EVA Related Dehydration 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	*2*	*3*	*3*	*3*	*3*	*3*

Comments and limitations:

1. **General comments.** This CLiFF characterizes dehydration that takes place during or after an EVA due to inadequate fluid intake or excess losses. Inadequate intake could occur from poor personal situational awareness of hydration status or lack of access due to drink bag failure. There are numerous operational and system safeguards in place to ensure that dehydration does not occur. Astronauts are instructed to hydrate prior to a planned EVA. Adequate fluid is available during the EVA to account for losses through exertion and after the EVA to make up for any unexpected fluid deficits. Engineering measures are in place to prevent drink bag failure. Finally, if an astronaut feels that he/she is becoming overly dehydrated and had depleted the drink bag, the EVA could be terminated. Although astronauts performing an EVA may encounter an enormous range of external temperatures, the suit has been designed to closely control internal temperatures and prevent overheating and dehydration despite heavy exertion. There have been no known reports of dehydration during spaceflight EVA's. The best case is considered to be dehydration from EVA that responds to oral rehydration. The worst case is dehydration from EVA that requires intravenous volume repletion or interferes with future EVA's.

2. **Incidence.** Given the lack of spaceflight data on dehydration during, engineering data which estimates the risk of dehydration on a lunar mission was used to calculate incidence. The risk is extremely low, thought to be between 1/10,000 and 1/100,000 per mission. These risks were translated into a distribution, and from this model an incidence proportion on a per EVA basis was calculated using the assumption of an average of 251 EVA's on a typical "long" lunar mission. There is no earth-based analog that can be used to compute incidence. The most robust terrestrial literature investigating dehydration exists in the pediatric literature. The best case/worst case probability is based on a Cochrane study that determined a failure rate of 4% in the use of oral rehydration to treat gastroenteritis in children. The clinical phase durations are based on terrestrial data and expert opinion showing the expected treatment and recovery times to regain a normal volume status. The RTDC surrogate for this condition is considered to be acute renal failure. However, even in the absence of IV fluids, adequate oral hydration should prevent renal failure from occurring. RTDC and Loss of crew life probabilities are both assumed to be zero for all cases whether treated or not. This assumption is based on the availability of ad lib oral fluids to all crewmembers. The probability density curve for incidence that was derived appears to be a reasonable representation of the engineering 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 only is applicable during microgravity or surface EVA's.

6. **Limitations**

- The incidence calculation is entirely determined by engineering risk analysis since there have not been any reports of EVA-related dehydration during spaceflight.
- Dehydration in spaceflight is multifactorial and heavily dependent on crew members being vigilant about their own hydration status prior to and during an EVA. Other operational and engineering safeguards are in place to ensure access to fluids.
- The current schedule of EVAs for our DRM is undetermined. Multiple EVAs on multiple days could substantially increase incidence of dehydration; however, we anticipate this risk to still be extremely low.
- The physical demands of an EVA in partial gravity may vary widely and the exact EVA parameters for lunar missions have not been set. Prolonged exertion may increase the incidence of dehydration over what is calculated in this CLIFF.
- Dehydration contributes to more dangerous disease processes such as rhabdomyolysis and heat illness; thus, the true effects of isolated dehydration are difficult to discern in the literature.
- Renal failure is an extremely unlikely outcome from dehydration during exertional activity alone; therefore, using it as the RTDC surrogate may not be the best indicator of need for higher level of care. However, the need for RTDC for dehydration, in general, is expected to be effectively 0 and thus does not change the approach to this condition.

Reviewed by:

David C. Hilmers