

EVA Related Paresthesia 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	3	3	3	3

Comments and limitations:

1. General comments. This CLIFF evaluates paresthesias (pain, “tingling” or loss of sensation) during EVA’s and specifically refers to a neuropathy caused by sustained pressure from the suit. This is generally a transient condition that resolves after pressure is removed from the affected body part. However, a compressive neuropathy of greater consequence may result from sustained pressure to a nerve over the course of a long EVA. The most frequently reported paresthesias are of the digital, ulnar, median, supra-clavicular, and peroneal nerves. Suit design has been implicated in conditions such as paresthesias, and important advances have been made throughout the space program to improve the comfort of the suit, including pressure points. It is unclear how well historical data that documents the incidence of paresthesias in older suits will inform the frequency in newer designs. However, even the best designs will still not fit perfectly, particularly during EVAs requiring repetitive movements that result in pressure points. Most paresthesias are transitory and may resolve during the EVA; thus, they may go unreported. The best case is considered to be mild paresthesia or local pain from a pressure or EVA suit pressure point, with tingling, numbness, and/or

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pain that resolves spontaneously. The worst case is a moderate to severe paresthesia and/or localized pain from a pressure or EVA suit pressure point that may require treatment with analgesics and/or steroids.

2. Incidence. The incidence for this condition is derived from the previous IMM CLIFF which was defined similarly and which used the 2010 and 2017 LSAH data drops. There has been no additional spaceflight data to inform this CLIFF since 2017. According to this dataset, there have been 53 paresthesia events related to EVA in 414 person-EVAs. It is likely that minor paresthesias are transitory and have gone unreported in the past which could lead to a small underestimate of the true incidence value. The exploration EMU may have a lower incidence of paresthesia because of better suit design; therefore, the incidence could be overestimated. The best case/worst case probabilities used data from preflight NBL training sessions in which 3 out of 114 reported paresthesias resulted in compressive neuropathy. Thus, 3/114 (2.6%) was assigned as the worst case value. The clinical phase durations, RTDC and Loss of crew life probabilities are supported by terrestrial evidence, and I am in agreement with their calculation. Both RTDC and Loss of crew life probabilities were considered to be zero given the medical condition definition. 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 dependent on mission phase as it is only applicable to EVA operations.

6. Limitations

- Under-reporting for this condition could have occurred during past space missions due to transitory paresthesias that were not of clinical consequence. This may result in underestimation of the incidence.
- The incidence was based on historical data from past spaceflights which used EVA suits that will not be utilized during exploration missions. Since the exploration space suits will presumably incorporate improvements in design, it is possible that the incidence of paresthesias will be lower than historical experience.
- There may be some overlap between the incidence estimate in this CLIFF and ICL 46 EVA Related Suit Contact Injury. The incidence for this CLIFF was taken directly from the IMM CLIFF and Antonsen et al, 2017 corroborates that the diagnosis of interest was reported as "paresthesia" for at least the first half of the events included. The incidence for ICL 46 EVA Related Suit Contact Injury was based only on documented abrasions and contusions caused by the suit (Scheuring et al, 2009).
- The clinical phase durations for this CLIFF were all taken from the prior IMM CLIFF which is based on an EVA Review Lockdown done in 2010. The ExMC composer/editor of this CLIFF does not have access to that primary source but felt after looking through multiple other sources that these estimates for duration were reasonable given that they are based on spaceflight data.

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- The ExMC composer/editor of this CLIFF assumed that RTDC and Loss of crew life for worst-case scenarios was 0%. A search through the NASA Technical Reports Server corroborated this assumption (i.e. no literature to support RTDC or Loss of crew life from EVA related paresthesia was identified).

Reviewed by:

David C. Hilmers