Clinical Finding Form (CliFF)

Branch: Baseline

ICL46_Eva Related Suit Contact Injury

EVA related suit contact injuries refer to contusions, abrasions, or hard impacts with the spacesuit. Most contact injuries are minor (Strauss, 2004). Gravity shifting inside the suit during test-runs at the NBL can lead to contact injuries not seen in spaceflight (Chappell et al, 2017).

INCIDENCE DATA INCLUDED IN THE MODEL

The model imports the following incidence information from the MEDPRAT Evidence Library Database: incidence data category, space adaption status, EVA status, incidence data type, incidence and occurrence distribution data and incidence data characteristics. Data category defines the type of data available for incidence calculations (i.e. raw data vs. adjusted data). Space adaptation identifies medical events that where onset occurs in the first 5-7 days of flight and does not reoccur. EVA-related incidence values identify medical events that occur only during an EVA. Incidence values types vary by data category and define the number of medical events per person-year (rates) or medical events per person at-risk (proportion) for each medical condition. Incidence values can be modified by crew characteristics such as gender sex and certain crew medical history characteristics. Modifying characteristics are noted below and incidence values are listed individually for each characteristic. Distributions are assigned to medical events incidence values and occurrences in the model. For each crewmember in a given trial, the incidence and number of occurrences of each medical condition are randomly selected from these probability distributions. Detailed descriptions of the distributions are included in the MEDPRAT Technical Description Document.

INCIDENCE DATA

SPACEFLIGHT LITERATURE

Scheuring et al. (2009) was used to inform the incidence distribution for this condition. The study evaluated the incidence musculoskeletal in-flight injuries among astronauts, as well as skin abrasions, contusions, and lacerations in a review spanning Mercury - Expedition 13 of the ISS Program. 44 contusions and abrasions were attributed to the EVA suit during that timeframe. Of note, these data are based on the Extravehicular Mobility Unit (EMU) suit used on the ISS – not the planned xEMU suit for Lunar surface EVAs. The following data sources were utilized in this review: post-flight medical debriefs, the LSAH medical record database, the Johnson Space Center (JSC) electronic medical record system, including ASCR specialist assessment and treatment logs, and the JSC Flight Medicine Clinic vault records. Musculoskeletal injury data in the ISS program was extracted from the private medical conferences held between the ISS crewmembers and their flight surgeon up to and including Expedition 13, as well as from the ASCR specialists supervising the crewmember's in-flight training regimen. Lastly, several entries came directly from personal communications with astronaut crewmembers or flight surgeons and the authors when not otherwise duplicated. Information collected on each injury included location, type, and a detailed narrative on the mechanism of injury, the type of exercise the crewmember performed during the flight, previous history of injury, treatment, and post-flight outcome. The term " in-flight" included lunar surface operations. This article notes small lacerations and abrasions to the hands are among the most common injuries occurring throughout the U.S. space program.

ANALOG LITERATURE

Strauss, 2004 is a prospective observational study of EVA suit symptoms and injuries experienced by NASA astronauts during EVA training at the NBL from July 2002 to January 2004. 770 test runs across 86 subjects were reviewed. Subjects filled out a comprehensive symptom questionnaire after each test run. Suit contact symptoms were common, occurring in 45.7% of test runs. Excluding hand-related injuries (these are covered by condition ICL42 – EVA Related Hand Injury) and only including contact injuries (i.e. excluding sprains/strains), 143 suit contact events reported (39 shoulder, 40 foot, 14 arms, 20 legs, 19 neck, 10 trunk, and 1 groin). This provides an incidence of 143 suit contact events per 770 test runs. This study could be particularly advantageous in helping to predict risk of suit contact injuries in a partial gravity environment (like the Lunar surface). For instance, the leg complaints were reported as primarily knee contact injuries that were worst with knee flexion and weight bearing. However, unlike the Lunar surface, in the NBL crewmember orientation varies (i.e. it is not limited to ambulation) and gravity shifting inside the suit has been shown to cause injuries that are not seen in the microgravity environment (Chappell et al, 2017). Also, of consideration is that these data are based on the Extravehicular Mobility Unit (EMU) suit used on the ISS – not the planned xEMU suit for Lunar surface EVAs.

TERRESTRIAL LITERATURE

It was assumed that terrestrial data would be inadequate for providing input that drives the incidence of this spaceflight specific condition. No terrestrial data searches were performed.

OVERALL INCIDENCE SUMMARY

INCIDENCE

Mean: 0.1807

SD: 0.02439

INCIDENCE SUMMARY

The incidence for this condition is informed by Scheuring et al, 2009. It reports 44 contusions/abrasions specifically attributed to the EVA suit from Mercury through ISS Expedition 13. Total EVAs Mercury through Expedition 13 was 247. IP: 0.1781 (95%CI: 0.1325, 0.2317). The Bayesian posterior distribution for the incidence proportion given the spaceflight data (44 events over 247 person-EVAs) under an uninformative prior is Beta(shape1=44.79, shape2=203.08) with mean 0.1807 and SD 0.02439.

TABLE 1. INCIDENCE MODEL

Incidence Details

Incidence Type
EVA

Segment
EVA All

Env. Exposure
NA

Sex
Any

Crowns
Any

Contacts
Any

Pregnancy
Any

Incidence Distribution

Occurrence Dist
Binomial

Incidence Dist.
Beta

Mean
0.1807

SD
0.0243901

Beta
(Alpha): 44.79
(Beta): 203.08

TABLE 2. INCIDENCE LEVEL OF CONFIDENCE (LOC)

Citation	Source	LOC Value
Scheuring et al, 2009	Spaceflight	4
Strauss, 2004	Analog	3

Scheuring et al, 2009 reports 44 cases of inflight abrasions and contusions due to the EVA suit from Mercury - ISS Expedition 13. Straus, 2004 is an analog prospective observational study conducted at the NBL in which there were 143 reported suit contact complaints in 770 test runs.

CREWMEMBER SELECTION/PREVENTION

DISQUALIFYING CONDITIONS

Refer to Medical Evaluation Documents (MED) Volume A, Medical Standards for ISS Crewmembers, International Space Station Program, Rev 3.4 (2016).

PREFLIGHT PREVENTATIVE MEASURES

Prevention methods include optimizing suit fit, crew training including avoiding work outside of the normal work envelop, the application of suit padding and pressure absorbing dressings to known affected body areas. (Strauss, 2004)

BEST CASE SCENARIO DEFINITION

Contusions, abrasions, friction injuries (blister, rash, chaffing) that resolve spontaneously. (Note this is exclusive of EVA Related Hand Injuries).

WORSE CASE SCENARIO DEFINITION

Contusions, abrasions, friction injuries (blister, rash, chaffing) that require treatment. (Note this is exclusive of EVA Related Hand Injuries).

CONDITIONS INCLUDED, BUT NOT EXPLICITLY STATED (CNES)

EVA related - Skin blister EVA related - Skin Chaffing EVA related - Contusions

BEST CASE/WORST CASE PROBABILITY COMMENTS

The EIS (Exposure Incidence System) is a comprehensive questionnaire that crewmembers complete after EVA training. As of August 12, 2021 there were 2,970 training exposure events in the database. This dataset does not include in-flight EVA data. Of these 2970 events, 618 reported they had "pain, discomfort, or injuries to report" after the exposure. Of those, 413 indicated that they used "post-exposure therapies (non-prescription medications, heat, ice, or topical analgesics" to treat their symptoms. Therefore, the worst-case scenario (requiring treatment) was assigned 413/618 = 66.82%. The best-case scenario (resolves spontaneously) was accordingly assigned a probability of 33.18%.

TABLE 3. BEST/WORST CASE PROBABILITY LEVEL OF CONFIDENCE (LOC)

Citation	Source	LOC Value
EIS Database, 2021	Analog	3

The EIS (Exposure Incidence System) is a comprehensive questionnaire that crewmembers complete after EVA training. As of August 12, 2021 there were 2,970 training exposure events in the databased (including NBL runs (2575), 1G NBL exposure events (175), 1G Suit Lab research and Development exposure events (145), and 1G Suit Lab EVA Training Exposure events (75)). This dataset does not include in-flight EVA data. Of these 2970 events, 618 reported they had "pain, discomfort, or injuries to report" after the exposure. Of those, 413 indicated that they used "post-exposure therapies (non-prescription medications, heat, ice, or topical analgesics" to treat their symptoms.

TABLE 4. CLIFF TREATMENT & OUTCOME TABLE BY CLINICAL PHASE

Case Scenario	Composite Incidence	Condition Probability %	CP1: Diagnosis		CP2: Treatment			CP3: Condition End State				
			TI%	Duration	TI%	Duration		TI%	RTDC		LOCL	
			Preset	Preset	Preset	Min	Max	Preset	Min%	Max%	Min%	Max%
Treated Best Case (TBC)	Mean: 0.1807 SD: 0.02439	33 - 33	100	0.616	5.60723	72	384	0	0	0	0	0
Treated Worst Case (TWC)		67 - 67	100	0.616	12.304	72	384	0	0	0	0	0
Untreated Best Case (UTBC)	N/A	N/A	N/A	0.616	29.9495	72	384	0	0	0	0	0
Untreated Worst Case (UTWC)	N/A	N/A	N/A	0.616	29.9495	72	384	0	0	0	0	0

TABLE 4 KEY

Composite Incidence: The same composite incidence will be used for both TBC and TWC. For EVA conditions: events per EVA (events/EVA). For space adaptation conditions: events per person (events/person). For non-spaceflight conditions: events per person year (events/py).

Condition Probability: The probability that CLiFF condition progresses to a worst case scenario. Best case scenario: 100%-Worst Case.

Clinical Phase General Comments:

- TI% = Task Impairment %. Task Impairment is the % of tasks that the crewmember is incapable of performing without impairment secondary to the medical condition.
- Durations are defined in hours.
- Removal to Definitive Care (RTDC): The probability the entire crew aborts the mission and returns to earth. This is considered as a condition end state result if any of the following criteria are met: 1) the potential for LOCL, 2) potential for significant permanent task impairment, or 3) potential for intractable pain.
- Loss of Crew Life (LOCL): The probability of death of affected crewmember due to medical condition.

Clinical Phase 1: Initial Assessment and Diagnosis:

- Covers only the initial assessment and diagnosis of the affected crewmember to define his or her medical condition. While the affected crewmember is being assessed, he or she is not able to perform any assigned tasks, thus Task Impairment (TI) during this phase is considered 100%. In the untreated case, there is no diagnosis performed, therefore Task Impairment and Duration will always be " not applicable."

Clinical Phase 2: Stabilization, Treatment, and Convalescence:

- The affected crewmember is receiving any appropriate initial or follow-on treatment for his or her medical condition to allow the crewmember to recover as much as he or she is able to recover in the spaceflight environment. Clinical phase 2 also encompasses relapses or recurrences of the same original medical condition in Clinical Phase 1. The duration of Clinical Phase 2 is expressed as minimum and maximum hours.

Clinical Phase 3: Condition End State:

- Reached once the affected crewmember has recovered from the medical condition as much as he or she is able to recover in the spaceflight environment amongst treated and untreated best and worst case scenarios. This may or may not be recovery from the given medical condition to the full extent possible. If this “recovered” state results in Removal to Definitive Care (RTDC) or Loss of Crew Life (LOCL) this will be noted in the condition end state results.

SCENARIO OVERVIEW COMMENTS

RTDC was determined to be 0% for all scenarios by the ExMC Clinician creating the CLiFF (corroborated by MedOps physician). Thus no RTDC surrogate was selected and no RTDC specific searches were performed. The duration is the same for all scenarios because treatment does not affect the duration of this condition (it can alleviate discomfort associated with abrasions, contusions, blisters, etc. but does not speed healing/resolution). The difference between the best and worst-case scenarios is treatment (best-case resolves spontaneously and worst-case requires treatment). The RTDC and LOCL were assigned as 0% for all scenarios. Therefore, the explanations for each scenario below are identical.

TREATED BEST CASE (TBC) SCENARIO COMMENTS

All scenarios for this condition have the same duration, RTDC, and LOCL. The explanation that follows is identical for all scenarios. The duration was assigned a range of 72-384 hours (3-16 days) for all scenarios because treatment does not affect the duration of this condition. The minimum duration was informed by an informational website provided by the National Health System in the UK regarding the minimum duration of skin blisters (NHS, 2020). The maximum duration was informed by healing times for abrasions (Andersen, 2014). RTDC or LOCL are not anticipated as an outcome of this condition. This assumption was corroborated by Medical Operations at JSC (in particular a flight surgeon with extensive experience with EVAs spanning both the Space Shuttle and ISS programs). Literature searches specific to RTDC and LOCL were not performed, but there was no evidence of risk of RTDC or LOCL in any literature examined for any other sections of the CLiFF. RTDC probability was assigned 0%. LOCL probability was assigned 0%.

TREATED WORST CASE SCENARIO (TWC) COMMENTS

All scenarios for this condition have the same duration, RTDC, and LOCL. The explanation that follows is identical for all scenarios. The duration was assigned a range of 72-384 hours (3-16 days) for all scenarios because treatment does not affect the duration of this condition. The minimum duration was informed by an informational website provided by the National Health System in the UK regarding the minimum duration of skin blisters (NHS, 2020). The maximum duration was informed by healing times for abrasions (Andersen, 2014). RTDC or LOCL are not anticipated as an outcome of this condition. This assumption was corroborated by Medical Operations at JSC (in particular a flight surgeon with extensive experience with EVAs spanning both the Space Shuttle and ISS programs). Literature searches specific to RTDC and LOCL were not performed, but there was no evidence of risk of RTDC or LOCL in any literature examined for any other sections of the CLiFF. RTDC probability was assigned 0%. LOCL probability was assigned 0%.

UNTREATED BEST CASE (UTBC) SCENARIO COMMENTS

All scenarios for this condition have the same duration, RTDC, and LOCL. The explanation that follows is identical for all scenarios. The duration was assigned a range of 72-384 hours (3-16 days) for all scenarios because treatment does not affect the duration of this condition. The minimum duration was informed by an informational website provided by the National Health System in the UK regarding the minimum duration of skin blisters (NHS, 2020). The maximum duration was informed by healing times for abrasions (Andersen, 2014). RTDC or LOCL are not anticipated as an outcome of this condition. This assumption was corroborated by Medical Operations at JSC (in particular a flight surgeon with extensive experience with EVAs spanning both the Space Shuttle and ISS programs). Literature searches specific to RTDC and LOCL were not performed, but there was no evidence of risk of RTDC or LOCL in any literature examined for any other sections of the CLiFF. RTDC probability was assigned 0%. LOCL probability was assigned 0%.

UNTREATED WORST CASE (UTWC) SCENARIO COMMENTS

All scenarios for this condition have the same duration, RTDC, and LOCL. The explanation that follows is identical for all scenarios. The duration was assigned a range of 72-384 hours (3-16 days) for all scenarios because treatment does not affect the duration of this condition. The minimum duration was informed by an informational website provided by the National Health System in the UK regarding the minimum duration of skin blisters (NHS, 2020). The maximum duration was informed by healing times for abrasions (Andersen, 2014). RTDC or LOCL are not anticipated as an outcome of this condition. This assumption was corroborated by Medical Operations at JSC (in particular a flight surgeon with extensive experience with EVAs spanning both the Space Shuttle and ISS programs). Literature searches specific to RTDC and LOCL were not performed, but there was no evidence of risk of RTDC or LOCL in any literature examined for any other sections of the CLiFF. RTDC probability was assigned 0%. LOCL probability was assigned 0%.

TABLE 5. CLINICAL PHASE II DURATION LEVEL OF CONFIDENCE (LOC)

Citation	Source	LOC Value
Abercromby et al, 2020	Analog	3
King, 2017	Terrestrial	
Eiland and Ridley, 2016	Terrestrial	
Andersen, 2014	Terrestrial	
NHS, 2020	Terrestrial	

There is a paucity of data in the literature regarding the length of symptoms from EVA suit contact injuries. Even datasets like the Exposure Incidence System lack consistent follow-up protocols to track the duration of suit-related issues (Abercromby et al, 2020). Thus, terrestrial data regarding the average duration to resolution of contusions (King, 2017), Abrasions (Eiland and Ridley, 2016; Andersen, 2014) and blisters (NHS, 2020) was used to inform the duration. Note that the only difference between the best and worst-case scenarios is that the best-case scenario resolves spontaneously and the worst-case scenario "requires treatment." All variations of this condition are self-limiting, and literature indicates that treatment does not hasten resolution. Thus, the durations are the same for all scenarios. No data could be found to support length of time that discomfort would require treatment for the worst-case scenario.

TABLE 6. RTDC LEVEL OF CONFIDENCE (LOC)

Citation	Source	LOC Value
N/A	N/A	3

RTDC is not an anticipated outcome of this condition. This assumption was corroborated by Medical Operations at JSC (in particular a flight surgeon with extensive experience with EVAs spanning both the Space Shuttle and ISS programs). No literature searches were performed specific to RTDC, but prior searches for incidence, duration, BC/WC probability would not support the need for RTDC.

TABLE 7. LOCL LEVEL OF CONFIDENCE (LOC)

Citation	Source	LOC Value
N/A	N/A	3

LOCL is not an anticipated outcome of this condition. This assumption was corroborated by Medical Operations at JSC (in particular a flight surgeon with extensive experience with EVAs spanning both the Space Shuttle and ISS programs). No literature searches were performed specific to LOCL, but prior searches for incidence, duration, BC/WC probability would not indicate LOCL as a feasible outcome.

CAPABILITY RESOURCE TABLE (CRT) OVERVIEW

Overview
During EVAs, contusions, abrasions, and friction injuries can occur with in the suit. There is a separate condition for EVA-related hand injuries, however, this condition covers injuries to other parts of the body.

CNES: None

Diagnostic Scope and Resourcing
Diagnostic resourcing starts with a history and physical exam. There are no labs, imaging, or other resourcing is needed for diagnosis.

Clinical Phase 1 Duration and Rationale
This version of IMPACT presumes physician level knowledge, skill, and ability will be present on the mission. The CRT working group SME consensus duration is as follows:

CP1 BC (Treated or Untreated): 0.616
CP1 WC (Treated or Untreated): 0.616

The highest scope of practice required for diagnosis includes the interpretation of the ultrasounds which is SOP 2 (paramedic/military medic).

Treatment Scope and Resourcing
In the best-case scenario, the injury is minor and resolves spontaneously. Though not part of the formal medical kit, moisturizer may be used given blister, rashes, or chaffing. In the worst-case scenario, a wound dressing may be needed for any contusions or abrasions.

Communications and Support Needs

Ground support with pictures or video can be considered for the worst-case scenario to help guide management.

IMM CLIFF RECONCILATION COMMENTS

EVA related suit contact injury is a unique condition to IMPACT 1.0. Therefore, the incidence, duration, and outcomes (RTDC, LOCL) are appropriately unique in this CLiFF.

LIMITATIONS SUMMARY

• Some overlap between the incidence of ICL 44- EVA Related Paresthesia and ICL 46 - EVA Related Suit Contact Injury may exist. The incidence for this CLiFF was taken directly from Scheuring et al, 2009 and is based only on documented abrasions and contusions caused by the suit. The incidence for ICL 44 – EVA Related Paresthesia was taken from the former IMM CLiFF and Antonsen et al, 2017 corroborates that the diagnosis of interest was reported as “paresthesia” for at least the first half of the events included (NASA, Paresthesias Secondary to Extravehicular Activity CLiFF, 2017; Antonsen et al, 2017).

TABLE 8. TASK IMPAIRMENT CALCULATION BASED ON AFFECTED HUMAN SYSTEMS TASK CATEGORIES (HSTC)

Clinical Phase 2: Treatment												
	Affected HSTCs											
	Cognitive - Simple	Cognitive - Complex	Communications	Inter-personal Skills	Vision	Hearing	Cardio-pulmonary	Dentition	GI	GU		
Treated Best Case (TBC)												
Untreated Best Case (UTBC)		664										
Treated Worst Case (TWC)												
Untreated Worst Case (UTWC)		664										
	Affected HSTCs (Continued)								TI Calculation			TI Score
	Hand (Dom)	Hand (Any)	Upper Extremity	Lower Extremity	Ambul & Standing (g)	Translation & Stabilization (microgravity)	Don/Doff Equipment	Pressure Ops	Total Tasks Impaired By Condition	Total Human System Category Tasks Full Mission	TI Decimal	TI %
Treated Best Case (TBC)								211	211	3763	0.0560723	5.60723
Untreated Best Case (UTBC)				22	196		34	211	1127	3763	0.299495	29.9495
Treated Worst Case (TWC)				22	196		34	211	463	3763	0.12304	12.304
Untreated Worst Case (UTWC)				22	196		34	211	1127	3763	0.299495	29.9495

Clinical Phase 3: Condition End State												
	Affected HSTCs											
	Cognitive - Simple	Cognitive - Complex	Communications	Inter-personal Skills	Vision	Hearing	Cardio-pulmonary	Dentition	GI	GU		
Treated Best Case (TBC)												
Untreated Best Case (UTBC)												
Treated Worst Case (TWC)												
Untreated Worst Case (UTWC)												
	Affected HSTCs (Continued)								TI Calculation			TI Score

	Hand (Dom)	Hand (Any)	Upper Extremity	Lower Extremity	Ambul & Standing (g)	Translation & Stabilization (microgravity)	Don/Doff Equipment	Pressure Ops	Total Tasks Impaired By Condition	Total Human System Category Tasks Full Mission	TI Decimal	TI %
Treated Best Case (TBC)									0	3763	0	0
Untreated Best Case (UTBC)									0	3763	0	0
Treated Worst Case (TWC)									0	3763	0	0
Untreated Worst Case (UTWC)									0	3763	0	0

TABLE 8 KEY
Human System Task Category (HSTC) Definitions: Cognitive-Simple: Tasks requiring simple cognitive involvement (low levels of attention, following simple checklists, and not requiring extensive decision making) in conjunction with inputs from other systems. Cognitive-Complex: Tasks requiring complex cognitive involvement (requiring constant attention, frequent interpretation of outside stimuli to inform real-time situations) in conjunction with inputs from other systems. Communication: Tasks requiring primarily communication, via hearing and speaking. Interpersonal Skills: Tasks requiring interpersonal, social interaction between crew including complex technical tasks that require extended crew interaction. Vision: Tasks in which visual information is required. Hearing: Tasks in which primarily auditory information is required, excluding communication, e.g. hearing alarms, medical auscultation, OOHAs. Cardiopulmonary: Tasks requiring greater-than-baseline cardiopulmonary effort, e.g. physically strenuous activities. Dentition: Tasks requiring use of teeth for mastication. GI (Gastrointestinal): Tasks requring use of the alimentary sytem, e.g. solids/liquids consumption and solids excretion. GU (Genitourinary): Tasks requiring use of the male/female genitourinary systems. Hand (Dominant): Tasks performed using primarily the hand, requiring use of the dominant hand (piloting, medical procedures, dental procedures). Hand (Any): Tasks performed using primarily the hand(s), with no preference for dominance, with equivalent bilateral effectiveness. Upper Extremity: Tasks requiring specific use of the upper extremities, excluding hands. Lower Extremity: Tasks requiring specific use of the lower extremities (excluding ambulation and standing in the presence of gravity), e.g. using exercise equipment. Ambulation and Standing (g): Tasks requiring use of both lower extremities to accomplish ambulation or standing in the presence of gravity. Translation and Stabilization (microgravity): Tasks requiring use of either the upper or lower extremities to accomplish translational movement and stabilization (securing oneself to remain stationary) in the setting of microgravity. Don/Doff Equipment: Tasks requiring the donning of personal equipment (including pressure suit, exercise harness, EVA equipment, etc). Pressure Ops: EVA/contingency tasks performed while pressurized in a suit.

Criteria for Assignment of Conditions to HSTCs (any of the following):
1) Is affected crew member physically incapable of performing the human system task category, without impairment, with the condition?
2) Would the treatment (e.g. medications) impair the crewmember's ability to perform the human system task category? (Does not apply to UTx)
3) Does the condition have a high likelihood of causing a significant aeromedical contraindication with an associated human system task category
4) Would performing tasks in an associated task category worsen the condition? (If so, it is affected).
5) Does pain associated with the condition impair any further human system categories?

TASK IMPAIRMENT COMMENTS

CP2: No comment. CP3: No comment.

EVIDENCE COLLECTION PROCESS

Mesh terms that most closely resembled the best-case and worst-case scenarios, and associated Conditions Included but Not Explicitly Stated (CNES), were utilized to build incidence, duration, RTDC, and LOCL searches by best- and worst-case.

Incidence:
Databases searched for spaceflight and analog incidence data included: PubMed, Google Scholar, NASA Technical Reports Server (NTRS) public search, Defense Technical Information Center (DTIC), and Barratt MR, Baker E, Pool SL. Principles of Clinical Medicine for Space Flight. New York, NY: Springer; 2019. 2nd Edition. Databases searched for terrestrial incidence included: DynaMed, PubMed, and Google Scholar.

Duration, RTDC, LOCL:
Databases searched for duration, RTDC, and LOCL included: Dynamed, Cochrane, PubMed, and Google Scholar. Note, that if duration, RTDC, or LOCL data was found in a DynaMed search, the other search engines were not included. Relevant articles were selected and reviewed. If applicable, the article was included in the CLiFF.

LEVEL OF CONFIDENCE (LOC) SCORING

Articles obtained to update the evidence behind this CLiFF were scored by ExMC editors, based on their applicability to the Exploration Spaceflight environment using the following grading scale:

4 – Confident
3 – Somewhat confident
2 – Neutral
1 – Somewhat unconfident
0 – Not confident

The following considerations factor into the grading scale above:

• How closely does the paper describe the medical condition as defined by the IMPACT 1.0 Condiltion List (relevance)?
• How closely does the population included resemble the astronaut population?
• Quality of the paper (number of subjects, methods, etc.)
• How much does the editor trust the source of the evidence?
• How closely does the editor think that the data represents the exploration spaceflight environment?
• Other considerations, at the discretion of the editor, supported in the comments for LOE scoring.

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ACRONYMS

ACRONYM	PHRASE
AAOMS	American Association of Oral and Maxillofacial Surgeons
AMA	American Medical Association
ARCL	All Remaining Conditions List
ARS	Acute Radiation Sickness
BHP	Behavioral Health and Performance
CAC	Coronary Artery Calcium
CHS	Crew Health and Safety
CL	Condition List
CliFF	Clinical Finding Form
CMO	Crew Medical Officer
COMFORT	Clinical Outcome Metrics for Optimization of Robust Training
CP1	Clinical Phase 1
CP2	Clinical Phase 2
CP3	Clinical Phase 3
CRL	Clinical Resource Level
CRT	Capability Resource Table
CST	Clinical Science Team
DCS	Decompression Syndrome
DRM	Design Reference Mission

ED	Emergency Medicine Doctor
EL	Evidence Library
EMCL	Exploration Medical Condition List
EMT	Emergency Medical Technician
EVA	Extravehicular Activity
EXMC	Exploration Medical Capability
HRP	Human Research Program
ICD	International Classification of Disease
ICL 1.0	IMPACT 1.0 Medical Conditions List
ICU	Intensive Care Unit
IMCL	iMED Condition List
iMED	Integrated Medical Evidence Database
IMM	Integrated Medical Model
IMPACT-MD	Impact Medical Database
IP	Incidence Proportion
IR	Incidence Rate
ISS	International Space Station
IV	Intravenous
JSC	Johnson Space Center
LEO	Low-Earth orbit
LEVA	Lunar Extravehicular Activity
LOCL	Loss of Crew Life
LOM	Loss of Mission
LSAH	Lifetime Surveillance of Astronaut Health
LSO	Lunar Surface Operations
MCL	Master Condition List
MEVA	Medical Extravehicular Activity
NASA	National Aeronautics and Space Administration
N/A	Not Applicable
NP	Nurse Practitioner
OBGYN	Obstetrics and Gynecology
OR	Occurrence Rate
PA	Physician Assistant
PDQ	Pain Disability Questionnaire
PFCL	Proposed Future Conditions List
PPE	Personal Protective Equipment
PTRS	Project Technical Requirements Specification
PRL	Pharmaceutical Resource Level
QTL	Quality Time Lost
RCL	Removed Conditions List
REP	Rochester Epidemiology Study
RTDC	Removal to Definitive Care
SANS	Spaceflight-Associated Neuro-ocular Syndrome

SAS	Space Adaptation Syndrome
SEVA	Spaceflight Extravehicular Activity
SME	Subject Matter Expert
SoP	Standard Operating Procedure
SPE	Solar Particle Event
TBD	To Be Determined
TI	Task Impairment