Burns secondary to Fire Cliff

Branch Baseline

Burn trauma can be caused by heat, freezing, electricity, chemicals, radiation, or friction. Depending on the location and burn depth, complications may occur, including shock, infection, electrolyte imbalance and respiratory failure. Burn wounds are internationally classified by depth, in the degrees, I to III. First degree involves only the epidermis. Second degree involves the dermis, papillary and reticular tissues. Third degree involves full thickness of the skin and subcutaneous fat or deeper. Clinically burns are measured by Wallace's rule of nines. (Evers, 2010)

A study covering the past 10 years classified burns by etiology. Thermal burns including fire / flame, scald, and contact with a hot object amounted to 71.25%, electrical 3.2%, and chemical 2.67%. Of these 17% of the records did not include an etiology. (Bassey, 2011)

There have not been any burns reported in the US space program but there were burns reported on a Russian Mir mission. (Marshburn, 2008)

Incidence Data Included in the Model

The model imports the following incidence information from the IMM database: incidence data category, space adaption status, incidence data, 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. fixed data). Space adaptation identifies medical events that onset occurs in the first 5 days of flight and does not reoccur. Incidence values vary by data category and define the number of medical events per person-year or medical events per person-at-risk for each medical condition. Incidence values can be modified by crew characteristics such as gender. 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 crew member 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 IMM Technical Description Document.

Incidence	
Data Category:	Fixed
Space Adaptation:	No
Incidence Type:	Rate

Distribution Data	
Incidence:	Fixed
Occurrence:	Poisson

Data Characteristics	
Fixed Rate:	0.00504

Incidence Comments

The incidence rate is derived from results of the ISS PRA Fire and Ammonia Model version 3.2.0 (4697 ISS PRA Model v.3.2.0, 2015}. The ISS PRA model calculated total likelihood for a six month time period that at least one crew person is in a module when a crew response-level fire event occurs. The mean was 2.52E-03 events per six months; 5th and 95th percentiles were 4.67E-04 and 6.90E-03 respectively {Ref: ISS PRA Model v.3.2.0, 2015}{ISS PRA Model v.3.2.0, 2015). Therefore, the IMM annual incidence of burns secondary to fire is estimated as 0.00504 events/person years (0.00252 * 2 to convert from 6 months to 1 year).

Information Regarding Prevention

Normal screen is in compliance with ISS 50667 Medical Evaluation Documents comprise first two volumes. (Volume A and B). Because this condition is secondary to fire there is likely there is mechanical failure so in addition to the crew screening there is testing to ensure all equipment and structure is flight readiness.

Incidence Level of Evidence (LOE)

The IMM level of evidence appropriate assessment of the quality of the IMM input data. Since IMM incorporates input data from a wide variety of sources including astronaut population, terrestrial or analog populations, and external models, an innovative approach to assess the quality of input data was required. Information obtained from the astronaut population and/or space flight is the more relevant so it is assigned the highest level of evidence and less relevant data sources are assigned a lower level of evidence.

Citation	LOE Value	LOE Category
ISS PRA Model v.3.2.0, 2015	3	Incidence

Incidence data not included in the model

The model pulls the incidence information from the IMM database ... the information shown below does not go into the model.

Incidence	
Data Category:	Fixed
Space Adaptation:	No
Incidence Type:	Rate

Distribution Data	
Incidence:	Fixed
Occurrence:	Poisson

Data Characteristics	
Fixed Rate:	0.0019

Incidence Comments

No burn incidence data has been reported on any US space missions. Burns were reported in a Russian crewmember which we are not including in our incidence. First and Second degree burns were reported on Russian crewmembers to the hands and forearms during a joint expedition on MIR. Burns were treated on board. (Gontcharov, 2005)

A US Navy submarine analog population was used for our model incidence. An analysis of 10 years of data collected on Polaris submarine patrols over the ten year period, 1963-1973, reported a total of 1685 medical events treated. Illness rates are indicated as new/cases/1000 man-days. There were a total of 23 second and third degree burns, causing 145 sick days; 6.3 sick days average per event. This was an all male population. There were 6 EVACs, but no information on what circumstances caused these events. Illness rates and the rate of days lost were significantly higher than those observed in the Navy surface ship population ($P < 0.05$). (Tansey, 1979) We calculated the rate per person year at 0.00190 (23 total burns/4,410,000 person-days). Six EVACs occurred but there was no information by condition.

Information Regarding Prevention

Vehicle requirements

The ISS medical kit contains resources for treatment of burns. Weight restrictions limit the ability to replace fluid volume in severe burns. The maximum quantity of crystalloid planned, 12 liters, would support a 70 kg, 154 pounds, crew member who has sustained burns over 40% of the body for 24 hours, following the Parkland prescription of 4ml per kilogram per percentage of surface burned, which is the minimum time needed to have a LEO return to Earth, and deliver the patient to definative medical care on the ground. (Marshburn, 2008)

Other

Eight instances of on board combustions have been documented to date, four in the US Space Shuttle program and four on the Russian space stations, Salyut and MIR. (Marshburn, 2008)

Alternative Incidence Data

Analog populations

A retrospective study of military burns in the United Kingdom (UK) military reported that there were 134 burn events requiring return to the UK during 2001-2007. The median age was 27, range 20-62. The mean total body surface area (TBSA) was 5%, range 1-70. The majority were partial sickness, and 20% full thickness. Most commonly affected areas were hands, face and the extremities. There were 5 inhalation injuries. Overall 60% were accidental burns and not sustained from combat. Typically patients arrive in the UK within 2 to 4 days of the injury, and some have arrived within 24 hours. Injury score for non-combat injuries was 2.4, SD 2.1. The types and proportions of accidental injuries are very similar when comparing US and UK figures. UK mortality rates are too low to make comparisons. (Foster, 2011)

Service in the deployed military environment carries risks for accidental (non-combat-related) burns. Examining these risks can assist in the development of military burn prevention measures. A study was done to examine non-combat burn epidemiology in the context of similar civilian data. Investigators performed a retrospective cohort study of consecutive casualties evacuated from operational military theaters in Iraq and Afghanistan to the sole tertiary military burn center in the US. Military data were compared with database samples of the US population from the American Burn Association and the Centers for Disease Control and Prevention. (Kauvar, 2009)

The main causes of the 180 non-combat burns seen from March 2003 to June 2008 were waste burning, fuel mishaps, and unintentional ordinance detonations. Overall prevalence of non-combat burns was 19.5 burns/100,000 person-years lived. If causes specific to military operations are removed, military prevalence was 13.0/100,000. More than one-third of non-combat burns occurred in the first year of the study; a period of stability followed. A similar US population had an accidental burn prevalence of 7.1/100,000 from 2003 to 2007. Burn size, presence of inhalation injury, and burn center mortality were not different from those in a similar civilian cohort. Deployed service members have a greater risk of unintentional burns than a similar civilian cohort does. This is in part because of the specific dangers of military activities. (Kauvar, 2009) Rates per person years are 0.000195; and 0.00013 removing military operations causes

Injury severity score was 6, SD 8. Of these 6% had inhalation injuries and 11% had non-burn injuries. Length of stay (LOS) was 17, SD 24. 24% had complications, 1.1% mortality. TBSA 11, SD 13%. Full thickness TBSA 5, SD 11. Mechanisms of injury differ from civilian burns. Some were military specific such as handling ammunition or gun powder. The hands were the most frequently burned area, in 67% of casualties, forearm in 51% and face in 48%. (Kauvar, 2009)

Non-Analog populations

The 2011 National Burn Repository reviewed the combined data set of acute burn admissions for the time period between 2001 and 2010. The two most common reported etiologies were fire / flame and scalds, and accounted for almost 8 out of 10 reported. There were 161,307 burn injuries in the US. 23,929 or 14.6% in the 40-49 age group and 17,216 or 10.5% in the 50-59 age group. By gender, females 40-49 had 6185 and 50-59 had 4,777. Males 40-49 had 17,744 and 50-59 12,439. A small proportion had large burns. Patients with a total burn size of 40% BSA or more accounted for only 4.2 % of cases. Burns due to Fire / Flame predominated in all cases. Overall 3.9% died. Pneumonia, cellulitis, and urinary tract infections are the most prevalent complications noted in burn center patients. Most flame injuries will require hospitalization and surgical excision and grafting. Scalding injuries are the most common etiology of thermal injury seen at burn centers but represent only 35% of the patients in the National Burn Repository (NBR). Contact burns are the second most common thermal injury, but represent only 9.5% of the data in the National Burn Repository (NBR). Electrical burns only compose 4.3% of the total entries in the National Burn Repository (NBR) and include both low and high voltage injuries. Chemical burns compromise 3.4% of the entries in the entire data set. (Bassey, 2011)

The NTDB reported 7,824 injuries by fire / flame with an incident rate of 1.15% including 476 deaths. Case fatality rate 6.08. By gender, rates are female 0.79, and male 1.35. (American College of Surgeons, 2010)

A retrospective analysis of National Hospital Ambulatory Medical Care Survey databases for 1996-2005 available from the Centers for Disease Control and Prevention. Subjects with a first diagnosis of a burn reported that less than 5% of burns were third degree or full thickness injuries. Admissions per year were stable at 5%. The most common causes of burn injury were contact with a hot liquid and contact with a hot object, and the most common body region affected was the upper extremities (40% each year), followed by burns to the head, face and neck. (Taira, 2010)

Treatment and Outcomes

Based on the best evidence available best and worst case percentage ranges are assigned. The medical condition is divided into three clinical phases in all three clinical phases a functional impairment is assigned. The clinical phase I and II's functional impairments remain for the duration for that respective clinical phase. The function impairment in clinical phase III represents final impairment for this medical condition and remains for the rest of the mission. Other mission end states include evacuation and loss of crew life.

The IMM checks medical resource availability once the number of medical events and scenarios has been established. If there is not sufficient essential resources called out in the CliFF, then the medical condition will go down an untreated best or worst case scenario pathway.

The table below summarizes the treated and untreated best and worst case scenarios.

	Clinical Phase I Diagnosis & Initial Treatment[1]		**Clinical Phase II On-going Treatment / Convalescence[2]**		**Clinical Phase III Recovered / Mission End State[3]**		
	FI* (%)	**Duration (hrs)**	**FI* (%)**	**Duration (hrs) (Min - ML - Max)**	**FI* (%)**	**EVAC** (%)**	**LOCL** (%)**
ISS-based Treatment (best case scenario %: 99 - 100)	100	0.33	3 - 44	72 - 120 - 168	0	0	0
ISS-based Treatment (worst case scenario %: 0 - 1)	100	0.75 - 1.5	23 - 67	24 - 36 - 48	0 - 67	100	0 - 100
Untreated Best Case	0	0	23 - 67	72 - 120 - 168	0 - 44	0 - 100	0
Untreated Worst Case	0	0	47 - 90	24 - 36 - 48	47 - 90	100	4 - 100

[1]Clinical Phase I: Clinical phase I covers only the initial assessment of the affected crew member to define his or her medical condition, and completion of appropriate initial treatment to stabilize the crew member. While the affected crew member is being assessed, he or she is not able to perform any assigned tasks, thus Functional Impairment during this phase is considered 100%. In the untreated case, there is no diagnosis performed or treatment given, therefore Functional Impairment and Duration will always be "not applicable".

[2]Clinical Phase II: On-going Treatment and Convalescence- During clinical phase II, the affected crew member is receiving any appropriate follow-on treatment for his or her medical condition to allow the crew member to recover as much as he or she is able to recover in the ISS environment. Clinical phase II also encompasses relapses or reoccurrences of the same original medical condition in clinical phase I necessitating additional treatment or recovery time due to unsuccessful primary treatment response. The duration in Clinical Phase II is expressed in minimum, most likely (ML) and maximum hours. This was updated for future capabilities in IMM but is currently not being used by the model.

[3]Clinical Phase III: Recovered/Mission End State- Clinical phase III is reached once the affected crew member has recovered from the medical condition as much as he or she is able to recover in the ISS environment. This may or may not be recovery from the given medical condition to the full extent possible. If this "recovered" state results in an evacuation or loss of the crew member, this will be noted in the mission end state results.

*Functional Impairment (FI) is a measure of the affected crew member's health and performance ability.

**Two mission end state results are addressed in the CliFF: 1) Evacuation (EVAC) - crew and patient are evacuated from the spacecraft due to the medical condition, and 2) Loss of crew (LOCL) - death of affected crew member due to medical condition. EVAC is considered as an end state result if any of the following criteria are met: 1) potential LOCL, 2) potential significant permanent impairment, or 3) potential intractable pain. Probability distributions are assigned for each range of values within the Table of Treatments and Outcomes.

Refer to the Integrated Medical Model Technical Document for more information on how risk is reported by the IMM, Crew Health Index (CHI) and Quality Adjusted Mission Time calculations.

Definition and Probability of Best and Worst Case Scenario: (includes definitions of best and worst case scenarios and identifies the probability of those scenarios.)

Scenario Comments

Best Case scenario is defined as first degree burn, or a second degree burn covering less than 9% of total body surface area (TBSA).

Worst Case scenario is defined as second degree burn greater than 9% of TBSA or any third degree burn.

The **probabilities of best case and worst case** were estimated based on the scenarios provided by the ISS PRA Fire and Ammonia Model version 3.2.0 (ISS PRA Model v.3.2.0, 2015)for a six month ISS mission, and are lower than terrestrial data (5% hospitalization, (Taira, 2010) .The ISS PRA Model estimated the likelihood of an uncontrollable fire event ("EVAC (Uncontrollable Fire- not vehicle)", mean- 1.05E-05) ({ISS PRA Model v.3.2.0, 2015)}. The ISS PRA Model also predicted the likelihood that at least one crew person is in a module when a crew response-level fire event occurs (mean- 2.52E-03) {ISS PRA Model v.3.2.0, 2015}. Therefore, a worst case burns secondary to fire event is estimated as 0-1% to account for uncertainty, with the upper bound derived from the ratio of the mean values of the likelihood of these two types of events (0.0000105 / 0.00252 = 0.42%). Thus a best case event is estimated as 99-100%.

Inhalation injury is addressed in the Smoke Inhalation Clinical Findings Form.

Best Case Comments

Burns functional impairments (FI) calculation follows the IMM severe non-space adaptation template. Complex Regional Pain Syndrome-Upper Extremity ratings are based on Table 15-26, p.454. The CRPS (UEI) ratings are then converted to percentage of Whole Person Impairment (WPI), which are based on Table 15-1, p 385. (American Medical Association, 2008) Complex Regional Pain Syndrome-Lower Extremity is based on Table 16-15, p.541 (American Medical Association, 2008). The CRPS (LEI) ratings are converted to percentage of Whole Person Impairment (WPI), which are based on Table 16-1, p 495 (American Medical Association, 2008). Skin disorders are based on Table 8-2, p 166-167 (American Medical Association, 2008). Final FI ratings are calculated combining the mentioned tables using the Combined Values Chart as indicated in Appendix A, pp 604-606 (American Medical Association, 2008).

In **Clinical Phase I,** by definition FI is estimated as 100%. Time to follow ISS procedures for worst case burns may take 45 to 90 minutes, 0.75 to 1.5 hours. During **Clinical Phase II:** FI is estimated to be 23 to 67%. Duration is estimated in 1 to 72 hours to follow procedures indicated in ISS medical checklist. In **Clinical Phase III:** FI is estimated to be 0 to 67%. Worst case burns would be a Class III medical event, a significant medical event requiring evacuation if occurring on orbit. Hospitalization has occurred for burns among the astronaut corps on the ground (Johnston, 2008) and analog populations (Kauvar, 2009); (Foster, 2011). Mortality rates have been estimated at 3.9% for burns in the 40-49 age cohort. (Bassey, 2011). Rates vary by percentage of area burned and severity. To allow for uncertainty, EVAC and LOCL are estimated at 0-100%.

Worst Case Comments

Burns functional impairments (FI) calculation follows the IMM severe non-space adaptation template. Complex Regional Pain Syndrome-Upper Extremity ratings are based on Table 15-26, p.454. The CRPS (UEI) ratings are then converted to percentage of Whole Person Impairment (WPI), which are based on Table 15-1, p 385. (American Medical Association, 2008) Complex Regional Pain Syndrome-Lower Extremity is based on Table 16-15, p.541 (American Medical Association, 2008). The CRPS (LEI) ratings are converted to percentage of Whole Person Impairment (WPI), which are based on Table 16-1, p 495 (American Medical Association, 2008). Skin disorders are based on Table 8-2, p 166-167 (American Medical Association, 2008). Final FI ratings are calculated combining the mentioned tables using the Combined Values Chart as indicated in Appendix A, pp 604-606 (American Medical Association, 2008).

In **Clinical Phase I,** by definition FI is estimated as 100%. Time to follow ISS procedures for worst case burns may take 45 to 90 minutes, 0.75 to 1.5 hours. During **Clinical Phase II:** FI is estimated to be 23 to 67%. Duration is estimated in 24 to 48 hours to follow procedures indicated in ISS medical checklist and minimal time to evacuation. In **Clinical Phase III:** FI is estimated to be 0 to 67%. Worst case burns would be a Class III medical event, a significant medical event requiring evacuation if occurring on orbit. Hospitalization has occurred for burns among the astronaut corps on the ground (Johnston, 2008) and analog populations (Kauvar, 2009); (Foster, 2011). Therefore, EVAC probability is considered 100%. Mortality rates have been estimated at 3.9% for burns in the 40-49 age cohort (Bassey, 2011). Rates vary by percentage of area burned and severity. To allow for uncertainty, and since terrestrial level of medical care would not be available on ISS, LOCL is estimated at 0-100%.

Untreated Best Case Comments

Burns functional impairments (FI) calculation follows the IMM severe non-space adaptation template. Complex Regional Pain Syndrome-Upper Extremity ratings are based on Table 15-26, p.454. The CRPS (UEI) ratings are then converted to percentage of Whole Person Impairment (WPI), which are based on Table 15-1, p 385. (American Medical Association, 2008) Complex Regional Pain Syndrome-Lower Extremity is based on Table 16-15, p.541 (American Medical Association, 2008). The CRPS (LEI) ratings are converted to percentage of Whole Person Impairment (WPI), which are based on Table 16-1, p 495 (American Medical Association, 2008). Skin disorders are based on Table 8-2, p 166-167 (American Medical Association, 2008). Final FI ratings are calculated combining the mentioned tables using the Combined Values Chart as indicated in Appendix A, pp 604-606 (American Medical Association, 2008).

During **Clinical Phase II,** FI is estimated to be 23 to 67%. Duration is similar to the treated best case scenario. In **Clinical Phase III,** FI is estimated to be 0 to 44%. Recovery might be possible but EVAC must be considered for intractable pain without resources on board. To allow for uncertainty. EVAC is estimated at 0-100%. LOCL is not expected for this scenario.

Untreated Worst Case Comments

Burns functional impairments (FI) calculation follows the IMM severe non-space adaptation template. Complex Regional Pain Syndrome-Upper Extremity ratings are based on Table 15-26, p.454. The CRPS (UEI) ratings are then converted to percentage of Whole Person Impairment (WPI), which are based on Table 15-1, p 385. (American Medical Association, 2008) Complex Regional Pain Syndrome-Lower Extremity is based on Table 16-15, p.541 (American Medical Association, 2008). The CRPS (LEI) ratings are converted to percentage of Whole Person Impairment (WPI), which are based on Table 16-1, p 495 (American Medical Association, 2008). Skin disorders are based on Table 8-2, p 166-167 (American Medical Association, 2008). Final FI ratings are calculated combining the mentioned tables using the Combined Values Chart as indicated in Appendix A, pp 604-606 (American Medical Association, 2008).

During **Clinical Phase II:** FI is estimated to be 47 to 90% and duration is 24 to 48 hours, similar to the treated worst case scenario. In **Clinical Phase III;** recovery is unlikely and FI is estimated to remain 47 to 90%. Untreated burns may meet all criteria for EVAC, i.e. potential loss of life, potential significant permanent impairment, or potential intractable pain. Therefore, EVAC is estimated at 100%. Mortality rates have been estimated at 3.9% for burns in the 40-49 age cohort (Bassey, 2011). LOCL **without** treatment is therefore estimated at 4-100%.

Treatment and Options Level of Evidence (LOE)

The IMM level of evidence appropriate assessment of the quality of the IMM input data. Since IMM incorporates input data from a wide variety of sources including astronaut population, terrestrial or analog populations, and external models, an innovative approach to assess the quality of input data was required. Information obtained from the astronaut population and/or space flight is the more relevant so it is assigned the highest level of evidence and less relevant data sources are assigned a lower level of evidence.

Citation	LOE Value	LOE Category
American Medical Association, 2008	3	FI
American Medical Association, 2008	3	FI
American Medical Association, 2008	3	FI
American Medical Association, 2008	3	FI
Johnston, 2008	2	EVAC
Kauvar, 2009	2	EVAC
Foster, 2011	2	EVAC
Bassey, 2011	4	EVAC
ISS PRA Model v.3.2.0, 2015	3	BCWC

The Resource Table (RT)

Resource	Units Required Best Case	Units Required Worst Case	Units Available At Start Of Mission	Consumable	Essential	Rationale
Bacitracin 500 units/gm. 28 gm tube	1	4	34	Yes	Yes	Topical Antibiotic
Blood Oximeter	0	1	1	No	Yes	Monitors the oxygen saturation of a patient's blood
Blood Pressure Cuff (regular, large)	0	1	2	No	Yes	Measure blood pressure
Blood Pressure Monitor	0	1	1	No	Yes	Measure blood pressure
Burn Bandage	2	10	10	Yes	No	To dress burn wounds.
BZK wipes	0	6	60	Yes	No	Cleanse skin.
CMRS	0	1	1	No	No	For crew safety
Gauze pads (4x4)	0	25	50	Yes	No	To absorb blood or fluids from skin
Iodine Swab Stick	6	8	14	Yes	No	To clean wound surrounding area
IV administration set	0	1	3	Yes	Yes	IV Fluids infusion
IV Cap	0	1	5	Yes	No	To attach IV fluids to Y-type catheter
IV Catheter (18G, 20G, or 22G)	0	1	14	Yes	Yes	IV fluid administration
IV Fluid 1L (1000mL)	0	4	5	Yes	Yes	To replenish fluids
IV Fluid Air Filter	0	1	3	Yes	No	To filter air from IV line
IV pressure infuser	0	1	1	No	No	IV Fluids infusion
Medical tape	0.07	0.1	5	Yes	No	Single-coated tape pressure adhesive tape
Nitrile gloves (large, medium, and small) (pair)	2	2	30	Yes	No	Personal Protective equipment for CMO
Nonstick Bandage (Telfa pads)	3	6	20	Yes	No	Non-adherent dressing to apply directly to wounds not covered by burn bandages
Sharps container	0	1	40	No	No	To dispose of medical waste such as used medical needles, scalpels, IV catheters, razors, vials
Stethoscope	1	1	2	No	Yes	To listen to lung sounds and evaluate breathing
Thermometer	0	1	1	No	No	To measure temperature
Tourniquet	0	1	1	No	No	To stop blood flow and engorge vein, this facilitates IV insertion
Tylenol (Acetaminophen) 325 mg	18	0	150	Yes	Yes	Pain relief.

Resource	Units Required Best Case	Units Required Worst Case	Units Available At Start Of Mission	Consumable	Essential	Rationale
Variable Oxygen System	0	1	1	No	Yes	To provide O2 for compromised breathing due to either direct airway involvement or airway edema due to large amount of IV fluids administered.
Vicodin HP (Hydrocodone/ Acetaminophen HP) 10 mg/660 mg	0	12	30	Yes	Yes	Pain relief

Resource Comments

The table was revised on 9/14/2011. The ISS medical checklist (Mission Operations Directorate (MOD), 2011) addresses burn treatment. Pain relief and intravenous fluids are in separate sections. All sections were combined in the Resource Table. All resources are available on board.

Inhalation injury is addressed in the Smoke Inhalation Clinical Findings Form.

Comparison of ISS medical checklist and terrestrial guidelines

Terrestrial guidelines (Gomez, 2007)recommend evaluate for non-thermal injuries, evaluate burn size, inhalation injury, fluid resuscitation, wound treatment, and admission or referral to burn center. ISS follows the same treatment, except on intravenous fluids where terrestrial guidelines start at 20% TBSA burns, and ISS at 9%.

Required Resources Level of Evidence (LOE)

The IMM level of evidence appropriate assessment of the quality of the IMM input data. Since IMM incorporates input data from a wide variety of sources including astronaut population, terrestrial or analog populations, and external models, an innovative approach to assess the quality of input data was required. Information obtained from the astronaut population and/or space flight is the more relevant so it is assigned the highest level of evidence and less relevant data sources are assigned a lower level of evidence.

Citation	LOE Value	LOE Category
NASA Mission Operations Directorate (MOD), 2011	2	Resources

Level Of Evidence

Input Data	LOE Average
Incidence	3
Functional Impairment	3
Best Case / Worst Case	3
EVAC / LOCL	2.5
Resources	2
QUALITY OF EVIDENCE	**2.7**

Description	Range
Excellent	1-2
Good	2.1-3
Fair	3.1-4
Poor	4.1-5

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