Neck Strain/Sprain 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: 2

   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*	*2*	*2*	*2*	*2*	*3*

Comments and limitations:

1. **General comments.** Non-specific neck pain is a very common complaint which generally arises from an injury, sprain or strain to the supporting muscles or ligaments attaching to or located near the cervical spine. Terrestrial studies show that acute, non-specific neck pain resolves in 90% of cases and becomes chronic in 10% of cases. Many of the terrestrial studies available investigated disability or sequalae from whiplash injuries, which are unlikely to occur in microgravity. Therefore, there is a paucity of data regarding neck sprains/strains as specifically defined in this CLiFF. The best case is considered to be a Grade I or II strain/sprain in which there is minimal or partial muscle or ligamentous tearing while the worst case is a Grade III strain/sprain in which there is full thickness muscle or ligamentous tearing, and/or instability.

2. **Incidence.** The incidence distribution for this CLiFF is based on 14 documented U.S. in-flight "neck injuries" that were reported in annotated reviews of records from Mercury through ISS Expedition 40. Unfortunately, there is no further characterization of the neck injuries. Some of these cases may not fit the CLIFF definition, leading to a possible overestimation of the composite incidence. The best case/worst case probabilities were challenging to calculate because there is little

data available that characterizes the best/worst case definitions. As a result the editor used a range of values for best case from 40-90%. The lower number used data from the previous IMM CLIFF for this medical condition which had a slightly different best/worst case definition. The larger number came from a study investigating the outcomes after terrestrial whiplash injuries. Again, clinical phase durations, RTDC and Loss of crew life probabilities are hampered by a lack of evidence that supports the best/worst case definitions used in this CLIFF. Some of the clinical phase durations were modified by the editor based on expert opinion. The studies that were cited in these calculations were supported by terrestrial evidence, and I am in agreement with their calculation. Loss of crew life probability was 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 should be largely independent of mission phase. The influence of partial gravity during surface lunar or Martian operations could alter the mechanism of neck injury, however.

6. **Limitations**

- The incidence for this CLiFF is based on in-flight "neck injury" data. While most of these injuries were likely sprains/strains, some may not, leading to an overestimation of the true incidence.

- Clinical phase duration, RTDC, and Loss of crew life were difficult to calculate due to the best/worst case definition used in this CLIFF. Most of the literature pertains to non-specific neck pain or whiplash and uses different grading schemes than this CLIFF.

- There is a paucity of data available to inform the best and worst-case probabilities, as defined, for this condition. Therefore, a range was assigned using prior IMM values (BC: 40%, WC 60%) and data regarding the proportion of non-specific neck pain cases that become chronic (10%). The final range assigned was BC: 40-90% and WC: 10-60%.

- There is a paucity of data related to neck sprains/strains as defined by this CLiFF. Most terrestrial literature deals with non-specific neck pain, neck injury (typically from high force accidents like motor vehicle accidents), or whiplash (again typically from MVA). This limits the applicability of this data to this CLiFF and to the spaceflight environment. This may lead to an overestimation of the clinical duration of a neck sprain/strain as defined by this CLiFF.

Reviewed by:

David C. Hilmers