

## Blunt Abdominal Injury (Blunt) CLIFF

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<br>Composite Incidence and Level of Confidence | Table 3, 4<br>BC/WC<br>Loss of Crew and probability | Table 4 - Clinical Phase 1, 2 durations<br><br>Table 5 – CP 2 Loss of Crew | Table 4 – RTDC %<br><br>Table 6 – RTDC Loss of Crew | Table 4 – Loss of Crew Life %<br><br>Table 7 – Loss of Crew Life, Loss of Crew | Table 8 – TI |
| Score                                                                                      | 2                                                          | 2                                                   | 2                                                                          | 3                                                   | 2                                                                              | 3            |

### Comments and limitations:

**1. General comments.** This CLIFF characterizes the risk of blunt abdominal trauma (BAT) during spaceflight. There is a wide range of injuries that can be caused by BAT from mild bruising or superficial abrasions to life-threatening internal organ damage. Estimates of the incidence of BAT on ISS were based on the National Trauma Data Bank incidence rates. However, it is felt that during Artemis missions in which the vehicles are of much smaller size than ISS, the risk of significant abdominal trauma in microgravity is extremely small. Thus, the terrestrial trauma evidence will only be applied during surface operations. Ideally, this would only be applied to non-EVA surface operations since the hard upper torso of the suit protects the abdomen from blunt trauma. However, the current version of IMPACT prevents us from segmenting the mission into surface EVA or non-EVA surface operations. For now, incidence data will apply to all surface operations but not to microgravity operations. There have been 6 reported cases of trunk injuries during spaceflight, but there was no delineation between abdominal and chest injuries making this data non-informative. All the cases reported were mild. For purposes of this CLIFF the best case scenario is defined as blunt abdominal trauma resulting in localized pain/discomfort and/or ecchymosis, with no hollow or solid organ involvement and no evidence of peritonitis or bleeding, requiring only

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supportive treatment. The worst case scenario is blunt abdominal trauma that causes abdominal visceral damage with possible secondary complications of internal bleeding, mesenteric injury, or peritonitis. Sepsis and traumatic hypovolemic shock are separate conditions covered in their respective CLIFFs.

**2. Incidence.** There is little spaceflight data that can be utilized to calculate the incidence of BAT as the descriptions of blunt trauma that have occurred do not specify location. Terrestrial data was therefore used to calculate the incidence rate. The best source was felt to be the National Trauma Data Bank from 2015 (the last year it was compiled). To estimate the types of BAT that might be encountered during spaceflight, incidents were excluded that have mechanisms of injury unlikely to occur among astronauts or that would result in penetrating abdominal trauma as this is not included in the condition definition. These exclusions include motor vehicle traffic (26%), pedal/cyclist (2%), other transport (5%), cut/pierce (4%), and fire arms-related (4%) abdominal injuries. From this data an incidence rate applicable to the spaceflight environment was compiled. As mentioned in the section above, the risk of BAT is considered extremely low in microgravity as compared to a partial gravity environment, such as on the lunar or Martian surface. Since MPRAT currently only has the capability to segment the missions between EVA and non-EVA operations, this incidence will be applied to all surface operations, both on EVA and inside the habitat. This will likely lead to a slight overestimate as the EVA suit will provide protection against BAT. The sample size of the National Trauma Data Bank is large and shows a narrow distribution with a tight variance centered near the estimated incidence. This most likely overstates the precision of the incidence as it applies to the spaceflight environment. The best case/worst case probability split is based on terrestrial studies that showed a range of 6-42% of cases meeting the WC definition. This estimate was decreased by 56% based on the categories of injuries that were not felt to be likely in space or were not included in the case definitions. The BC/WC probability split of 86/14% used the adjusted midpoint of the range of WC injuries reported in the studies. The clinical phase durations, RTDC and Loss of crew life probabilities are supported by terrestrial evidence. RTDC used the need for hospitalization as a surrogate. The RTDC and Loss of crew life probabilities for TBC and UTBC are assumed to be zero by definition.

**3. Clinical phase data.** I am in agreement with the clinical phase 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.

**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 constrained by mission segment. The incidence is assumed to be zero during microgravity operations and is only applied during surface operations.

### 6. Limitations

- There have been 6 reported cases of truncal injuries during spaceflight, but there was no specification as to location or severity of the trauma. Thus, this information was not informative.
- The overall confidence in the mean incidence value is probably overstated because of the large sample size of the National Trauma Data Bank which results in a very narrow probability distribution.

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- This medical condition is constrained by mission segment. The incidence is assumed to be zero during microgravity operations and is only applied during surface operations.
- Estimates of the incidence of BAT on ISS were based on the National Trauma Data Bank incidence rates. However, it is felt that during Artemis missions in which the vehicles are of much smaller size than ISS, the risk of significant abdominal trauma in microgravity is extremely small. Thus, the terrestrial trauma evidence will only be applied during surface operations. Ideally, this would only be applied to non-EVA surface operations since the hard upper torso of the suit protects the abdomen from blunt trauma. However, the current version of IMPACT prevents us from segmenting the mission into surface EVA or non-EVA surface operations. For now, incidence data will apply to all surface operations but not to microgravity operations.
- It is possible that there will be overlap with ICL 116 Traumatic Hypovolemic Shock since abdominal trauma may be the cause of shock.
- If looking at the BC definition in isolation, it is possible that patients with localized pain or bruising may not present to the hospital following blunt abdominal trauma; however, for the purposes of this CLIFF the assumption is made that even a best case scenario blunt abdominal trauma is of sufficient severity to warrant evaluation in the hospital.
- The BC/WC probability split was based on reports in the general population. This included patients older than 70 years and by mechanisms of injury unlikely to occur during spaceflight.

Reviewed by:

David C. Hilmer