

Burn Chemical Skin 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: 1

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	1	2	3	3	2	3

Comments and limitations:

1. General comments. This CLIFF characterizes chemical burns that affect the skin. There is a separate CLIFF that addresses chemical burns to the eye. The nature and severity of a chemical burn varies widely and is dependent on the individual chemical. Predicting the incidence of burns along with their severity is difficult without knowledge of the hazardous substances carried on board. The risk also depends on the engineering safeguards built into the system to mitigate the risk of exposure. While there have been several reports of thermal burns in space, there have not been any cases of chemical burns. A related CLIFF with a similar definition is ICL 109 Toxic Dermal Injury and there may be some overlap. The best case is considered to be chemical exposure to the skin requiring irrigation that causes superficial damage, OR partial thickness damage involving less than 5% TBSA that meets all of the following criteria: i) non-circumferential, ii) does not cross a major joint line, iii) is not at risk for permanent impairment of body part function (e.g. extensive burns to hands, face, perinium, genitals). The worst case is a chemical exposure to the skin requiring irrigation that causes partial thickness burns involving greater than 20% TBSA, full thickness burns involving greater than 5% TBSA, or burns that meet any of the following criteria: i) circumferential, ii) crosses a major joint line, iii) threatens to impair body part function.

Burn Chemical Skin CLIFF Peer Review

2. Incidence. Since there is no spaceflight data available and military data is limited and primarily focused on chemical weapon injuries, an epidemiologic study from South Korean and a workmen's compensation survey were used to compute composite incidence. This approach is intended to study both the incidence of chemical burns in the general population and in the workplace. The studies break down the burns by location, so that they only apply to dermal burns and not to injuries to the eyes (the subject of another CLIFF). While providing the best data available, the selected studies have several limitations. The incidence of a chemical burn is going to be entirely dependent on the chemicals used during the specific spaceflight and may vary widely from the estimated incidence here. Chemical burns in both the home and workplace are not subject to the same engineering safeguards as are built into spacecraft. The best case/worst case probabilities used data from two studies that looked at length of hospital stay and percentage of second degree or greater burns. A worst case range of 66-96.9% was estimated based on these investigations. The clinical phase durations, RTDC and Loss of crew life probabilities are supported by terrestrial evidence, and I am in agreement with their calculation. 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 not dependent on mission phase but exposure to hazardous chemicals may be greater during EVA's operations near the external surfaces of the spacecraft.

6. Limitations

- A related CLIFF with a similar definition is ICL 109 Toxic Dermal Injury, and there may be some overlap.
- The estimated incidence is dependent on the specific chemicals that will be carried onboard. Depending on the exact nature of hazardous substances on board and the engineering safeguards built in, the incidence may vary widely from mission to mission.
- Chemical burns in both the home and workplace are not subject to the same engineering safeguards as are built into spacecraft which may make terrestrial studies a poor representation of the hazards encountered during spaceflight.
- The BC definition includes partial thickness burn <5% TBSA and the WC scenario include partial thickness >20% TBSA which leaves a cohort of patients that are not covered in either group of medium severity.
- Full thickness burns <5% are not covered in either WC or BC definitions.
- Surrogate BC and WC scenarios for RTDC reference use ABA burn criteria for referral; however, in the ABA criteria all chemical burns should be referred to a burn center. This is not feasible for our mission parameters as small chemical burns without sensitive tissue involvement will likely be treated primarily without evacuation.
- BC and WC have a large range from minimum to maximum values as the studies utilized do not strictly follow our BC and WC definitions. For example, many will break down partial thickness burns into superficial and deep. There are also different cutoffs for minor burns

Burn Chemical Skin CLIFF Peer Review

based on TBSA% with some using 5% while many will use 10%. Likely WC scenario has a slightly overestimated range of values.

- Durations are often dependent on burns in general and are not specific to chemical burns. Chemical burns often involve deep tissue and the duration of condition may be an underestimate but are dependent on the chemicals involved and location of the injury.
- There is a paucity of literature on chemical burns as it only constitutes ~10% of all burns. Thermal burns were used in many instances to determine incidence, RTDC, duration, and Loss of crew life which may not represent chemical burn values accurately.
- As with many conditions, literature on untreated conditions does not exist for ethical reasons and thus duration, RTDC, and Loss of crew life are likely to significantly underestimate actual values.

Reviewed by:

David C. Hilmers