G86 Inferior Vena Cava Compression: A Possible Mechanism for Arrest Related Death

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After attending this presentation, attendees will understand a potential pathophysiologic mechanism of arrest related death (ARD) not previously studied or discussed in the literature.

This presentation will impact the forensic science community by providing a possible explanation for sudden, arrest-related death that is not yet established in the literature.

The physiology of sudden ARDs proximal to restraint has not been elucidated. Prior work has not suggested a relationship between position, restraint, or thorax compression up to 50 lbs with regard to clinical impact on respiration. However, the impact of these variables on Central Venous Return (CVR) has not been studied. Decreased CVR is a theoretical concern in a subject with tachycardia from resistive exertion, mental excitement, or sympathomimetic ingestions. A sudden change in CVR could cause an acute decrease of cardiac preload leading to possible decreased coronary artery perfusion pressure and ischemia or the induction of a maladaptive neuro-cardiogenic reflex. This, in turn, could lead to a brady-asystolic cardiac arrest. This study used ultrasound to measure the size of the Inferior Vena Cava (IVC) as a surrogate marker of CVR when positional change and thoracic compression occurs.

This was a prospective study of human volunteers. Subjects had ultrasounds of their IVC in transverse and longitudinal planes performed in four positions. Maximum and minimum measurement values were obtained in each position after accounting for respiratory variability. The four positions were: (1) standing; (2) lying prone; (3) lying prone with 100 lbs of weight applied uniformly to the upper back; and, (4) lying prone with 147 lbs of weight applied uniformly to the upper back. The weight was meant to simulate thoracic compression during a restraint procedure. A custom table and weight mechanism was used to allow access to visualize the IVC in the prone position and to apply the weight

uniformly to all subjects. IVC values were measured with a handheld ultrasound with a phased array (5-2MHz) transducer, operated by an RDMS sonographer. Data were analyzed using descriptive statistics and k sample for equality of medians test.

There were 24 subjects that completed the study protocol. The median (interquartile range) IVC measurements for all positions are as follows:

- Longitudinal maximum was 1.86 cm standing (1.57-2.16), 1.67 cm prone (1.05-2.26), 1.205 cm with 100 lbs compression (0.83 - 1.58), and 0.805 cm with147 lbs compression (0.46-1.29), ($p < 0.0001$).
- Longitudinal minimum was 1.21 cm standing (1.01-1.51), 1.14 cm prone (0.64-1.61), 0.70 cm with 100 lbs compression (0.45-1.02), and 0.28 cm with 147 lbs compression (0.0-0.79), ($p<0.0001$).
- Transverse maximum was 1.63 cm standing (1.43-1.93), 1.45 cm prone (1.17-2.02), 1.12 cm with 100 lbs compression (0.76-1.65), and 0.74 cm with 147 lbs compression (0.46-1.13), ($p<0.0001$).
- Transverse minimum was 1.18 cm standing (0.93-1.39), 1.01 cm prone (0.77-1.47), 0.38 cm with 100 lbs compression (0.0-1.15), 0.31 cm with 147 lbs compression (0.0-0.52), ($p<0.0001$).

There was significant difference between the IVC size in the longitudinal and transverse planes at maximum and minimum between all positions. The IVC size was greatest while standing. It became sequentially smaller with prone positioning and application of weight force. It was smallest while lying prone with 147 lbs of thorax compression. These findings support a possible pathophysiologic mechanism of ARDs that has not previously been reported. Further study in this area is recommended.

Arrest Related Death, In-Custody Death, Sudden Death

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