

Barotrauma 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	4	3	3	3	4	3

Comments and limitations:

1. **General comments.** Barotrauma of the ear and sinuses occurs when there are pressure changes in the gases trapped within these cavities. This condition happens when there is a difference in pressure between the enclosed volume and the ambient pressure, and the change in ambient pressure overcomes the capacity of the enclosed space to equalize. Changes in pressure occur during space flight missions when the crewmember is transferring between habitable volumes of differing pressures (such as in an airlock), when pressurizing and depressurizing for an EVA, and when contingencies result in changing pressures in the spacecraft. During some space shuttle missions, the cabin pressure was lowered to 10.2 psi to reduce the amount of time needed to pre-breathe by EVA astronauts. It is felt that the risk of barotrauma at constant cabin pressure is extremely low and can be considered zero. Accordingly, the incidence is based on the number of EVA's that are performed during a mission with each participating crewmember at risk. It is felt that this approach represents a significant improvement from the previous IMM CLIFF that covered this condition.

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2. Incidence. The incidence is calculated on a per-EVA basis for each crewmember who participated. In order to use spaceflight data, the number of barotrauma events that were reported during space shuttle and ISS missions (through Expedition 39/40) were calculated using LSAH data. Under the assumption that all reports of barotrauma occurred in conjunction with EVA's, the total number of individual spacewalks during those missions was totalled. This resulted in the incidence of barotrauma per individual spacewalk. There is probably some under-reporting of very mild barotrauma as it can be self-limited. However, the resulting incidence is felt to be a reasonable reflection of the incidence of significant barotrauma. The best case/worst case probabilities, return to definitive care (RTDC) and loss of crew life probabilities are supported by terrestrial evidence. The composite probability density curve that was derived appears to be a reasonable representation of the data presented. The standard deviation is appropriate for the level of uncertainty that exists for the true incidence.

3. Clinical phase data. I am in agreement with the clinical phase 1 durations 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 durations. The phase 2 duration was modified during the course of the review, and I am in agreement with the changes made.

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 mission phase dependent. It is postulated to occur only during the pressure changes associated with EVA. The risk is considered to be zero during periods when the cabin pressure remains constant.

6. Limitations

- Under-reporting for this condition could have occurred during past space missions since barotrauma may be mild and easily cleared by the crew. This could result in underestimation of the incidence.
- If there are significant cabin pressure changes during transition from a lunar/Martian lander and habitat to an orbiting vehicle, these events may also result in barotrauma. Each such occurrence should be considered as a separate at-risk event, equal to an individual EVA. Reconsideration of these risks will need to be done after IMPACT 1.0.
- It is important that MPRAT implement the calculated incidence on a per-crewmember basis. In other words, if three crewmembers experience a pressure change as a result of an EVA, these are three separate events.

Reviewed by:

David C. Hilmers