Clinical Finding Form (CliFF)

Branch: Baseline

ICL41_Eva Related Fingernail Delamination

The extramobility unit (EMU) gloves, while pressurized, create a number of pressure points on the upper extremity and cause skin and soft tissue irritation. Fingernail injury and loss (onycholysis) has been a major complaint among crew members while on extravehicular activity (EVA) and during neutral buoyancy lab (NBL) training. This is in part due to the engineering requirements of the suit to maintain pressure and durability but still allow for maximal dexterity to perform tasks. Moisture accumulation within the glove tip and finger/hand size appear to be major contributing factors to this injury pattern (Jones, 2008; Opperman, 2010). Thus far, fingernail delamination has only been reported as a minor discomfort and has yet to substantially impact an EVA. However, future lunar missions will likely require longer and more frequent EVA than current ISS missions and this accumulative stress on the fingers may ultimately impact mission objectives. There are several mitigation strategies including gluing or bandaging fingertips to reduce fingernail trauma which have resulted in only moderate reduction of injury. Next generation xEMU gloves aim to reduce these pressure points and are anticipated to address this problem directly.

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, RA et al. 2009 is the only study available that looked solely at spaceflight data. However, this study focused on musculoskeletal injuries in general and did not provide data necessary on fingernail injury specifically to calculate incidence rate. Opperman, RA et al. 2010 and Charvat, JM et al. 2015 both used a combination of NBL and spaceflight data with large database driven sample sizes. Charvat, JM et al. 2015 in particular was extremely comprehensive, well powered, and thus used for the incidence calculations.

ANALOG LITERATURE

Viegas, SF et al. 2004 and Strauss, S 2004 used NBL training sessions to derrive their incidence of fingernail and upper extremity injuries. These studies have a higher incidence than spaceflight data. This may be due to a number of biases such as Hawthorne effect, survey bias, sampling bias, etc... Or this may be due to the specific differences in temperature, gravity, suit design etc... between the operations performed while in the NBL versus inflight. Nonetheless, while NBL data is very high quality it is less valuable than the spaceflight specific data reported above.

TERRESTRIAL LITERATURE

No terrestrial data was used as this was an EVA specific activity and general rates of terretstrial onycholysis are not indicative of incidence in flight

OVERALL INCIDENCE SUMMARY

INCIDENCE

Mean:0.002656 SD: 4.719E-4

INCIDENCE SUMMARY

The Bayesian posterior distribution for the incidence proportion given the spaceflight and NBL data under an uninformative prior is Beta(shape1=31.59, shape2=11862.65) with mean 0.002656 and SD 4.719E-4. This data was based on Charvat, JM etal. 2015 which had 4 events out of 322 spaceflight EVAs and 27 events out of 11,704 NBL runs.

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
0.00265591

SD
0.000471892

Beta
(Alpha): 31.59
(Beta): 11862.7

TABLE 2. INCIDENCE LEVEL OF CONFIDENCE (LOC)

Citation	Source	LOC Value
Viegas, SF et al. 2004	Analog	3
Opperman, RA et al. 2010	Analog and Spaceflight	4
Scheuring RA et al. 2009	Spaceflight	1
Charvat, JM et al. 2015	Analog and Spaceflight	4
Strauss, S 2004	Analog	3

There is robust data on the incidence of EVA related fingernail delamination. Several studies use NBL training and test run data to capture injury incidence rate. Viegas, SF et al. 2004 reviewed 548 training runs and identified the rate of fingertip injuries however does not specify to onycholysis. Strauss, S 2004 was an internal report produced by NASA based on NBL injuries and identified fingertip injuries. It performed sub group analysis of 18 atronauts with onycholysis. The details of subgroup selection are unclear and may not represent the corps as a whole. Sheuring, RA et al. 2009 has spaceflight spcific injuries from LSAH but does not specify a clear indcidence rate and thus not useful. Both Oppperman, RA et al. 2010 and Charvat, JM et al. 2015 use large database NBL and spaceflight data to determine incidence and therefore recieved a 4. The EVA and NBL data from Charvat, JM et al. 2015 was used to calculate incidence although it does have some limitations. The total number of NBL runs performed (>11,000) vastly out weighs the number of EVAs (>300) and because these events are considered equivalent the NBL data drives the ultimate incidence calculation. However, the team agreed that while the EVA data is more accurately representative to ISS EVA incidence, the NBL data is more accurate to partial gravity injury incidence. Both datasets were included with equal weight.

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

There are no specific pre-flight preventative screening measures based on a Medical Requirements Integration Documents (MRID) search as this condition is specific to minor repetitive finger trauma while on EVA. However, one component of pre-flight training is NBL training sessions which includes medical screening of astronauts and soft tissue evaluation. While not explicitly stated, during this process the suit fit and mitigation strategies for soft tissue injuries are evaluated and implemented prior to launch to minimize injury inflight.

BEST CASE SCENARIO DEFINITION

Mild to moderate nail bed trauma with partial onycholysis that responds to treatment.

WORSE CASE SCENARIO DEFINITION

Severe nail bed trauma causing onycholysis and/or nail loss despite treatment.

CONDITIONS INCLUDED, BUT NOT EXPLICITLY STATED (CNES)

Onycholysis

BEST CASE/WORST CASE PROBABILITY COMMENTS

While there have been many studies evaluating the incidence of fingernail delamination associated with EVA, almost none of them specify the degree or type of fingernail injury consistently. This makes calculation of best case and worst case scenario difficult based on the definitions provided. The only exception was Charvat, JM et al. 2015 which reports fingernail injuries while on EVA by type (figure 9). Here they report 1 fingernail abrasion, 6 fingernail "traumas", 2 subungual hematomas, and 1 instance of onycholysis. If we assume that "fingernail trauma" does not include complete onycholysis then our proportion of BC to WC scenario is 9:1 or 90% and 10% respectively.

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

Citation	Source	LOC Value
Charvat, JM et al. 2015	Spaceflight	2
Viegas, SF et al. 2004	Analog	N/A
Opperman, RA et al. 2010	Spaceflight	N/A
Scheuring, RA et al. 2009	Spaceflight	N/A
Strauss, S 2004	Analog	N/A

Charvat, JM et al. 2015 provides some limited data on specific types of fingernail injuries. This is a small sample size with somewhat vague descriptions of injuries. No other studies provided the specific type of fingernail injury thus condition probability was unable to be calculated

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:0.002656 SD: 4.719E-4	90 - 90	100	0.5829	13.3803	168	336	0	0	0	0	0
Treated Worst Case (TWC)		10 - 10	100	0.5829	14.5628	2920	4380	0	0	0	0	0
Untreated Best Case (UTBC)	N/A	N/A	N/A	0.5829	13.3803	168	1008	0	0	0	0	0
Untreated Worst Case (UTWC)	N/A	N/A	N/A	0.5829	14.5628	2920	4380	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

The general approach to fingernail delamination will start with prevention. Astronauts spend approximately 12 hours in the NBL training for EVA for every 1 hour spent on EVA while in spaceflight. This helps crew members identify pressure points and recurrent soft tissue injuries in order to mitigate them in flight. Trimming nails, skin glue, and tapping of fingers are among several approaches to limit onycholysis. While in flight treatment of nail injury involves local wound care and further bandaging to limit pain and discomfort. The effectiveness of these treatments is unclear and likely limited given the ongoing complaints from crew. At least one crew member removed their fingernails to mitigate this recurrent trauma while on EVA. To date, these injuries have not appeared to have any significant impact on EVA or mission success. RTDC and LOCL are assumed to be 0% by definition of this condition.

TREATED BEST CASE (TBC) SCENARIO COMMENTS

The best case scenario is mild to moderate nail bed trauma with partial onycholysis that responds to treatment. The duration of this condition when treated is between 1-2 weeks based on expert opinion in the absence of any evidence. RTDC and LOCL are both 0% in this condition.

TREATED WORST CASE SCENARIO (TWC) COMMENTS

The worst case definition for this condition is severe nail bed trauma causing onycholysis and/or nail loss despite treatment. The duration of this condition ranges from 4-6 months based on Tos, P et al. 2012 which defines recovery range after complete nail loss based on expert opinion. RTDC and LOCL are 0% in this condition

UNTREATED BEST CASE (UTBC) SCENARIO COMMENTS

The best case scenario is mild to moderate nail bed trauma with partial onycholysis that responds to treatment. The duration of this condition when untreated is between 1-6 weeks based on expert opinion in the absence of any evidence and the agreed upon time to recovery of nail tensile strength per Viegas, SF et al. 2004. RTDC and LOCL are both 0% in this condition.

UNTREATED WORST CASE (UTWC) SCENARIO COMMENTS

The worst case definition for this condition is severe nail bed trauma causing onycholysis and/or nail loss despite treatment. The duration of this condition ranges from 4-6 months based on Tos, P et al. 2012 which defines recovery range after complete nail loss based on expert opinion. This range in duration is the same between the treated and untreated conditions because treatment is likely to have little to no impact on recovery time after nail loss. RTDC and LOCL are 0% in this condition

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

Citation	Source	LOC Value
Tos, P et al. 2012	Terrestrial	2
Viegas, SF et al. 2004	Spaceflight	
Strauss, EJ et al. 2008	Terrestrial	
Baden, H.P. 1965	Terrestrial	
Seiler, M et al. 2021	Terrestrial	

Duration LOC is scored at 2 because there is limited information available. The vast majority of reported durations are based on expert opinion. Strauss, EJ et al. 2008 and Seiler, M et al. 2021 are prospective studies but look at nailbed injury as opposed to delamination and thus may not be as accurate to this condition

TABLE 6. RTDC LEVEL OF CONFIDENCE (LOC)

Citation	Source	LOC Value
NA	NA	4

The RTDC is accepted to be 0% based on the surrogate RTDC and confines of this condition

TABLE 7. LOCL LEVEL OF CONFIDENCE (LOC)

Citation	Source	LOC Value
NA	NA	4

The LOCL is accepted to be 0%. This condition is extremely minor and has no risk of LOCL. Several crew members have noted discomfort with complete onycholysis that was distracting but did not impact EVA. In an absolute worst case this condition may limit crew function or require scrubbing EVA but would not impact RTDC or LOCL.

CAPABILITY RESOURCE TABLE (CRT) OVERVIEW

Overview Fingernail delamination refers to fingernails falling off after trauma sustained during spacewalks. The pathophysiology is not completely understood, however, it is believed to be caused by pressure on the fingertips or complications with circulation with the pressurized gloves. CNES: None Diagnostic Scope and Resourcing Diagnostic resourcing is straightforward and involves collection of history and evaluation of the hands following the injury. 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): 0.5829 CP1 WC (Treated or Untreated): 0.5829 The highest scope of practice required for diagnosis includes the interpretation of the ultrasounds which is SOP 1. Treatment Scope and Resourcing Therapeutic scope is also straightforward and includes a wound care dressing bundle for both the best case and worst case. For worst case, resourcing for a digital block and extra equipment for nail removal and bleeding management exist in the case of severe nail bed trauma. Communications and Support Needs Ground support and communications are not needed during diagnosis and acute management, however, can be adjunctively considered following the acute period.

IMM CLIFF RECONCILATION COMMENTS

The IMM CLIFF Delamination Secondary to Extravehicular Activity has the same definition as the current version of this CLIFF and defines best case and worst case scenario the same way. Prior incidence data was based on Saile, 2017 which was based on available data from IMED and LSAH data. In this updated version of the CLIFF for this condition we include several studies that did large database evaluation for NBL and EVA fingernail delamination injury to improve the power and accuracy of our incidence calculation. All prior literature was incorporated into this CLIFF and terrestrial data was included to determine duration of this condition.

LIMITATIONS SUMMARY

• Glove models have changed over time and there appears to be a correlation with the current model having a higher incidence of fingernail injury • Literature on the xEMU is not available and likely will have a lower incidence of fingernail injuries as there has been extensive research into why delamination on EVA occurs which specifically was meant to guide design of the xEMU. • Duration of this condition is based on expert opinion as space flight data does not report healing time and there are no large studies in terrestrial literature due to the minimal severity of this condition.

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)		664										
Untreated Best Case (UTBC)		664										
Treated Worst Case (TWC)		664		89								
Untreated Worst Case (UTWC)		664		89								
	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)	132							211	1007	3763	0.267606	26.7606
Untreated Best Case (UTBC)	132							211	1007	3763	0.267606	26.7606
Treated Worst Case (TWC)	132							211	1096	3763	0.291257	29.1257
Untreated Worst Case (UTWC)	132							211	1096	3763	0.291257	29.1257

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: The initial event in BC had less trauma, but partial onycholysis would be anticipated to be more persistently painful vs. complete onycholysis in WC.

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 Conditlion 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.

REFERENCES

Reference
Baden, H. P. (1965). "Regeneration of the Nail." Archives of Dermatology: 619-620.
Charvat, J. M., et al. (2015). Spacesuit Glove- Induced Hand Trauma and Analysis of Potentially Related Risk Variables. International Conference on Environmental Systems. Bellevue, Washington.
Jones, J. A., et al. (2008). "The use of an extended ventilation tube as a countermeasure for EVA-associated upper extremity medical issues." Acta Astronautica 63(7-10): 763-768.
Opperman, R. A., et al. (2010). "Probability of spacesuit-induced fingernail trauma is associated with hand circumference." Aviat Space Environ Med 81(10): 907-913.
Scheuring, R. A., et al. (2009). "Musculoskeletal injuries and minor trauma in space: incidence and injury mechanisms in U.S. astronauts." Aviat Space Environ Med 80(2): 117-124.
Seiler, M., et al. (2021). "Non-operative treatment versus suture refixation of the nail plate in paediatric fingernail avulsion injuries." J Hand Surg Eur Vol 46(5): 523-529.
Strauss, E. J., et al. (2008). "A prospective, randomized, controlled trial of 2-octylcyanoacrylate versus suture repair for nail bed injuries." J Hand Surg Am 33(2): 250-253.
Strauss, S. (2004). Extravehicular Mobility Unit Training Suit Symptom Study Report. Houston, Texas, Lyndon B. Johnson Space Center.
Tos, P., et al. (2012). "Surgical treatment of acute fingernail injuries." J Orthop Traumatol 13(2): 57-62.
Viegas, S. F., et al. (2004). "Physical demands and injuries to the upper extremity associated with the space program." J Hand Surg Am 29(3): 359-366.

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