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Clinical practice

The pathology of lethal exposure to the Riot Control Agents: Towards a forensics-based methodology for determining misuse

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ABSTRACT

The aim of this is to review deaths associated with the use of Riot Control Agents (RCAs) and to assess how the presenting pathologies is such cases may better inform cause of death conclusions upon autopsy. We also sought to present which additional steps should be added to the Minnesota protocol and the European harmonization of medico-legal autopsy rules in suspected cases of deaths associated with the use of RCAs.

We included 10 lethal cases in our study. In three cases, RCAs were found to be the sole cause of death, in three cases RCAs were ruled a secondary cause of death due asphyxia or asthma subsequent to exposure to RCAs and in four cases RCAs were contributory factors to death. In three cases the responsible agents were identified as Chloroacetophenone (CN), Chlorobenzylidene malononitrile (CS) and Oleoresin capsicum (OC) and in the remaining 7 cases, the agent was OC alone.

As there are no specific findings in suspected cases of death associated with RCA use, establishing cause of death and whether RCAs are the sole cause or only a contributory factor will be based on the elimination of other possible causes of death. For this reason, a specifically structured autopsy is essential. This specifically structured autopsy should contain basic principles of the Minnesota Protocol and the European harmonization of medico-legal autopsy rules with the following additional steps taken: examination of clothing, eyes, and skin; examination of pharyngeal, tracheobronchial, and eusophegeal mucosas; and a thorough recording of the steps taken by the party conducting the arrest, including other possible causes of in-custody death, as well as a detailed medical history of the deceased.

1. Introduction

Chemical agents known as Riot Control Agents (RCAs), including harassing agents, lacrimatory agents, and tear gases, are used by civil authorities, government agencies, and military forces when dealing with civil disturbances from large crowds and/or individuals for two main reasons:

1 To deter, disperse, or render temporarily incapacitated those involved in disturbances.

2 To ensure minimal physical intervention and reduction of face-to-face conflict between law enforcement or responding personnel and demonstrators.[1]

RCAs should have three main characteristics:

- Rapid time of onset of effects (seconds to several minutes).
- Relatively brief duration of effects (15–30 min) once the victim has escaped the contaminated atmosphere and has been decontaminated (i.e., removed the material from his clothing).
- A high safety ratio (the ratio of the lethal dose [estimated] to the effective dose).[2]

The five most commonly used RCAs are Chloroacetophenone (CN), Chlorobenzylidene malononitrile (CS), Dibenz (b, f)1: 4 -oxazepine (CR), Oleoresin capsicum (OC) and pelargonic acid vanillylamide (PAVA).[3]

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RCAs are known as efficacious peripheral sensory irritants that create irritating or noxious sensations due to their acute action on the sensory nervous system of the eyes, respiratory tract, and skin. OC is the only naturally occurring RCA and capsaicinoids are the most important chemicals in OC. Capsaicin activates protective reflexes such as bronchoconstriction, sneezing, coughing, apnea, and/or rapid shallow breathing in response to airway irritation. Other RCAs possess similar effects. The recently developed product PAVA is a so-called synthetic capsaicin.[1,4]

RCAs are generally thought to have high safety margins without long-term health effects, however, this is not always the case. RCAs also may have chronic effects and their safety ratios may be lower than expected, especially in more vulnerable subjects.[5–8] In some cases RCAs have been found to have harmful effects on humans through their solvents and/or carriers and through impact injuries caused by delivery systems (i.e.,cartridges).[9,10]

The proper use of RCAs is described in police guidelines. These guidelines specify that RCAs should not applied intentionally in a concentrated form directly to a person. Such agents should be applied by trained police officers and may aggravate pre-existing medical conditions (e.g., asthma, emphysema, bronchitis, heart ailment, and the like).[11–13]

Suspected extra-legal, arbitrary, and summary executions can be investigated under the Minnesota Protocol, a detailed set of international guidelines providing detailed instructions for conducting forensic autopsies and analysis of skeletal remains.[14] The Minnesota Protocol was adopted by the UN the Economic and Social Council in its resolution 1989/65 on May 24, 1989. Another international standard that is widely used is the European harmonization of medico-legal autopsy rules.[15] Although these standards are not specifically designed for investigating suspected cases of deaths associated with the use of RCAs, they still can be applied for these cases.

In this study we reviewed deaths associated with the use of RCAs with an aim at assessing how the presenting pathologies may inform autopsy conclusions concerning cause of death. Also, we have identified additional steps that should be taken into consideration for possible addition to the Minnesota Protocol and the European harmonization of medico-legal autopsy rules in cases of deaths subsequent to the use of RCAs.

2. Methodology

Search databases were PubMed/MEDLINE and Web of Science up to August 2013. The relevant search terms “Riot control agent”, “Crowd control agent”, “pepper spray”, “pepper gas”, “Chloroacetophenone”, “Chlorobenzylidene malononitrile”, “Dibenz (b, f) 1: 4 −oxazepine”, “Oleoresin of capsicum”, “'oleoresin capsicum”, “pelargonic acid vanillylamide”, “death” and “harmful effect” were used. Moreover the reference lists in selected articles and the abstracts published at major international conferences were manually searched. To retrieve additional grey literature reports, conference proceedings and newspapers, the search was expanded by using the generic search engine Google with the same keywords (www.google.com, between 01.01.1995 and 01.08.2013).

There were total 10 lethal cases were found where RCAs were a main cause of death or contributory factor to death.

3. Case summaries

3.1. Case 1

3.1.1. 29-year-old Caucasian male

After struggling with the police, the subject barricaded himself in his room. The patient was exposed to chloroacetophenone (CN) in this room for approximately 30 min. Dimensions of the room were 9′1″ × 9′1″ × 8′6″ and only a small high window, which was raised slightly, and one broken panel of a wooden door allowed for ventilation. Family history indicates the subject was paranoid and had experienced periods of self destructive tendencies.

3.1.2. Antemortem findings

On admission to the hospital the patient was agitated and under restraints. The conjunctivae were suffused. The pupils were small and unresponsive, There was abundant mucoid discharge from both the nose and the mouth. The subject remained in a semi-comatose condition for approximately 12 h and then suddenly developed pulmonary edema and died.

3.1.3. Postmortem findings

The face, neck, and upper chest were intensely cyanotic and the conjunctivas were markedly suffused. The mouth and nasal passages exuded abundant frothy fluid.

Each lung weighed approximately 1000 g. The mucosa of the trachea and bronchi was tremendously swollen and covered by a frothy pale fluid. One section of the lungs the pulmonary tissues showed extreme edema and in the basilar portions, (particularly posteriorly), there were foci of intra-alveolar hemorrhage. All of the respiratory tissues, starting from the mucosa of the pyriform sinus and including the intrinsic structures of the larynx and extending to the trachea, showed marked swelling and were covered with bubbly frothy fluid.

Microscopic Examination: Multiple sections from the larynx, trachea, and bronchi showed diffuse superficial acute necrosis of the respiratory mucosa with the formation of a pseudomembrane of fresh fibrin mixed with acutely inflammed cells. The submucosal tissues were tremendously swollen due to congestion, edema, and acute inflammatory cell infiltration.

Many of the bronchioles showed desquamation of the epithelium lining and their walls were edematous and acutely inflamed. In other regions the desquamated surface was covered by a fibrinous pseudomembrane. The adjacent pulmonary arteries showed occasional acute inflammation on their walls. The alveolar capillaries were markedly congested and virtually all of the alveoli were filled with protein-rich fluid. In places, a hyaline membrane lined the alveoli. In other foci the presence of fluid mixed with blood and acute inflammatory cells was indicative of early bronchopneumonia.

Cause of death: Chloroacetophenone (CN) Poisoning.[16]

3.2. Case 2

3.2.1. 33-year-old Caucasian male

Following a disturbance in a maximum security prison, inmates were exposed to CN and CS for approximately 110 min. The ventilating fans of the building were turned off and the windows and doors were closed during the incident. The subject was found dead under his bunk approximately 46 h after the initial exposure.

3.2.2. Postmortem findings

Cyanosis of the face and head were present. Subpleural petechiae were present in both lungs (right, 780 g and left, 850 g), which were hyperemic with mild edema. The entire larynx and tracheobronchial tree were covered with gray−white material, characteristic of exudate with pseudomembrane formation. Patchy, ill-defined small areas of consolidation were evident in the lungs.

Microscopic examination revealed extensive necrosis and ulceration of the mucosal epithelium of the larynx, trachea, and bronchi and its replacement by a pseudomembrane of fibrin-rich exudate containing polymorphonuclear leukocytes and their degenerating forms. Scattered areas of bronchopneumonia were