

Lower Extremity sprain/strain 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	3	3

Comments and limitations:

1. **General comments.** Sprains and strains arising from injury to the supporting muscles, ligaments or tendons of the lower extremity are among the most common musculoskeletal complaints. As defined in this CLIFF these injuries include strain/sprain to the hip, thigh, knee, calf, Achilles tendon, ankle and foot. Sports injuries, overuse, trauma, and falls are common mechanisms on earth. In microgravity, however, the incidence of trauma, sports injuries, and falls would be expected to be lower. In partial G, that would be encountered during surface lunar or Martian operations, the incidence may be slightly higher. The best case is considered to be a Grade I (minor) or II (moderate) strain/sprain in which there is minimal or partial muscle or ligamentous tearing while the worst case is a Grade III (severe) 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 55 documented U.S. in-flight “ankle, hip and knee sprain/strains” that were reported in several annotated reviews of records from Mercury through ISS Expedition 40. Terrestrial and analog studies were not deemed to be useful because of differences in environment, in mechanism, and in demographics. The best

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case/worst case probabilities used data from two military analog sources that examined the rate of hospitalization for lower extremity injuries. The clinical phase durations, RTDC and Loss of crew life probabilities are supported by terrestrial evidence, and I am in agreement with their calculation. 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. EVA operations may have a higher incidence since astronauts must overcome the resistance of the suit while working which may result in strain/sprain to the lower extremities. In addition, the incidence may be higher during partial G surface operations.

6. Limitations

- Under-reporting for this condition could have occurred during past space missions due to subtle strain/sprains to the lower extremity that may not have been mentioned during debriefs. This may result in underestimation of the incidence.
- This medical condition may be dependent on mission phase. EVA operations may have a higher incidence since astronauts must overcome the resistance of the suit while working which may result in strain/sprain to the lower extremities. In addition, the incidence may be higher during partial G surface operations..
- The incidence of this condition is based on spaceflight data regarding in-flight ankle, knee, and hip sprains/strains. Ankle sprains are the most common lower extremity sprain/strain which makes this approximation reasonable, but the incidence of all lower-extremity sprains/strains may be underestimated due to the limited incidence data.
- The maximum duration for the treated worst-case scenario is based on a systematic review of poorly defined return to play criteria after Achilles tendon rupture. Terrestrially, return-to-play takes longer than return to normal activity or work activity because the dynamic forces on the tendon during athletic activity (particularly sharp stops/starts and jumping) put it at risk for re-injury. The average return to play time was used, but this may be an overestimate of the duration since it is based on return to play.
- For the untreated scenarios, the data is limited to primarily ankle sprains.

Reviewed by:

David C. Hilmers