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Review

The problem of police-related cardiac arrest

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ABSTRACT

The term "positional asphyxia" was originally used to describe the situation in which the upper airways becomes compromised by sharp angulation of the head or neck, or where the chest wall is splinted and the diaphragm is prevented from moving because of an unusual position of the body. The term was redefined in the early 1980s to describe sudden death during physical restraint of an individual who is in a prone position. A large percent of reported victims were overweight males. Most were in early middle age and manifesting psychotic behavior at the time of death. Most were reported to have unremarkable autopsies, save for the finding, in many cases, of cocaine or methamphetamine (more recently synthetic cannabinoids and cathinones as well). As no cause of death was apparent (other than non-specific signs such as pulmonary edema), it became common practice to attribute death to force exerted on the decedent's back. When experimental studies with human volunteers disproved this notion, the term "restraint asphyxia" was substituted for positional asphyxia, but with nearly the exact same meaning. No experimental study has ever determined the actual amount of force necessary to cause asphyxia by force applied to the back (although the range of required static force is known), nor the duration for which it must be applied.

This review discusses the epidemiology and the evidence for and against the theory of "restraint/positional" asphyxia. It also considers alternative theories of causation, including the findings of studies suggesting that cardiac channelopathies/cardiomyopathies may explain many cases of ARD.

1. Introduction to arrest-related deaths

More than 80% of individuals who experience a cardiac arrest are over 65 years of age and atherosclerosis is the underlying cause in the vast majority of cases.[1] Less than half of those with witnessed cardiac arrests are found to have an initial rhythm of ventricular fibrillation or ventricular tachycardia,[2] the remainder present with pulseless electrical activity or asystole.[3] The older notion that asystole occurred only after prolonged ventricular fibrillation no longer applies. In those under 40 years of age the descriptors are entirely different, and when only those under the age of 40 years are considered, a different picture of SCD/ARD emerges.

A 2013 study retrospectively analyzed cases of SCD in a Canadian population cohort under the age of 40. Information was extracted from a coronial database of 1741 deaths that had occurred during the year 2008. The researchers identified 174 cases of SCD in individuals aged two to 40 years. In 126 of the cases (72%), structural heart disease was identified, but in 48 cases (28%), nearly one-third, no cause of death could be identified, and arrhythmia of unspecified origin was presumed to be the cause of death. Because this was a retrospective study, neither the cardiac dissection protocols used, nor the findings of the cardiac examinations were mentioned,[4] if they were ever recorded in detail.

In 2015 Krexi et al. reported the results of another retrospective study. A protocol for extensive examination of the heart, a cardiac pathologist was applied.[5,6] A cohort of 110 successive SCD cases were analyzed with the goal of studying SCD occurring during, or immediately after the occurrence of a stressful event in a predominately young cohort (mean age 36 years). Diverse psychological and physical stressors were considered, ranging from the taking of an important school examination, to being involved in a fistfight or automobile accident (without injury). Only 10% of the deaths reported in the entire group involved police restraint

Abbreviations: ARD, Arrest related death; BJD, Bureau of Justice Statistics; CI, Cardiac Index; CI, Confidence Interval; CO, Cardiac Output; LE, Law Enforcement; LQT, Long QT Syndrome; LVODT, left Ventricular Outflow Tract; MPRP, Maximal Prone Restraint Position; MVV, Maximal Voluntary Ventilation; PEA, Pulseless Electrical Activity; PVC, Premature Ventricular Contraction; SaO2, Hemoglobin oxysaturation; SCD, Sudden cardiac arrest; SUDEP, Sudden Death in Epileptics; SV, Stroke Volume.

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("arrest – related deaths," or ARD). A striking 53 percent of the hearts were found to be free of apparent structural abnormality, leading the authors to conclude that cardiac channelopathies, or cardiomyopathy of unspecified type had predisposed to stress-induced SCD.[7] The presenting rhythm at the time of witnessed arrest was not reported, and the authors speculated that almost any type of ventricular arrhythmia was possible.

When unexplained sudden death occurs in immediate proximity to a stressor, the suspicion immediately arises that temporal proximity establishes a causal nexus between outcome and stressor. This is, of course, one of the oldest and most tempting fallacies in formal logic ("post hoc ergo propter hoc" – "after this, therefore because of this"). Only 10% of stress-associated deaths found in the Krexi study involved police (ARD), yet such events always receive a disproportionate share of media coverage and raise suspicions of police misbehavior. When fallacious reasoning is combined with preexisting conformational bias (selecting information that supports an existing belief or goal and suppressing information that is contradictory) and foundational bias (a conclusion based on lack of basic fundamental knowledge), false conclusions become unavoidable. The result is that not only do ARDs go unexplained, at least in any acceptable scientific sense, but also that courts, not scientists, are left to determine causation, as unexplained ARD invariably results in litigation. That should not be the case. The purpose of this paper is to identify and review both the most common misconceptions about ARD and the concensus of existing peer-reviewed scientific literature on the problem new avenues of research into possible genetic mechanisms of death will also be briefly reviewed.

1.1. Incidence

Unlike gun shot-related deaths or blunt trauma, ARDs are rare. Even in the United States, where the subject generates considerable media coverage and outrage, the incidence of ARD is hard to know because functional monitoring systems are not in place. In 2008 approximately 43 million face-to-face contacts between the public and law enforcement personnel (LE) occurred.[8] Force was threatened or used in 1.4% (560,000) of these incidents, or once per 1234 encounters (0.08%) with death resulting once per 1269 uses of force, or 0.002% of the time. Out of 13 million actual arrests, approximately 600 deaths (0.003%) occurred.[8,9]

Comparison of demographics between cases of ARD and police encounters where non-lethal forces had been used is revealing. ARD victims are >80 percent white, largely middle aged, and nearly 90% male (see Table 1 below). Individuals who had a police contact where force was used, but no death resulted, were only 72.4 percent male. Of these, both male and female, 58.6% were white, 26.3% were Black > African American, and only 13.7% Hispanic. Two-thirds of all the arrestees were over age 30 years.[10] Given the paucity of data about ARD cases, it is not possible to conclude with any certainty, but it appears that women are, in some way, less vulnerable to ARD. Whether or not that is really the case has not been established. Many more cases must be considered before a statistically valid conclusion can be reached.

In 2014, the Bureau of Justice Statistics (BJS), the agency responsible for identifying and reporting all eligible cases of ARD to the United States Justice Department, undertook a review of the completeness and accuracy of their database. BJS concluded that their data collection process was deeply flawed, at least regarding ARD, and did not identify nearly as many deaths as were occurring. They promptly ceased publication (http://www.bjs.gov/index.cfm?ty=tp&tid=82). In the absence of reliable information from the Federal Government, this leaves only peer-reviewed published epidemiologic studies as the only other reliable source of data, although efforts to form non-government reporting sources are ongoing.

However, we are not entirely without data. A paper in the Journal of Trauma and Critical Care, published earlier this year (e-published ahead of print), reviewed data collected by five different government sponsored reporting systems. The review was designed to detect reported police encounters, arrests, and ARDs occurring from 2003 to 2011. This CDC survey reported that a total of 715,118 non-fatal injuries and 3156 fatal injuries of civilians occurred during the time period. The Nation Wide Inpatient Sample (another government database, NIS) captured a total of 19,482 inpatient admissions related to law enforcement injuries. This represents non-fatal injury rate of a 0.9%. Mortality for the whole nine-year period was 0.0004 with a 0.004% per arrest rate for civilians during the nine-year period. The Bureau of Justice Statistics (BJS) reported a total of 4523 "arrest related deaths" during that same nine-year period (0.005% mortality rate per arrest). Of these 2931 of the deaths were deemed "arrest related homicides," accounting for 65% of all ARD.[11,12]

2. Epidemiologic estimates and indicators

A study based on internet-reported incidents identified 162 arrest-related deaths within the United States, during the year 2009, was published in 2013. Unfortunately, because of the methodology employed, the denominator can only be guessed, leaving the incidence undetermined. However, the patient demographics of the reported deaths fit the well-recognized pattern seen in ARD: white men with a mean age 36 years, many obese, with virtually all decedents exhibiting bizarre, agitated behavior. Usually there were reports of drug abuse just prior to death. Law enforcement control techniques employed in these 162 cases included none (14%); empty-hand techniques (69%); use of intermediate weapons such

Table 1
Distribution of time from system onset to death, race, and sex in published case series and studies of ARD.

Study	First hour	1–48 h	>48 h	Race	Sex
Mash et al., n = 99, with ED, 6 hobbled (Ref[14])	42%	47%	15.5%	White, 91% Black, 32.9% Hispanic, 19%	White women, 8%; Black women 4%; Hispanic 1%; Total 8.9%
Krexi et al. x 110, no hobble, just stressful event, 7% involved[7]	100%	–	–	Race not given	89% males
Hall et al., 1 death out of 4828 violent police encounters, had ED not prone[13]	100%	–	–	Race not given	87.5% males
Ross et al., no deaths out of 110,173 arrests 1085 prone, <200 hobbled[11]	0%	0%	0%	Race not given	87% males
Stratton et al. X 20, with ED, all hobbled[43]	100%	–	–	White, 20% Black, 30% Hispanic, 30%	95% males