

Clinical Finding Form (CLiFF)

Branch

Baseline

ICL65_Hearing Loss

There is no comparable IMM CLiFF for this condition. This CLiFF is based on sensorineural hearing loss since there is no incidence data for conductive hearing loss.

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

Spaceflight literature regarding hearing loss is related to noise-induced hearing loss. These data from the IMM CLiFF Hearing Loss are used in the Hearing Loss - Noise Related CLiFF (ICL-66).

ANALOG LITERATURE

The existing data surrounding analog populations is centered around sensorineural hearing loss, more specifically, noise related hearing loss. The best data encountered looked at the military population. The most analogous population was thought to be USAF aviators, from this study an incidence of 14.7/1000 person years was found.

TERRESTRIAL LITERATURE

Terrestrial data on hearing loss is broad and mostly encompasses either pediatric or populations that are over the age of 65. Data outlined in JAMA in 2013 from the National Health and Examination Surveys outlined the incidence throughout all age groups from 1999-2006. Hearing loss, in general, increases with age. The data that delineates between different forms of hearing loss is lacking likely due to the difficulty in tracking exposures. Much of the data collected has significant overlap with CLiFF ICL66 "Hearing Loss-Noise related".

OVERALL INCIDENCE SUMMARY

INCIDENCE

mean 2.7E-4 and SD 7.495E-7

INCIDENCE SUMMARY

The posterior distribution for the incidence rate given terrestrial data of (133,188 events over 493,288,889 person-years) under an uninformative prior is Gamma(shape=129773, rate=480640641) with mean 2.7E-4 and SD 7.495E-7. The incidence of sensorineural hearing for both males and females age 45-54 is 30/100,000 = 0.003 events/person-year, (Alexander, 2013). LOE =3 (somewhat confident) based on age-appropriate general terrestrial population data for males and females age 45 to 54. The current average active astronaut age is 48.

TABLE 1. INCIDENCE MODEL

Incidence Details

Incidence Type
General

Segment
All
 Env. Exposure
NA

 Sex
Any
 Crowns
Any
 Contacts
Any

 Pregnancy
Any
Incidence Distribution
 Occurrence Dist
Poisson
 Incidence Dist.
Gamma
 Mean
0.00027
 SD
7.495E-07

 Gamma
(Shape): 129773
(Rate): 4.80641E+08

TABLE 2. INCIDENCE LEVEL OF CONFIDENCE (LOC)

Citation	Source	LOC Value
Swenor, B. K., et al., 2013	Terrestrial	
Alexander TH, et al. 2013	Terrestrial	3
Clark, 2001	Spaceflight	
Kadem, 2018	Spaceflight	
Buckey, et al. 2001	Spaceflight	

The most relevant study is Alexander, 2013. The incidence of sensorinueral hearing for both males and females age 45-54 is 30/100,000 = 0.003 events/person-year. The current average active astronaut age is 48. LOE =3 (somewhat confident) based on age-appropriate general terrestrial population data for males and females age 45 to 54.

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

No specific preventive measures for sensorineural hearing loss. Astronauts undergo annual hearing tests and a preflight hearing test.

BEST CASE SCENARIO DEFINITION

A reversible or conductive hearing loss that manifests as a Mission Significant Threshold Shift (M-STS) that resolves within 30 days and does not impair communication.

WORSE CASE SCENARIO DEFINITION

A sensorineural or non-reversible hearing loss that manifests as an M-STS lasting greater than 30 days or impairs communication.

CONDITIONS INCLUDED, BUT NOT EXPLICITLY STATED (CNES)

Hearing loss - Sensorineural Hearing Loss - Conductive

BEST CASE/WORST CASE PROBABILITY COMMENTS

Best case/worst case condition probability is 65%/35%. This is based on a 65% recovery rate of sudden sensorineural hearing loss to functional hearing levels regardless of treatment. (Mattox, 1997). Natural history of sudden sensorineural hearing loss. The Annals of otology, rhinology, and laryngology. Jul-Aug 1997;86.

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

Citation	Source	LOC Value
Mattox, 1997	Terrestrial	3

The incidence of sensorineural hearing for both males and females age 45-54 is 30/100,000 = 0.003 events/person-year. The current average active astronaut age is 48. LOE = 3 (somewhat confident) based on age-appropriate general terrestrial population data for males and females age 45 to 54.

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 2.7E-4 and SD 7.495E-7	65 - 65	100	1.12	6.77651	0	720	0	0	0	0	0
Treated Worst Case (TWC)		35 - 35	100	1.45	29.7901	720	720	0	0	0	0	0
Untreated Best Case (UTBC)	N/A	N/A	N/A	1.12	6.77651	0	720	0	0	0	0	0
Untreated Worst Case (UTWC)	N/A	N/A	N/A	1.45	29.7901	720	720	29.7901	0	60	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

Best case by definition is reversible and does not result in RTDC or LOCL. Worst case will impair mission functionality for greater than 30 days, if not permanently. 36-60% of idiopathic cases may not recover to functional levels or at least have significant losses. No LOCL expected. May want to consider changing the best case definition to "A reversible sensorineural hearing loss that resolves within 30 days and does not impair communication." There is no incidence data for conductive hearing loss.

TREATED BEST CASE (TBC) SCENARIO COMMENTS

Best case definition is a conductive hearing loss, reversible, does not impair communication, lasts less than 14 days. The duration and prognosis for conductive hearing loss is largely dependent upon the underlying etiology.

TREATED WORST CASE SCENARIO (TWC) COMMENTS

It should be mentioned that worst case definition is a sensorineural or non-reversible hearing loss with a duration of at least 30 days or an impairment in communication, but with sudden sensorineural hearing loss patients rarely recover if no improvement is seen in 14 days. Consider changing worst case scenario to a sensorineural or non-reversible hearing loss with a duration of at least 14 days or an impairment in communication

UNTREATED BEST CASE (UTBC) SCENARIO COMMENTS

Best case definition of conductive hearing loss, reversible, does not impair communication, or lasts less than 30 days. The duration and prognosis for conductive hearing loss is largely dependent upon the underlying etiology.

UNTREATED WORST CASE (UTWC) SCENARIO COMMENTS

Worst case defined as sensorineural hearing loss, non reversible, impairing communication or not resolved after 30 days. Prognosis of idiopathic SSNHL: 65% of idiopathic cases reported to recover functional hearing levels regardless of treatment, most recover within 14 days (Mattox 1977) 40% of untreated idiopathic cases reported to recover hearing with interaural threshold difference below 20 decibels (dB) (Guyot 2000) if no improvement within two weeks, patient unlikely to recover. No LOCL expected

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

Citation	Source	LOC Value
N/A	N/A	4

LOC = 4 for CP2 durations based on best case and worst case definitions. May want to consider changing best case and worst case definitions to include 14 days as duration based on Mattox study (Mattox, 1997).

TABLE 6. RTDC LEVEL OF CONFIDENCE (LOC)

Citation	Source	LOC Value
Guyot, 200	Terrestrial	

Treated Best Case RTDC LOE = 4 based on best case definition. Treated Worst Case RTDC = 4 based on worst case definition. Untreated Best Case RTDC LOE = 4 based on best case definition. Untreated Worst Case RTDC LOE = 3 based on a terrestrial study (Guyot, 2000).

TABLE 7. LOCL LEVEL OF CONFIDENCE (LOC)

Citation	Source	LOC Value
N/A	N/A	4

LOCL LOC = 4 for all scenarios. LOCL is not expected for this condition.

CAPABILITY RESOURCE TABLE (CRT) OVERVIEW

Overview

Sudden hearing loss is defined as the quick onset of subjective hearing impairment in one or both ears. The hearing loss may be resultant of conductive pathologies, sensorineural pathologies, or a mixture of both. 1 A conductive hearing loss occurs when there is a problem propagating sound waves from an external environment to the inner ear by way of the tympanic membrane and middle ear ossicles. 2 A conductive hearing loss is typically perceived as a "mechanical error." These can occur secondary to cerumen impaction, otologic foreign body, otosclerosis, cholesteatoma, middle ear serous effusion or otitis media. A sensorineural loss is usually recognized as a "nerve" problem and can result from cochlear, auditory nerve, or central processing failures. This type of hearing loss most is most often idiopathic, but can also result from vestibular schwannomas, strokes, malignancies, noise exposure, and ototoxic medications. The severity of hearing loss is categorized by audiometry and is described as either: mild-- a loss of 26-40 decibels (dB), moderate-- a loss of 41-60 dB, severe-- a loss of 61-80 dB, or profound-- a loss of 80 dB or greater. 1 A 'sudden' sensorineural hearing loss must occur within 72 hours and consist of a decline in hearing of 30 dB affecting three or more sequential frequencies. 3-5 A sudden sensorineural hearing loss can be extremely debilitating as it is associated with tinnitus, vertigo, inability to communicate and the incapacity to localize sound.

The United States Department of Labor's Occupational Safety and Health Administration (OSHA) defines a standard threshold shift, or STS as "a change in hearing threshold, relative to the baseline audiogram for that employee, of an average of 10 decibels (dB) or more at 2000, 3000, and 4000 hertz (Hz) in one or both ears." 6 NASA has adopted this definition and made it mission specific (M-STs) by using preflight audiometry (performed in a clinic) and comparing it to inflight and post flight hearing thresholds.

The best-case scenario is a mild hearing loss that will resolve with time. Although the definition states that a conductive loss is possible, cerumen impaction, otitis externa, otitis media, noise related hearing loss, barotrauma are all separate CRT conditions. Other forms of conductive hearing loss such as tumors or otosclerosis are not likely reversible except for an otologic foreign body. Although this would be an abnormal circumstance inflight, the best-case scenario does provide for this circumstance. The worst-case scenario is a sensorineural or non-reversible hearing loss. Although it may be difficult to differentiate between a hearing loss that is reversible or non-reversible at the time of presentation, in contrast to the best-case scenario, the worst-case condition would be a severe to profound hearing loss associated with significant impediment.

CNES: Hearing loss – Sensorineural, Hearing Loss - Conductive

Diagnostic Scope and Resourcing

In the best case, diagnosis will be made via history, physical exam, and inflight audiometry assessment. Inflight audiometry not only serves to quantify the severity of hearing loss but can also differentiate between the type of hearing loss by quantifying Air- and bone conduction thresholds. Since crewmembers have immediate access to this technology, there is no need to possess a tuning fork to conduct Weber and Rinne tests. Further, if a conductive loss is identified, the latest iteration of the inflight audiometric test (KUDUwave™) can perform tympanograms, or determine how the eardrum moves in response to the air pressure in the ear canal. Given the benign nature of this condition, ground communications are not resourced for the best case. Diagnostics in the worst case do not change with the exception of having access to ground communications as significant debility to the crew-member is expected in this scenario.

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): 1.12 hours

This is the longest reasonable time to complete the task for an experienced clinician (adjusted for being in the spaceflight environment) 1) to remove a crewmember from duties 2) obtain a history 3) examine the patient and 4) conduct and interpret an inflight audiometry test.

CP1 WC (Treated or Untreated): 1.45 hours

This is the longest reasonable time to complete the task for an experienced clinician (adjusted for being in the spaceflight environment) This is the longest reasonable time to complete the task for an experienced clinician (adjusted for being in the spaceflight environment) 1) to remove a crewmember from duties 2) obtain a history 3) examine the patient 4) conduct and interpret an inflight audiometry test 5) set up for ground communications.

The highest scope of practice code used in this CRT which includes interpretation of diagnosis, performing diagnostic tests and performing treatment would be a four: this is at intern/PA/NP level.

Treatment Scope and Resourcing

In the best-case scenario, treatment is limited to removing an otologic foreign body if one is present. Placing sharp instruments within the ear canal is less favorable than other means given the risk of tympanic membrane perforation. Treatment guidelines pertaining to the worst-case scenario state that clinicians can consider initiating a 10-day course of corticosteroids as initial therapy with patients who experience sudden onset sensorineural hearing loss within two weeks of symptom onset. 3 Steroids are associated with several risks including suppression of hypothalamic pituitary-adrenal axis, aseptic necrosis of the hip and hyperglycemia and thus would be avoided in the best-case scenario. The typical recommend course for steroids is one daily dose for 10 days, followed by a taper over a similar period. Although treatment for sudden sensorineural hearing loss in terrestrial conditions can include intratympanic steroid injections, inflight this is not feasible given lack of expertise (requires otolaryngologic training) and an inflight otologic microscope.

Communications and Support Needs

In the best-case scenario, diagnosis and course of treatment is uncomplicated and likely within the scope of care of onboard crew members. In the worst-case condition, ground communications are necessary given the sudden impairment of the affected crewmember and the need to ensure an accurate diagnosis.

IMM CLIFF RECONCILIATION COMMENTS

Current treatment should be captured in the CRT.

LIMITATIONS SUMMARY

Spaceflight data is limited primarily to ISS and STS vehicles. The ambient noise levels in Artemis vehicles may differ. There is considerable overlap with noise-related hearing loss that leads to sensorineural hearing loss (SNHL). Under-reporting for this condition could have been significant during past space missions due to lack of testing and subtle noise-related hearing loss that may not have been apparent to the crew. This may result in underestimation of the incidence.

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)						44						
Untreated Best Case (UTBC)						44						
Treated Worst Case (TWC)		664	113	89		44						
Untreated Worst Case (UTWC)		664	113	89		44						
	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	255	3763	0.0677651	6.77651
Untreated Best Case (UTBC)								211	255	3763	0.0677651	6.77651
Treated Worst Case (TWC)								211	1121	3763	0.297901	29.7901
Untreated Worst Case (UTWC)								211	1121	3763	0.297901	29.7901
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)		664	113	89		44						
	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	T1 Decimal	T1 %
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)								211	1121	3763	0.297901	29.7901

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 requiring use of the alimentary system, 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 Condition 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

1. Alexander TH, Harris JP. Incidence of sudden sensorineural hearing loss. Otol Neurotol. 2013 Dec;34(9):1586-9. doi: 10.1097/MAO.000000000000222. PMID: 24232060.
2. Mattox, 197 Natural history of sudden sensorineural hearing loss. The Annals of otology, rhinology, and laryngology. Jul-Aug 1997;86.
- Nieman CL, Oh ES. Hearing Loss. Ann Intern Med. 2020;173:itc81-itc96.
3. Cunningham LL, Tucci DL. Hearing Loss in Adults. N Engl J Med. 2017;377:2465-2473.
4. Chandrasekhar SS, Tsai Do BS, Schwartz SR, et al. Clinical Practice Guideline: Sudden Hearing Loss (Update). Otolaryngol Head Neck Surg. 2019;161:S1-s45.
5. Michels TC, Duffy MT, Rogers DJ. Hearing Loss in Adults: Differential Diagnosis and Treatment. Am Fam Physician. 2019;100:98-108.
6. Nieman CL, Reed NS, Lin FR. Otolaryngology for the Internist: Hearing Loss. Med Clin North Am. 2018;102:977-992.
7. 1904.10 - Recording criteria for cases involving occupational hearing loss.: United States Department of Labor, Occupational Safety and Health Administration; 2019.

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