.

Key finding: Ocular burning and redness predominated; seven subjects had corneal abrasions and six had respiratory symptoms.

Safety finding: No patient required hospitalization because of OC toxicity.

Key value: Demonstrates that clinically significant ocular and respiratory effects are possible while serious systemic toxicity remains uncommon.

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10. Busker, R. W., & van Helden, H. P. M. (1998)

Toxicologic Evaluation of Pepper Spray as a Possible Weapon for the Dutch Police Force: Risk Assessment and Efficacy.

American Journal of Forensic Medicine and Pathology, 19(4), 309–316.

DOI: 10.1097/00000433-199812000-00003

Priority: Supporting mechanism, risk, and efficacy study.

Contribution: Evaluated the toxicologic risks and operational efficacy of pepper spray for potential Dutch police use.

Key value: Bridges toxicology and policing rather than examining medical effects in isolation.

Limitation: Older evidence and product/formulation characteristics may not perfectly represent all contemporary sprays.

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11. Steffee, C. H., Lantz, P. E., Flannagan, L. M., Thompson, R. L., & Jason, D. R. (1995)

Oleoresin Capsicum (Pepper) Spray and "In-Custody Deaths."

American Journal of Forensic Medicine and Pathology, 16(3), 185–192.

DOI: 10.1097/00000433-199509000-00001

Priority: Foundational mortality/forensic paper.

Contribution: Examined deaths occurring in temporal proximity to OC use.

Key value: Important early forensic evidence for evaluating whether pepper spray itself should be considered causal in complex in-custody deaths.

Limitation: Case-based mortality literature cannot establish a denominator-based probability of death.

Evidence Rating

Operational effectiveness: ★★★★☆

Strong field evidence that OC often reduces aggression, but immediate incapacitation is not guaranteed.

General injury evidence: ★★★★★

Multiple field studies and contemporary comparative analyses consistently indicate low injury rates.

Serious-injury probability: ★★★★☆

Serious direct injury appears uncommon, although ocular and respiratory complications occur.

Mortality evidence: ★★★☆☆

Deaths proximate to OC use are documented, but direct causal attribution is uncommon and heavily confounded.

Comparative evidence: ★★★★★

Among the strongest comparative findings in the less-lethal literature; OC generally appears less injurious than baton, canine, CEW, and direct physical force.

High-threat effectiveness evidence: ★★★☆☆

Direct evidence exists showing important limitations at close range and against lethally armed subjects, but this area remains underdeveloped.

Overall confidence: Moderate-to-high.

Research-library conclusion

Handheld chemical spray – particularly oleoresin capsicum spray – has one of the most favourable risk-benefit profiles among commonly studied police less-lethal weapons. Real-world studies show that it frequently reduces aggressive behaviour and is consistently associated with lower injury rates than batons, police canines, and many forms of physical force. Its principal limitation is not medical toxicity but tactical reliability: OC produces intense irritation rather than guaranteed physical incapacitation, often operates at short range, may require several seconds to take effect, and can contaminate officers and bystanders. These limitations become particularly important in edged-weapon encounters, where a failed or delayed effect at close distance may expose an officer or third party to lethal injury. The strongest evidence therefore supports handheld chemical spray as a low-injury option for active resistance and lower-level violence when officers retain sufficient time and distance to tolerate incomplete or delayed effect. Its weakest justification is against merely verbal or passive resistance, already-controlled persons, or immediately dangerous armed subjects where the consequences of failure are catastrophic.

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