

Sudden Cardiac Arrest CLIFF Peer Review

1. *Strength of evidence presented in CLIFF in modeling the characteristics and mission impact of this medical condition within the spaceflight environment?*

Score: 3

Grading Scale:

4 – Confident

3 – Somewhat confident

2 – Neutral

1 – Somewhat unconfident

0 – Not confident

2. How confident are you that these data accurately represent the spaceflight environment?	Tables 1, 2 Composite Incidence and Level of Confidence	Table 3, 4 BC/WC Loss of Crew and probability	Table 4 - Clinical Phase 1, 2 durations Table 5 – CP 2 Loss of Crew	Table 4 – RTDC % Table 6 – RTDC Loss of Crew	Table 4 – Loss of Crew Life % Table 7 – Loss of Crew Life, Loss of Crew	Table 8 – TI
Score	3	3	2	3	4	4

Comments and limitations:

1. General comments. This CLIFF characterizes sudden cardiac arrest (SCA) that could occur during spaceflight. SCA is a condition in which the heart either stops beating, or there is an arrhythmia such as ventricular fibrillation or ventricular tachycardia that results in very low or non-existent cardiac output. There are a number of etiologies including metabolic derangements such as hyperkalemia, an ischemic event, toxins, electrical shock, or drugs causing prolongation of the QT interval. Due to lack of adequate cerebral perfusion, SCA can quickly lead to irreversible brain injury; thus, quick recognition and response to this emergent condition are paramount. Astronauts are well-screened, so it is unlikely that SCA in spaceflight would be due to a pre-existing condition. There have been no reports of SCA during spaceflight. The best case definition is a witnessed arrest with a cardiac rhythm of ventricular tachycardia or ventricular fibrillation, responsive to airway management, defibrillation, and CPR. The worst case definition is an unwitnessed arrest, a witnessed arrest with a cardiac rhythm other than V-Tach/V-Fib, or an arrest that is non-responsive to airway management, defibrillation, and CPR.

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2. Incidence. Since there is no spaceflight data available, the incidence calculation was primarily based on a study of US Air Force active duty flight crewmembers. This is a reasonable analog to the astronaut population since USAF air crewmembers are well-screened, generally healthy, and the study group was similar in age to astronauts (31-53 years, average age 44 years). Over the 5 year study period, there were 8 cases of sudden cardiac death reported, yielding a mean of 4.775×10^{-5} per person year. The limitations of this study include the lack of female representation and the assumption that sudden cardiac death is the same as sudden cardiac arrest. These limitations are offset by the finding that females have a lower risk of sudden cardiac death, and by the fact that most SCA leads to death and therefore meets the definition of sudden cardiac death. The best case/worst case probabilities used data from three large terrestrial studies that estimated the risk of VT/VF arrests which is the best case. The estimates ranged from 21.5% to 36.7%. A midpoint of 25% was chosen based on a preference for the most recent data. The clinical phase durations, RTDC and Loss of crew life probabilities are supported by terrestrial evidence, and I am in agreement with their calculation. RTDC was determined to be 100% in all cases by the clinical science team. The Loss of crew life for all untreated cases was estimated at 100% and approached 100% even for the treated cases. The probability density curve that was derived appears to be a reasonable representation of the data presented.

3. Clinical phase data. I am in agreement with the clinical phase 1 duration entered in this CLIFF. This data was compiled by a team of expert clinicians, and I was involved in the discussions leading to the calculation of the clinical phase duration. CP2 was supported by terrestrial evidence.

4. Task impairment. The analysis was performed and reviewed by a separate team of expert clinicians. I am aware of the methods that were used but did not directly participate in the discussions.

5. Dependence on mission phase or duration of mission. This medical condition is not dependent on mission phase although underlying coronary heart disease leading to sudden cardiac arrest may be unmasked during heavy exertion.

6. Limitations

- There are no reports of SCA during spaceflight, so analog data was used to calculate the incidence.
- An analog population of USAF crewmembers were used to inform the incidence. The limitations of this study include the lack of female representation and the assumption that sudden cardiac death is the same as sudden cardiac arrest. These limitations are offset by the finding that females have a lower risk of sudden cardiac death, and by the fact that most SCA leads to death and therefore meets the definition of sudden cardiac death.
- This medical condition is not dependent on mission phase although underlying coronary heart disease leading to sudden cardiac arrest may be unmasked during heavy exertion.
- There is likely to be significant overlap with other conditions whose end state is cardiac arrest. Examples of other CLIFFs where they might be overlap include cardiogenic shock, seizures and acute coronary syndrome.

Reviewed by:

David C. Hilmers