
Spontaneous DCC (s-DCC): Is a proposed mechanism of spontaneous respiratory arrests in individuals with critical diaphragm fatigue thought to cause some cases of SIDS, SUDC and SCD. Sleep is an especially vulnerable time, primarily because of REM sleep inactivation of airway dilator and respiratory accessory muscles (added diaphragmatic workload). The process is rapid, with only 5-10 s before hypoxic syncope and 1-2 min before cardiac arrest ensue (however, can be aborted by rescue breaths).

Traumatic DCC (t-DCC): Is speculated to be a severe form of abdominal winding injury (celiac or solar plexus syndrome). It occurs from a heavy, non-penetrating blow to the epigastrium or chest, stunning the diaphragm and inducing respiratory arrest by a *sustained* diaphragmatic spasm (diaphragm cramp). As above, this would rapidly progress to syncope, cardiac arrest and death if not aborted. In contrast, milder impacts induce a forced expiratory apnea from *transient* diaphragm spasm, whereby the victim cannot inspire momentarily (until the diaphragm recovers).

Seizure DCC (sz-DCC): Seizure activity is proposed to hyperstimulate the diaphragm via the phrenic nerves (causing SUDEP by terminal apnea). This presents as a mixture of periictal hyperpneas, hypopneas and apneas, causing net hypoxemia (and sometimes cyanosis). This alone can trigger DCC. However, if seizure continues, lactic acidosis and critical hypoxemia will develop (both of which impair skeletal muscle contractility), and could also catalyze DCC. Additionally, a postictal roll to prone position, compensatory tachypnea or onset of REM sleep can trigger delayed-onset DCC (added diaphragm workload).

- 1 Historically, compared to the other vital pump (heart), the diaphragm has been grossly understudied and underappreciated as causing serious disease.
- 2 DCC is thought to have exceptionally high mortality (few survivors who live to talk about it). The most commonly affected age groups in s-DCC are infants and preverbal children; too young to remember (childhood amnesia). Also, nocturnal cases are triggered in REM sleep, a deep sleep stage that makes recall of events less clear. Those who survive hypoxic syncope of t-DCC will likely have retrograde amnesia, unable to recall the respiratory arrest (e.g. collapse of NFL player in 2023).
- 3 The process is unwitnessed in nocturnal cases, and silent because of the inspiratory arrest (victim unable to cry out for help).
- 4 Death from DCC respiratory arrest is rapid and mimics other conditions like choking, seizure and collapse from a sudden cardiac arrest (e.g. VFib, VTach). This would lead to misclassification of the primary cause of death. Those in fatal winding injuries would be also be misclassified as traumatic cardiac arrests or commotio cordis.
- 5 Excitation as diaphragm spasm or cramp is not visible because the diaphragm is internal. Specialized studies are needed. Also, excitation is difficult to capture because of its spontaneous, unpredictable and transient nature. Continuous diaphragm EMG offers the best alternative; however, spasms and cramps would then need to be filtered from electrical noise and body movement artifacts.

- 6 Similar to VFib and VTach of the heart, pathological excitation of diaphragm muscles do not persist postmortem (making it undetectable at autopsy). Also, the internal mechanical airway obstruction of DCC is not visible (as the offending agent is the diaphragm itself).
- 7 Gross evidence of diaphragm excitation is not visible to the naked eye. Also, current autopsy guidelines in sudden unexpected deaths omit diaphragm histology, thus, missing the myopathic changes.
- 8 Given DCC apnea is silent, it can go undetected at home and in non-monitored hospital inpatients. Even in patients receiving respiratory monitoring, airflow is not measured; rather chest impedance (respiratory efforts only). Because of continued chest movements in DCC (attempting to breathe against obstruction), the apnea alarm is not triggered. Also, where many false alarms occur, as is common on busy wards, apnea alarms sometimes do not receive immediate attention (as does cardiac arrest). Therefore, the apnea of DCC is being missed in all settings. Lastly, oxygen desaturation alarms are a late finding, thus missing the critical event.

DCC: diaphragm cramp-contraction, SIDS: sudden infant death syndrome, SUDC: sudden unexplained death in childhood, SCD: sudden cardiac death, SUDEP: sudden unexpected death in epilepsy, EMG: electromyography, VFib: ventricular fibrillation, VTach: ventricular tachycardia

Table 3 – Why diaphragm cramp-contraction is unknown to medicine. Speculation is provided as to how it has evaded detection historically.