

Executive Summary

The IMM v4.1 with Lockdown ID #6 (which includes input from spaceflight data through STS mission 114 and ISS Expedition 13) was used to simulate two Gateway missions, a 4 crew-16 day mission and a 4 crew-42 day mission, to provide a medical risk assessment. The fully treated timelines are presented for both simulated missions. For the 4 crew-16 day mission the IMM forecasted a 0.253% probability of EVAC and a 0.025% probability of LOCL. For the 4 crew-42 day mission, a 1.116% probability of EVAC and a 0.075% probability of LOCL were forecasted. The frequency of EVAC and LOCL over the entire simulations, lists of influential conditions for EVAC and LOCL, the frequency and probability of occurrence for each medical condition are also presented in this report.

Background

The IMM simulates medical events during space flight missions in order to estimate the medical risk for crewmembers during a mission via the main IMM outputs, CHI and probability of EVAC and LOCL. The IMM is a stochastic model that uses Monte Carlo methodology to simulate missions.

The IMM consists of a three-step process. First, mission and crew member characteristics are specified to define a particular mission profile. Next, medical events, mitigations, and outcomes during the space flight mission are randomly generated based on pre-defined values and probability distributions. Finally, total crew health and mission impact outcomes are summarized. For this report, the primary outcomes are the probabilities of EVAC and LOCL.

The IMM is most useful for comparing risks among multiple mission profiles based on probable events, resource availability, and the ability of the crew to diagnose and treat medical conditions. Biased results may be incurred due to limitations of the model, but the bias will be consistent across mission profiles within the same service request.

Methods

Crew and Mission Parameters

The DRMs were configured using the crew profile illustrated in Table 1.

The outcomes of certain IMM medical conditions are sex-specific and influenced by crew medical history. Pre-existing conditions that influence IMM outcomes include: coronary artery calcium score (CAC), dental crowns, contact lenses, and history of any prior abdominal surgery. Pre-existing conditions, as defined here, are consistent with historical U.S. crew data. The number of extravehicular activity (EVA) excursions influences the probability of EVA-dependent medical conditions.

Table 1: Crew Profile

	Sex	CAC	Crowns	Contacts	Prior Abdominal Surgery	EVA
Crew 1	Male	Yes	Yes	No	No	No
Crew 2	Male	No	No	Yes	Yes	No
Crew 3	Female	No	Yes	No	No	No
Crew 4	Female	No	No	Yes	No	No

Medical Conditions and Resources

The incidence of IMM medical events occurring during simulated missions are based on historical mission and cohort data from the Integrated Medical Evidence Database (iMED). For each condition, the percentage of “best case” and “worst case” scenarios are also specified, as well as a defined set of medical resources that is required to diagnose and treat the medical condition. The medical resources listed for each condition are contained in a condition resources table in iMED. This table details the resources and quantity necessary for treatment in both the best and worst case scenario for each condition. The model input parameters that are used to dictate the occurrence and treatment of each condition are contained in a parameters table in iMED. For instance, the data in this table would be used to determine which crewmember is eligible for which condition, whether the condition is best or worst case, and the effects of being best or worst case. All medical condition data inputs to the model are pulled from the iMED by a SQL query written in MATLAB scripts. In-flight medical treatment is assumed to follow a specified protocol or clinical practice guidelines for each medical condition and is constrained by resource availability on the ISS (i.e. the ISS medical capabilities (MedCap)).

Main Outcomes

The IMM primary medical outcomes include: total medical events (TME), crew health index (CHI), probability of Evacuation (EVAC), probability of Loss of Crew Life (LOCL), and required resources.

CHI is a calculated percentage using the quality-adjusted mission time lost (QAMTL) due to in-flight medical events and resources available to treat those conditions [3].

$$\text{CHI} = (1 - (\text{QAMTL} \div \text{Mission Length})) \times 100$$

For a given condition, QAMTL is determined by summing the product of functional impairment and duration for all three clinical phases of that condition: i) diagnosis and initial treatment, ii) ongoing treatment, and iii) end-state. CHI percent values range from 0-100, where zero represents complete crew impairment and one hundred represents a completely functional crew.

EVAC in the context of IMM means that medical evacuation from the ISS would be considered for definitive treatment of the afflicted crew member(s). EVAC is considered an end state result if any of the following criteria is met: 1) potential LOCL; 2) potential significant permanent impairment; or 3) potential intractable pain. When EVAC is calculated by the IMM, no consideration has been given to the availability of a return vehicle or the likelihood of a successful clinical outcome should a return vehicle be available.

LOCL in the context of IMM should be interpreted to mean that the clinical scenario resulted in death of the affected crew member(s). In the current version of the IMM, it is possible for crew members to be assigned more than one endstate of EVAC and/or LOCL. These assumptions should result in slightly high (conservative) IMM forecasts for the occurrence of EVAC and LOCL. Determining the probability of EVAC and LOCL for the given DRMs is one of the main objectives of this service request.

Required resources for treatment are tracked for each DRM. The number of each resource that is needed from the given available resource quantities to treat all medical events is recorded. If more of any particular resource is used than is available, then that is recorded as a “depleted” resource for the medical capabilities scenario. In IMM version 4, any other events that require a “depleted” resource go partially treated if there are available alternate resources in the medical capabilities scenario. (If there are no alternate resources available, those conditions go untreated.) In the fully treated scenario, all events go treated. The initial quantities for the available resources are baselined to the ISS environment with 6 month resupply. This service request is focused on a fully treated scenario.

Modeling Approach

A simulation was run for a 16 day and a 42 mission using the crew profile shown above. One hundred thousand (100,000) trials were run for each DRM, where each trial can be considered an individual “mission”. This ensures that the distribution of outcomes meets convergence criteria. Convergence criteria are met when there is less than, or equal to a 5% change in the average standard deviation of the CHI, EVAC, and LOCL primary model outcomes in the last two - 1,000 mission increments. This last step is performed manually by the modelers using the IMMV4ConvergenceReport.

IMM outcomes were determined for the DRMs under three scenarios: 1) ISS MedCap scenario where all conditions are treated or untreated based on the available essential resources of the ISS MedCap using an all or nothing methodology; 2) All Treated scenario where supplies are limitless and all conditions are fully treated; and 3) Untreated scenario where none of the conditions are treated. Total medical events (TME) and CHI are calculated as means, with 95% confidence intervals (CIs) for the associated distributions. EVAC and LOCL are probabilities, with 95% confidence intervals (CI) for EVAC and LOCL obtained using bootstrap resampling of the simulation output [3]. In this report, only the EVAC and LOCL results for the fully treated capabilities timeline are presented as requested.

Key Assumptions and Limitations [4] of IMM Version 4

1. Version 4 assumes that all non-SA and non-extravehicular activity (EVA) related conditions have a uniform likelihood of occurring throughout the mission duration. Space Adaptation Syndrome conditions occur in the first 5 days of the mission, with a peak occurrence at 48 hours.
2. Version 4 assumes that EVA-related medical conditions occur at the start time of the EVA.
3. Version 4 assumes that individuals cannot get the same condition for which they are currently being treated (i.e. during Clinical Phase (CP) I and II) with one exception: crew members may have concurrent occurrences of EVA-linked medical conditions with the exception of decompression sickness.

4. EVAC LOCL is generated for each medical event, and then the timing of the EVAC or LOCL is generated according to a specified distribution.
5. Version 4 assumes that individuals are no longer at risk for further conditions once their status changes to either EVAC or LOCL. From the start time of the EVAC or LOCL, the functional impairment of the crew member is assumed to be 100%.
6. When the status of a crew member changes to EVAC, only one crew member is evacuated.
7. The IMM assumes that, per crew member, the first condition requiring a specific therapy utilizes all resources required for treating that condition before a second condition has access to those resources.
8. Most medical conditions, with exceptions including acute radiation syndrome and EVA-linked conditions, occur independently of the occurrence of mission events and other medical conditions. Currently there is no correlation or association within or between crew members for most medical conditions.
9. The model assumes another crew member is available to act as caregiver but does not track the time impact of providing this care.
10. Medical procedures are accurately followed and successful; no mistakes occur in executing medical procedures.
11. Crew medical skill level and preflight/inflight training is not modeled.
12. All diagnoses are 100% accurate.
13. All pharmaceuticals maintain maximum efficacy.
14. All medical events receive the appropriate treatment.
15. All medical events respond to the treatment as expected terrestrially.
16. All medical equipment is 100% reliable.
17. For each of the medical conditions specified in iMED, all crew members with the same characteristics (sex, presence of CAC, crowns, contacts, history of abdominal surgery) have the same likelihood distribution of experiencing the condition.
18. All crew members are assumed to have all intrinsic body parts intact (i.e. appendix, gall bladder, and uterus or prostate, etc.).
19. IMM assumes ISS power, potable water and oxygen resources are always available in unlimited supply.
20. No Russian medical capabilities aboard the ISS are available to US crew members.
21. Medical capabilities do not include the use of personal crew carry-on items contained in the Individual Medical Accessories Kit, (IMAK).
22. If a crew member is undergoing treatment for concurrent medical conditions requiring the same consumable resource, the crew member will only utilize resources at the level required by the condition that requires the most resources.
23. If the primary resource required for treating a medical condition is unavailable, one or more alternative resources are considered, if appropriate. One example might be using aspirin in place of Tylenol.
24. Total quantities of a consumable medical resource requiring a daily dose will be adjusted if a dosage schedule runs past the end of the mission.
25. If a solar particle event causes acute radiation sickness in one or more crew members, IMM assumes the condition begins identically in all affected crew members at the beginning of the solar particle event.
26. The IMM does not decrement non-consumable items and allows all non-consumable items to be used simultaneously by multiple astronauts.

Results

The IMM simulation results for EVAC and LOCL for the simulated missions are presented in the tables below. The simulation results in the tables are for the fully treated timelines. Table 2 contains the overall probabilities of EVAC and LOCL and by medical category. Table 3 contains the frequency for the number EVAC and LOCL over all 100,000 trials. Tables 4-7 show the lists of top ten influential conditions for EVAC and LOCL for both simulated missions. Tables 8-11 contain the frequency and probability of occurring in both simulated missions

Table 2: Probability of at least one evacuation (EVAC) and loss of crew life (LOCL), by condition category with 95% confidence intervals (CI).

		EVAC		LOCL	
		Probability (%)	95% CI	Probability (%)	95% CI
4 Crew 16 Days	All Conditions	0.253	(0.222, 0.286)	0.025	(0.017, 0.037)
	Medical Illness	0.174	(0.150, 0.204)	0.014	(0.008, 0.023)
	Injury/Trauma	0.053	(0.040, 0.071)	0.008	(0.004, 0.017)
	Environmental	0.026	(0.017, 0.037)	0.003	(0.001, 0.009)
4 Crew 42 Days	All Conditions	1.116	(1.052, 1.180)	0.075	(0.058, 0.094)
	Medical Illness	0.924	(0.865, 0.979)	0.033	(0.023, 0.046)
	Injury/Trauma	0.139	(0.118, 0.161)	0.033	(0.023, 0.046)
	Environmental	0.055	(0.05, 0.08)	0.009	(0.004, 0.016)

Table 3: Frequency and percent of EVAC and LOCL.

EVAC						LOCL		
		Event Count	Frequency	Percent			Frequency	Percent
4 Crew 16 Days		0	99747	97.747			99975	99.975
		1	253	0.253			25	0.025
		2	0	0			0	0
4 Crew 42 Days		0	98884	98.884			99925	99.925
		1	1110	1.110			75	0.075
		2	6	0.006			0	0

Table 4: 4 Crew-16 Days fully treated top ten influential conditions for EVAC

Scenario	Treated	Medical Condition	Category	Total EVAC	Percent Contribution	Cumulative Percent
WORST CASE	TREATED	DENTAL: ABSCESS	MEDICAL	38	15.01976285	15.01976285
WORST CASE	TREATED	NEPHROLITHIASIS	MEDICAL	26	10.27667984	25.29644269
WORST CASE	TREATED	SMOKE INHALATION	ENVIRONMENTAL	16	6.324110672	31.62055336
BEST CASE	TREATED	SMALL BOWEL OBSTRUCTION	MEDICAL	15	5.928853755	37.54940711
WORST CASE	TREATED	WRIST FRACTURE	INJURY/TRAUMA	13	5.138339921	42.68774704
WORST CASE	TREATED	SEPSIS	MEDICAL	13	5.138339921	47.82608696
WORST CASE	TREATED	URINARY RETENTION (SPACE ADAPTATION)	MEDICAL	8	3.162055336	50.98814229
WORST CASE	TREATED	BACK SPRAIN/STRAIN	INJURY/TRAUMA	7	2.766798419	53.75494071
BEST CASE	TREATED	STROKE (CEREBROVASCULAR ACCIDENT)	MEDICAL	6	2.371541502	56.12648221
WORST CASE	TREATED	ACUTE SINUSITIS	MEDICAL	5	1.976284585	58.1027668

Table 5: 4 Crew-42 Days fully treated top ten influential conditions for EVAC

Scenario	Treated	Medical Condition	Category	Total LOCL	Percent Contribution	Cumulative Percent
WORST CASE	TREATED	VISUAL IMPAIRMENT AND/OR INCREASED INTRACRANIAL PRESSURE (VIIP)(SPACE ADAPTATION)	MEDICAL	507	45.18716578	45.18716578
WORST CASE	TREATED	DENTAL: ABSCESS	MEDICAL	111	9.893048128	55.0802139
WORST CASE	TREATED	NEPHROLITHIASIS	MEDICAL	75	6.684491979	61.76470588
WORST CASE	TREATED	SEPSIS	MEDICAL	31	2.762923351	64.52762923
WORST CASE	TREATED	SMOKE INHALATION	ENVIRONMENTAL	30	2.673796791	67.20142602
WORST CASE	TREATED	BACK SPRAIN/STRAIN	INJURY/TRAUMA	27	2.406417112	69.60784314
BEST CASE	TREATED	SMALL BOWEL OBSTRUCTION	MEDICAL	20	1.782531194	71.39037433
WORST CASE	TREATED	TRAUMATIC HYPOVOLEMIC SHOCK	INJURY/TRAUMA	17	1.515151515	72.90552585
WORST CASE	TREATED	HIP/PROXIMAL FEMUR FRACTURE	INJURY/TRAUMA	16	1.426024955	74.3315508
WORST CASE	TREATED	URINARY RETENTION (SPACE ADAPTATION)	MEDICAL	15	1.336898396	75.6684492

Table 6: 4 Crew-16 Days fully treated top ten influential conditions for LOCL

Scenario	Treated	Medical Condition	Category	Total LOCL	Percent Contribution	Cumulative Percent
WORST CASE	TREATED	SEPSIS	MEDICAL	6	24	0.24
WORST CASE	TREATED	TRAUMATIC HYPOVOLEMIC SHOCK	INJURY/TRAUMA	5	20	0.44
WORST CASE	TREATED	MEDICATION OVERDOSE/ADVERSE REACTION	MEDICAL	4	16	0.6
WORST CASE	TREATED	STROKE (CEREBROVASCULAR ACCIDENT)	MEDICAL	2	8	0.68
WORST CASE	TREATED	TOXIC EXPOSURE: AMMONIA	ENVIRONMENTAL	2	8	0.76
WORST CASE	TREATED	SMOKE INHALATION	ENVIRONMENTAL	1	4	0.8
WORST CASE	TREATED	HEAD INJURY	INJURY/TRAUMA	1	4	0.84
WORST CASE	TREATED	APPENDICITIS	MEDICAL	1	4	0.88
WORST CASE	TREATED	CHEST INJURY	INJURY/TRAUMA	1	4	0.92
WORST CASE	TREATED	ABDOMINAL INJURY	INJURY/TRAUMA	1	4	0.96

Table 7: 4 Crew-42 Days fully treated top ten influential conditions for LOCL

Scenario	Treated	Medical Condition	Category	Total LOCL	Percent Contribution	Cumulative Percent
WORST CASE	TREATED	TRAUMATIC HYPOVOLEMIC SHOCK	INJURY/TRAUMA	17	22.66666667	0.226666667
WORST CASE	TREATED	MEDICATION OVERDOSE/ADVERSE REACTION	MEDICAL	12	16	0.386666667
WORST CASE	TREATED	SEPSIS	MEDICAL	12	16	0.546666667
WORST CASE	TREATED	CHEST INJURY	INJURY/TRAUMA	8	10.66666667	0.653333333
WORST CASE	TREATED	HEAD INJURY	INJURY/TRAUMA	6	8	0.733333333
WORST CASE	TREATED	SMOKE INHALATION	ENVIRONMENTAL	5	6.66666667	0.8
WORST CASE	TREATED	STROKE (CEREBROVASCULAR ACCIDENT)	MEDICAL	5	6.66666667	0.866666667
WORST CASE	TREATED	TOXIC EXPOSURE: AMMONIA	ENVIRONMENTAL	4	5.333333333	0.92
WORST CASE	TREATED	APPENDICITIS	MEDICAL	3	4	0.96
WORST CASE	TREATED	ABDOMINAL INJURY	INJURY/TRAUMA	2	2.66666667	0.986666667

Table 8: 4 crew-16 days frequency of each condition over all 100,000 trials

Medical Condition	Scenario	Events
ABDOMINAL INJURY	BEST CASE	1
ABDOMINAL INJURY	WORST CASE	2
ABDOMINAL WALL HERNIA	BEST CASE	11
ABDOMINAL WALL HERNIA	WORST CASE	0
ABNORMAL UTERINE BLEEDING	BEST CASE	429
ABNORMAL UTERINE BLEEDING	WORST CASE	9
ACUTE ANGLE-CLOSURE GLAUCOMA	BEST CASE	1
ACUTE ANGLE-CLOSURE GLAUCOMA	WORST CASE	0
ACUTE ARTHRITIS	BEST CASE	47
ACUTE ARTHRITIS	WORST CASE	0
ACUTE CHOLECYSTITIS/BILIARY COLIC	BEST CASE	16
ACUTE CHOLECYSTITIS/BILIARY COLIC	WORST CASE	2
ACUTE COMPARTMENT SYNDROME	BEST CASE	0
ACUTE COMPARTMENT SYNDROME	WORST CASE	0
ACUTE DIVERTICULITIS	BEST CASE	10
ACUTE DIVERTICULITIS	WORST CASE	5
ACUTE PANCREATITIS	BEST CASE	6
ACUTE PANCREATITIS	WORST CASE	0
ACUTE PROSTATITIS	BEST CASE	28
ACUTE PROSTATITIS	WORST CASE	2
ACUTE RADIATION SYNDROME	BEST CASE	44
ACUTE RADIATION SYNDROME	WORST CASE	1
ACUTE SINUSITIS	BEST CASE	3634
ACUTE SINUSITIS	WORST CASE	270
ALLERGIC REACTION (MILD TO MODERATE)	BEST CASE	6720
ALLERGIC REACTION (MILD TO MODERATE)	WORST CASE	279
ALTITUDE SICKNESS	BEST CASE	2
ALTITUDE SICKNESS	WORST CASE	0
ANAPHYLAXIS	BEST CASE	6
ANAPHYLAXIS	WORST CASE	0
ANGINA/MYOCARDIAL INFARCTION	BEST CASE	6
ANGINA/MYOCARDIAL INFARCTION	WORST CASE	1
ANKLE SPRAIN/STRAIN	BEST CASE	7064
ANKLE SPRAIN/STRAIN	WORST CASE	135
ANXIETY	BEST CASE	72
ANXIETY	WORST CASE	4
APPENDICITIS	BEST CASE	12
APPENDICITIS	WORST CASE	3
ATRIAL FIBRILLATION/ ATRIAL FLUTTER	BEST CASE	9
ATRIAL FIBRILLATION/ ATRIAL FLUTTER	WORST CASE	5
BACK PAIN (SPACE ADAPTATION)	BEST CASE	206731

BACK PAIN (SPACE ADAPTATION)	WORST CASE	3175
BACK SPRAIN/STRAIN	BEST CASE	19910
BACK SPRAIN/STRAIN	WORST CASE	387
BAROTRAUMA (EAR/SINUS BLOCK)	BEST CASE	19589
BAROTRAUMA (EAR/SINUS BLOCK)	WORST CASE	325
BEHAVIORAL EMERGENCY	BEST CASE	0
BEHAVIORAL EMERGENCY	WORST CASE	0
BURNS SECONDARY TO FIRE	BEST CASE	92
BURNS SECONDARY TO FIRE	WORST CASE	0
CARDIOGENIC SHOCK SECONDARY TO MYOCARDIAL INFARCTION	BEST CASE	0
CARDIOGENIC SHOCK SECONDARY TO MYOCARDIAL INFARCTION	WORST CASE	0
CHEST INJURY	BEST CASE	0
CHEST INJURY	WORST CASE	5
CHOKING/OBSTRUCTED AIRWAY	BEST CASE	1859
CHOKING/OBSTRUCTED AIRWAY	WORST CASE	11
CONSTIPATION (SPACE ADAPTATION)	BEST CASE	67990
CONSTIPATION (SPACE ADAPTATION)	WORST CASE	342
DECOMPRESSION SICKNESS SECONDARY TO EXTRAVEHICULAR ACTIVITY	BEST CASE	0
DECOMPRESSION SICKNESS SECONDARY TO EXTRAVEHICULAR ACTIVITY	WORST CASE	0
DENTAL : EXPOSED PULP	BEST CASE	274
DENTAL : EXPOSED PULP	WORST CASE	67
DENTAL CARIES	BEST CASE	3319
DENTAL CARIES	WORST CASE	1974
DENTAL: ABSCESS	BEST CASE	312
DENTAL: ABSCESS	WORST CASE	91
DENTAL: AVULSION (TOOTH LOSS)	BEST CASE	46
DENTAL: AVULSION (TOOTH LOSS)	WORST CASE	6
DENTAL: CROWN LOSS	BEST CASE	45
DENTAL: CROWN LOSS	WORST CASE	5
DENTAL: FILLING LOSS	BEST CASE	85
DENTAL: FILLING LOSS	WORST CASE	8
DEPRESSION	BEST CASE	54
DEPRESSION	WORST CASE	1
DIARRHEA	BEST CASE	20895
DIARRHEA	WORST CASE	347
ELBOW DISLOCATION	BEST CASE	0
ELBOW DISLOCATION	WORST CASE	0
ELBOW SPRAIN/STRAIN	BEST CASE	7814
ELBOW SPRAIN/STRAIN	WORST CASE	164
EYE CHEMICAL BURN	BEST CASE	3619
EYE CHEMICAL BURN	WORST CASE	302
EYE CORNEAL ULCER	BEST CASE	17
EYE CORNEAL ULCER	WORST CASE	0
EYE INFECTION	BEST CASE	2984

EYE INFECTION	WORST CASE	280
EYE IRRITATION/ABRASION	BEST CASE	44807
EYE IRRITATION/ABRASION	WORST CASE	245
EYE PENETRATION (FOREIGN BODY)	BEST CASE	1
EYE PENETRATION (FOREIGN BODY)	WORST CASE	0
FINGER DISLOCATION	BEST CASE	613
FINGER DISLOCATION	WORST CASE	0
FINGERNAIL DELAMINATION SECONDARY TO EXTRAVEHICULAR ACTIVITY	BEST CASE	0
FINGERNAIL DELAMINATION SECONDARY TO EXTRAVEHICULAR ACTIVITY	WORST CASE	0
GASTROENTERITIS	BEST CASE	2373
GASTROENTERITIS	WORST CASE	206
HEAD INJURY	BEST CASE	2
HEAD INJURY	WORST CASE	4
HEADACHE (CO2 INDUCED)	BEST CASE	12511
HEADACHE (CO2 INDUCED)	WORST CASE	326
HEADACHE (LATE)	BEST CASE	30922
HEADACHE (LATE)	WORST CASE	319
HEADACHE (SPACE ADAPTATION)	BEST CASE	132026
HEADACHE (SPACE ADAPTATION)	WORST CASE	8444
HEARING LOSS	BEST CASE	2142
HEARING LOSS	WORST CASE	1287
HEMORRHOIDS	BEST CASE	1319
HEMORRHOIDS	WORST CASE	10
HERPES ZOSTER REACTIVATION (SHINGLES)	BEST CASE	546
HERPES ZOSTER REACTIVATION (SHINGLES)	WORST CASE	103
HIP SPRAIN/STRAIN	BEST CASE	2578
HIP SPRAIN/STRAIN	WORST CASE	73
HIP/PROXIMAL FEMUR FRACTURE	BEST CASE	0
HIP/PROXIMAL FEMUR FRACTURE	WORST CASE	4
HYPERTENSION	BEST CASE	106
HYPERTENSION	WORST CASE	8
INDIGESTION	BEST CASE	3616
INDIGESTION	WORST CASE	262
INFLUENZA	BEST CASE	509
INFLUENZA	WORST CASE	163
INSOMNIA (SPACE ADAPTATION)	BEST CASE	179578
INSOMNIA (SPACE ADAPTATION)	WORST CASE	929
KNEE SPRAIN/STRAIN	BEST CASE	4646
KNEE SPRAIN/STRAIN	WORST CASE	92
LOWER EXTREMITY (LE) STRESS FRACTURE	BEST CASE	846
LOWER EXTREMITY (LE) STRESS FRACTURE	WORST CASE	115
LUMBAR SPINE FRACTURE	BEST CASE	2
LUMBAR SPINE FRACTURE	WORST CASE	1
MEDICATION OVERDOSE/ADVERSE REACTION	BEST CASE	1300

MEDICATION OVERDOSE/ADVERSE REACTION	WORST CASE	11
MOUTH ULCER	BEST CASE	5649
MOUTH ULCER	WORST CASE	322
NASAL CONGESTION (SPACE ADAPTATION)	BEST CASE	233148
NASAL CONGESTION (SPACE ADAPTATION)	WORST CASE	1122
NECK SPRAIN/STRAIN	BEST CASE	5774
NECK SPRAIN/STRAIN	WORST CASE	128
NEPHROLITHIASIS	BEST CASE	34
NEPHROLITHIASIS	WORST CASE	26
NEUROGENIC SHOCK	BEST CASE	0
NEUROGENIC SHOCK	WORST CASE	0
NOSE BLEED (SPACE ADAPTATION)	BEST CASE	3932
NOSE BLEED (SPACE ADAPTATION)	WORST CASE	138
OTITIS EXTERNA	BEST CASE	1868
OTITIS EXTERNA	WORST CASE	30
OTITIS MEDIA	BEST CASE	1728
OTITIS MEDIA	WORST CASE	178
PARESTHESIAS SECONDARY TO EXTRAVEHICULAR ACTIVITY	BEST CASE	0
PARESTHESIAS SECONDARY TO EXTRAVEHICULAR ACTIVITY	WORST CASE	0
PHARYNGITIS	BEST CASE	6753
PHARYNGITIS	WORST CASE	289
RESPIRATORY INFECTION	BEST CASE	20679
RESPIRATORY INFECTION	WORST CASE	303
RETINAL DETACHMENT	BEST CASE	0
RETINAL DETACHMENT	WORST CASE	2
SEIZURES	BEST CASE	2
SEIZURES	WORST CASE	0
SEPSIS	BEST CASE	37
SEPSIS	WORST CASE	13
SHOULDER DISLOCATION	BEST CASE	0
SHOULDER DISLOCATION	WORST CASE	0
SHOULDER SPRAIN/STRAIN	BEST CASE	14253
SHOULDER SPRAIN/STRAIN	WORST CASE	298
SKIN ABRASION	BEST CASE	57166
SKIN ABRASION	WORST CASE	3398
SKIN INFECTION	BEST CASE	7987
SKIN INFECTION	WORST CASE	277
SKIN LACERATION	BEST CASE	160
SKIN LACERATION	WORST CASE	485
SKIN RASH	BEST CASE	60185
SKIN RASH	WORST CASE	292
SLEEP DISORDER	BEST CASE	84818
SLEEP DISORDER	WORST CASE	465
SMALL BOWEL OBSTRUCTION	BEST CASE	28

SMALL BOWEL OBSTRUCTION	WORST CASE	2
SMOKE INHALATION	BEST CASE	253
SMOKE INHALATION	WORST CASE	37
SPACE MOTION SICKNESS (SPACE ADAPTATION)	BEST CASE	247507
SPACE MOTION SICKNESS (SPACE ADAPTATION)	WORST CASE	43774
STROKE (CEREBROVASCULAR ACCIDENT)	BEST CASE	10
STROKE (CEREBROVASCULAR ACCIDENT)	WORST CASE	3
SUDDEN CARDIAC ARREST	BEST CASE	0
SUDDEN CARDIAC ARREST	WORST CASE	1
TOXIC EXPOSURE: AMMONIA	BEST CASE	0
TOXIC EXPOSURE: AMMONIA	WORST CASE	5
TRAUMATIC HYPOVOLEMIC SHOCK	BEST CASE	8
TRAUMATIC HYPOVOLEMIC SHOCK	WORST CASE	5
URINARY INCONTINENCE (SPACE ADAPTATION)	BEST CASE	11966
URINARY INCONTINENCE (SPACE ADAPTATION)	WORST CASE	1107
URINARY RETENTION (SPACE ADAPTATION)	BEST CASE	12586
URINARY RETENTION (SPACE ADAPTATION)	WORST CASE	2176
URINARY TRACT INFECTION	BEST CASE	12652
URINARY TRACT INFECTION	WORST CASE	677
VAGINAL YEAST INFECTION	BEST CASE	2844
VAGINAL YEAST INFECTION	WORST CASE	488
VISUAL IMPAIRMENT AND/OR INCREASED INTRACRANIAL PRESSURE (VIIP)(SPACE ADAPTATION)	BEST CASE	0
VISUAL IMPAIRMENT AND/OR INCREASED INTRACRANIAL PRESSURE (VIIP)(SPACE ADAPTATION)	WORST CASE	0
WRIST FRACTURE	BEST CASE	33
WRIST FRACTURE	WORST CASE	13
WRIST SPRAIN/STRAIN	BEST CASE	3381
WRIST SPRAIN/STRAIN	WORST CASE	44

Table 9: 4 crew-42 days frequency of each condition over all 100,000 trials

Medical Condition	Scenario	Events
ABDOMINAL INJURY	BEST CASE	6
ABDOMINAL INJURY	WORST CASE	2
ABDOMINAL WALL HERNIA	BEST CASE	21
ABDOMINAL WALL HERNIA	WORST CASE	3
ABNORMAL UTERINE BLEEDING	BEST CASE	1205
ABNORMAL UTERINE BLEEDING	WORST CASE	25
ACUTE ANGLE-CLOSURE GLAUCOMA	BEST CASE	3
ACUTE ANGLE-CLOSURE GLAUCOMA	WORST CASE	0
ACUTE ARTHRITIS	BEST CASE	127
ACUTE ARTHRITIS	WORST CASE	2
ACUTE CHOLECYSTITIS/BILIARY COLIC	BEST CASE	55
ACUTE CHOLECYSTITIS/BILIARY COLIC	WORST CASE	4
ACUTE COMPARTMENT SYNDROME	BEST CASE	0
ACUTE COMPARTMENT SYNDROME	WORST CASE	2
ACUTE DIVERTICULITIS	BEST CASE	49
ACUTE DIVERTICULITIS	WORST CASE	17
ACUTE PANCREATITIS	BEST CASE	10
ACUTE PANCREATITIS	WORST CASE	2
ACUTE PROSTATITIS	BEST CASE	102
ACUTE PROSTATITIS	WORST CASE	8
ACUTE RADIATION SYNDROME	BEST CASE	131
ACUTE RADIATION SYNDROME	WORST CASE	0
ACUTE SINUSITIS	BEST CASE	9287
ACUTE SINUSITIS	WORST CASE	804
ALLERGIC REACTION (MILD TO MODERATE)	BEST CASE	17437
ALLERGIC REACTION (MILD TO MODERATE)	WORST CASE	732
ALTITUDE SICKNESS	BEST CASE	4
ALTITUDE SICKNESS	WORST CASE	0
ANAPHYLAXIS	BEST CASE	23
ANAPHYLAXIS	WORST CASE	0
ANGINA/MYOCARDIAL INFARCTION	BEST CASE	23
ANGINA/MYOCARDIAL INFARCTION	WORST CASE	7
ANKLE SPRAIN/STRAIN	BEST CASE	18624
ANKLE SPRAIN/STRAIN	WORST CASE	389
ANXIETY	BEST CASE	202
ANXIETY	WORST CASE	6
APPENDICITIS	BEST CASE	38
APPENDICITIS	WORST CASE	8
ATRIAL FIBRILLATION/ ATRIAL FLUTTER	BEST CASE	17
ATRIAL FIBRILLATION/ ATRIAL FLUTTER	WORST CASE	1
BACK PAIN (SPACE ADAPTATION)	BEST CASE	206910

BACK PAIN (SPACE ADAPTATION)	WORST CASE	3073
BACK SPRAIN/STRAIN	BEST CASE	53246
BACK SPRAIN/STRAIN	WORST CASE	1081
BAROTRAUMA (EAR/SINUS BLOCK)	BEST CASE	51081
BAROTRAUMA (EAR/SINUS BLOCK)	WORST CASE	755
BEHAVIORAL EMERGENCY	BEST CASE	0
BEHAVIORAL EMERGENCY	WORST CASE	0
BURNS SECONDARY TO FIRE	BEST CASE	243
BURNS SECONDARY TO FIRE	WORST CASE	2
CARDIOGENIC SHOCK SECONDARY TO MYOCARDIAL INFARCTION	BEST CASE	0
CARDIOGENIC SHOCK SECONDARY TO MYOCARDIAL INFARCTION	WORST CASE	0
CHEST INJURY	BEST CASE	3
CHEST INJURY	WORST CASE	9
CHOKING/OBSTRUCTED AIRWAY	BEST CASE	4911
CHOKING/OBSTRUCTED AIRWAY	WORST CASE	22
CONSTIPATION (SPACE ADAPTATION)	BEST CASE	67803
CONSTIPATION (SPACE ADAPTATION)	WORST CASE	310
DECOMPRESSION SICKNESS SECONDARY TO EXTRAVEHICULAR ACTIVITY	BEST CASE	0
DECOMPRESSION SICKNESS SECONDARY TO EXTRAVEHICULAR ACTIVITY	WORST CASE	0
DENTAL : EXPOSED PULP	BEST CASE	752
DENTAL : EXPOSED PULP	WORST CASE	193
DENTAL CARIES	BEST CASE	8605
DENTAL CARIES	WORST CASE	5083
DENTAL: ABSCESS	BEST CASE	832
DENTAL: ABSCESS	WORST CASE	219
DENTAL: AVULSION (TOOTH LOSS)	BEST CASE	107
DENTAL: AVULSION (TOOTH LOSS)	WORST CASE	31
DENTAL: CROWN LOSS	BEST CASE	106
DENTAL: CROWN LOSS	WORST CASE	20
DENTAL: FILLING LOSS	BEST CASE	227
DENTAL: FILLING LOSS	WORST CASE	25
DEPRESSION	BEST CASE	143
DEPRESSION	WORST CASE	13
DIARRHEA	BEST CASE	54582
DIARRHEA	WORST CASE	839
ELBOW DISLOCATION	BEST CASE	1
ELBOW DISLOCATION	WORST CASE	0
ELBOW SPRAIN/STRAIN	BEST CASE	20671
ELBOW SPRAIN/STRAIN	WORST CASE	410
EYE CHEMICAL BURN	BEST CASE	9258
EYE CHEMICAL BURN	WORST CASE	747
EYE CORNEAL ULCER	BEST CASE	24
EYE CORNEAL ULCER	WORST CASE	0
EYE INFECTION	BEST CASE	7677

EYE INFECTION	WORST CASE	670
EYE IRRITATION/ABRASION	BEST CASE	116590
EYE IRRITATION/ABRASION	WORST CASE	585
EYE PENETRATION (FOREIGN BODY)	BEST CASE	1
EYE PENETRATION (FOREIGN BODY)	WORST CASE	1
FINGER DISLOCATION	BEST CASE	1681
FINGER DISLOCATION	WORST CASE	6
FINGERNAIL DELAMINATION SECONDARY TO EXTRAVEHICULAR ACTIVITY	BEST CASE	0
FINGERNAIL DELAMINATION SECONDARY TO EXTRAVEHICULAR ACTIVITY	WORST CASE	0
GASTROENTERITIS	BEST CASE	6141
GASTROENTERITIS	WORST CASE	525
HEAD INJURY	BEST CASE	3
HEAD INJURY	WORST CASE	14
HEADACHE (CO2 INDUCED)	BEST CASE	33183
HEADACHE (CO2 INDUCED)	WORST CASE	832
HEADACHE (LATE)	BEST CASE	81862
HEADACHE (LATE)	WORST CASE	854
HEADACHE (SPACE ADAPTATION)	BEST CASE	131982
HEADACHE (SPACE ADAPTATION)	WORST CASE	8679
HEARING LOSS	BEST CASE	5789
HEARING LOSS	WORST CASE	3395
HEMORRHOIDS	BEST CASE	3472
HEMORRHOIDS	WORST CASE	20
HERPES ZOSTER REACTIVATION (SHINGLES)	BEST CASE	1490
HERPES ZOSTER REACTIVATION (SHINGLES)	WORST CASE	242
HIP SPRAIN/STRAIN	BEST CASE	6860
HIP SPRAIN/STRAIN	WORST CASE	157
HIP/PROXIMAL FEMUR FRACTURE	BEST CASE	2
HIP/PROXIMAL FEMUR FRACTURE	WORST CASE	16
HYPERTENSION	BEST CASE	246
HYPERTENSION	WORST CASE	31
INDIGESTION	BEST CASE	9337
INDIGESTION	WORST CASE	699
INFLUENZA	BEST CASE	1271
INFLUENZA	WORST CASE	446
INSOMNIA (SPACE ADAPTATION)	BEST CASE	179126
INSOMNIA (SPACE ADAPTATION)	WORST CASE	927
KNEE SPRAIN/STRAIN	BEST CASE	12012
KNEE SPRAIN/STRAIN	WORST CASE	237
LOWER EXTREMITY (LE) STRESS FRACTURE	BEST CASE	2236
LOWER EXTREMITY (LE) STRESS FRACTURE	WORST CASE	288
LUMBAR SPINE FRACTURE	BEST CASE	13
LUMBAR SPINE FRACTURE	WORST CASE	5
MEDICATION OVERDOSE/ADVERSE REACTION	BEST CASE	3314

MEDICATION OVERDOSE/ADVERSE REACTION	WORST CASE	17
MOUTH ULCER	BEST CASE	14462
MOUTH ULCER	WORST CASE	802
NASAL CONGESTION (SPACE ADAPTATION)	BEST CASE	232762
NASAL CONGESTION (SPACE ADAPTATION)	WORST CASE	1155
NECK SPRAIN/STRAIN	BEST CASE	15432
NECK SPRAIN/STRAIN	WORST CASE	310
NEPHROLITHIASIS	BEST CASE	104
NEPHROLITHIASIS	WORST CASE	75
NEUROGENIC SHOCK	BEST CASE	0
NEUROGENIC SHOCK	WORST CASE	0
NOSE BLEED (SPACE ADAPTATION)	BEST CASE	4166
NOSE BLEED (SPACE ADAPTATION)	WORST CASE	138
OTITIS EXTERNA	BEST CASE	4971
OTITIS EXTERNA	WORST CASE	80
OTITIS MEDIA	BEST CASE	4609
OTITIS MEDIA	WORST CASE	530
PARESTHESIAS SECONDARY TO EXTRAVEHICULAR ACTIVITY	BEST CASE	0
PARESTHESIAS SECONDARY TO EXTRAVEHICULAR ACTIVITY	WORST CASE	0
PHARYNGITIS	BEST CASE	17551
PHARYNGITIS	WORST CASE	854
RESPIRATORY INFECTION	BEST CASE	54622
RESPIRATORY INFECTION	WORST CASE	784
RETINAL DETACHMENT	BEST CASE	1
RETINAL DETACHMENT	WORST CASE	2
SEIZURES	BEST CASE	13
SEIZURES	WORST CASE	0
SEPSIS	BEST CASE	72
SEPSIS	WORST CASE	31
SHOULDER DISLOCATION	BEST CASE	0
SHOULDER DISLOCATION	WORST CASE	1
SHOULDER SPRAIN/STRAIN	BEST CASE	37303
SHOULDER SPRAIN/STRAIN	WORST CASE	779
SKIN ABRASION	BEST CASE	149089
SKIN ABRASION	WORST CASE	8765
SKIN INFECTION	BEST CASE	20877
SKIN INFECTION	WORST CASE	758
SKIN LACERATION	BEST CASE	405
SKIN LACERATION	WORST CASE	1249
SKIN RASH	BEST CASE	156656
SKIN RASH	WORST CASE	778
SLEEP DISORDER	BEST CASE	222953
SLEEP DISORDER	WORST CASE	1133
SMALL BOWEL OBSTRUCTION	BEST CASE	41

SMALL BOWEL OBSTRUCTION	WORST CASE	10
SMOKE INHALATION	BEST CASE	673
SMOKE INHALATION	WORST CASE	124
SPACE MOTION SICKNESS (SPACE ADAPTATION)	BEST CASE	247570
SPACE MOTION SICKNESS (SPACE ADAPTATION)	WORST CASE	43741
STROKE (CEREBROVASCULAR ACCIDENT)	BEST CASE	17
STROKE (CEREBROVASCULAR ACCIDENT)	WORST CASE	11
SUDDEN CARDIAC ARREST	BEST CASE	0
SUDDEN CARDIAC ARREST	WORST CASE	1
TOXIC EXPOSURE: AMMONIA	BEST CASE	0
TOXIC EXPOSURE: AMMONIA	WORST CASE	9
TRAUMATIC HYPOVOLEMIC SHOCK	BEST CASE	21
TRAUMATIC HYPOVOLEMIC SHOCK	WORST CASE	17
URINARY INCONTINENCE (SPACE ADAPTATION)	BEST CASE	11949
URINARY INCONTINENCE (SPACE ADAPTATION)	WORST CASE	1157
URINARY RETENTION (SPACE ADAPTATION)	BEST CASE	12550
URINARY RETENTION (SPACE ADAPTATION)	WORST CASE	2141
URINARY TRACT INFECTION	BEST CASE	32844
URINARY TRACT INFECTION	WORST CASE	1739
VAGINAL YEAST INFECTION	BEST CASE	7635
VAGINAL YEAST INFECTION	WORST CASE	1394
VISUAL IMPAIRMENT AND/OR INCREASED INTRACRANIAL PRESSURE (VIIP)(SPACE ADAPTATION)	BEST CASE	65819
VISUAL IMPAIRMENT AND/OR INCREASED INTRACRANIAL PRESSURE (VIIP)(SPACE ADAPTATION)	WORST CASE	5162
WRIST FRACTURE	BEST CASE	102
WRIST FRACTURE	WORST CASE	11
WRIST SPRAIN/STRAIN	BEST CASE	8630
WRIST SPRAIN/STRAIN	WORST CASE	130

Table 10: 4 crew-16 days probability of occurrence

Medical Condition	Probability == 0	Probability >= 1	Probability >= 1 Best Case	Probability >= 1 Worst Case
ABDOMINAL INJURY	9.9997E-01	2.8792E-05	2.1594E-05	7.1980E-06
ABDOMINAL WALL HERNIA	9.9992E-01	7.8952E-05	6.9477E-05	9.4742E-06
ABNORMAL UTERINE BLEEDING	9.9545E-01	4.5454E-03	4.4545E-03	9.0908E-05
ACUTE ANGLE-CLOSURE GLAUCOMA	9.9999E-01	7.3418E-06	5.8734E-06	1.4684E-06
ACUTE ARTHRITIS	9.9954E-01	4.6336E-04	4.5177E-04	1.1584E-05
ACUTE CHOLECYSTITIS/BILIARY COLIC	9.9982E-01	1.7862E-04	1.6076E-04	1.7862E-05
ACUTE COMPARTMENT SYNDROME	9.9999E-01	7.0089E-06	2.6634E-06	4.3455E-06
ACUTE DIVERTICULITIS	9.9975E-01	2.4878E-04	1.8534E-04	6.3440E-05
ACUTE PANCREATITIS	9.9995E-01	5.3862E-05	4.4436E-05	9.4258E-06
ACUTE PROSTATITIS	9.9957E-01	4.2920E-04	4.0130E-04	2.7898E-05
ACUTE RADIATION SYNDROME	9.9954E-01	4.5984E-04	4.5754E-04	2.2992E-06
ACUTE SINUSITIS	9.6230E-01	3.7697E-02	3.4681E-02	3.0158E-03
ALLERGIC REACTION (MILD TO MODERATE)	9.3198E-01	6.8023E-02	6.5303E-02	2.7209E-03
ALTITUDE SICKNESS	9.9999E-01	9.5145E-06	9.3718E-06	1.4272E-07
ANAPHYLAXIS	9.9991E-01	8.6031E-05	8.5600E-05	4.3015E-07
ANGINA/MYOCARDIAL INFARCTION	9.9990E-01	9.6368E-05	8.1913E-05	1.4455E-05
ANKLE SPRAIN/STRAIN	9.2972E-01	7.0280E-02	6.8874E-02	1.4056E-03
ANXIETY	9.9921E-01	7.8819E-04	7.5272E-04	3.5469E-05
APPENDICITIS	9.9984E-01	1.6382E-04	1.3515E-04	2.8668E-05
ATRIAL FIBRILLATION/ ATRIAL FLUTTER	9.9992E-01	8.2789E-05	6.6645E-05	1.6144E-05
BACK PAIN (SPACE ADAPTATION)	5.1025E-02	9.4898E-01	9.3474E-01	1.4235E-02
BACK SPRAIN/STRAIN	8.1435E-01	1.8565E-01	1.8194E-01	3.7130E-03
BAROTRAUMA (EAR/SINUS BLOCK)	8.1993E-01	1.8007E-01	1.7737E-01	2.7010E-03
BEHAVIORAL EMERGENCY	1.0000E+00	2.5057E-06	2.2426E-06	2.6310E-07
BURNS SECONDARY TO FIRE	9.9912E-01	8.8273E-04	8.7832E-04	4.4137E-06
CARDIOGENIC SHOCK SECONDARY TO MYOCARDIAL INFARCTION	1.0000E+00	1.1197E-06	1.4556E-07	9.7411E-07
CHEST INJURY	9.9996E-01	4.4931E-05	1.5726E-05	2.9205E-05
CHOKING/OBSTRUCTED AIRWAY	9.8097E-01	1.9030E-02	1.8934E-02	9.5148E-05
CONSTIPATION (SPACE ADAPTATION)	4.7417E-01	5.2583E-01	5.2320E-01	2.6291E-03
DENTAL ABSCESS	9.9648E-01	3.5158E-03	2.7775E-03	7.3831E-04
DENTAL AVULSION (TOOTH LOSS)	9.4879E-01	5.1209E-02	3.2262E-02	1.8947E-02
DENTAL CARIES	9.9598E-01	4.0220E-03	3.1774E-03	8.4462E-04
DENTAL CROWN LOSS	9.9949E-01	5.1152E-04	3.9387E-04	1.1765E-04
DENTAL EXPOSED PULP	9.9955E-01	4.5372E-04	3.8113E-04	7.2596E-05
DENTAL FILLING LOSS	9.9911E-01	8.9499E-04	8.1444E-04	8.0549E-05
DEPRESSION	9.9943E-01	5.6931E-04	5.2377E-04	4.5545E-05

DIARRHEA	8.0950E-01	1.9050E-01	1.8765E-01	2.8576E-03
ELBOW DISLOCATION	9.9999E-01	9.1290E-06	7.9423E-06	1.1868E-06
ELBOW SPRAIN/STRAIN	9.2358E-01	7.6418E-02	7.4890E-02	1.5284E-03
EYE CHEMICAL BURN	9.6230E-01	3.7697E-02	3.4870E-02	2.8273E-03
EYE CORNEAL ULCER	9.9988E-01	1.2387E-04	1.2264E-04	1.2387E-06
EYE INFECTION	9.6849E-01	3.1514E-02	2.8993E-02	2.5212E-03
EYE IRRITATION/ABRASION	6.3871E-01	3.6129E-01	3.5948E-01	1.8064E-03
EYE PENETRATION (FOREIGN BODY)	1.0000E+00	1.6350E-06	8.1750E-07	8.1750E-07
FINGER DISLOCATION	9.9362E-01	6.3839E-03	6.3519E-03	3.1919E-05
GASTROENTERITIS	9.7471E-01	2.5292E-02	2.3269E-02	2.0234E-03
HEAD INJURY	9.9993E-01	7.4033E-05	3.3315E-05	4.0718E-05
HEADACHE (CO2 INDUCED)	8.7978E-01	1.2022E-01	1.1722E-01	3.0056E-03
HEADACHE (LATE)	7.3066E-01	2.6934E-01	2.6665E-01	2.6934E-03
HEADACHE (SPACE ADAPTATION)	1.7752E-01	8.2248E-01	7.7314E-01	4.9349E-02
HEARING LOSS	9.6612E-01	3.3883E-02	2.1177E-02	1.2706E-02
HEMORRHOIDS	9.8727E-01	1.2727E-02	1.2663E-02	6.3635E-05
HERPES ZOSTER REACTIVATION (SHINGLES)	9.9362E-01	6.3839E-03	5.4901E-03	8.9374E-04
HIP SPRAIN/STRAIN	9.7385E-01	2.6151E-02	2.5628E-02	5.2301E-04
HIP/PROXIMAL FEMUR FRACTURE	9.9995E-01	4.6471E-05	3.0206E-06	4.3451E-05
HYPERTENSION	9.9887E-01	1.1313E-03	1.0012E-03	1.3010E-04
INDIGESTION	9.6230E-01	3.7697E-02	3.5058E-02	2.6388E-03
INFLUENZA	9.9362E-01	6.3839E-03	4.7879E-03	1.5960E-03
INSOMNIA (SPACE ADAPTATION)	9.1306E-02	9.0869E-01	9.0415E-01	4.5435E-03
KNEE SPRAIN/STRAIN	9.5469E-01	4.5314E-02	4.4408E-02	9.0628E-04
LOWER EXTREMITY (LE) STRESS FRACTURE	9.9050E-01	9.5042E-03	8.4112E-03	1.0930E-03
LUMBAR SPINE FRACTURE	9.9997E-01	3.2742E-05	2.7339E-05	5.4024E-06
MEDICATION OVERDOSE/ADVERSE REACTION	9.8727E-01	1.2727E-02	1.2663E-02	6.3635E-05
MOUTH ULCER	9.4399E-01	5.6009E-02	5.3209E-02	2.8005E-03
NASAL CONGESTION (SPACE ADAPTATION)	2.9421E-02	9.7058E-01	9.6573E-01	4.8529E-03
NECK SPRAIN/STRAIN	9.4212E-01	5.7879E-02	5.6722E-02	1.1576E-03
NEPHROLITHIASIS	9.9936E-01	6.3936E-04	3.8681E-04	2.5255E-04
NEUROGENIC SHOCK	1.0000E+00	9.1499E-07	4.5750E-07	4.5750E-07
NOSE BLEED (SPACE ADAPTATION)	9.6434E-01	3.5658E-02	3.4410E-02	1.2480E-03
OTITIS EXTERNA	9.8097E-01	1.9030E-02	1.8744E-02	2.8544E-04
OTITIS MEDIA	9.8097E-01	1.9030E-02	1.7127E-02	1.9030E-03
PHARYNGITIS	9.3198E-01	6.8023E-02	6.4962E-02	3.0611E-03
RESPIRATORY INFECTION	8.0950E-01	1.9050E-01	1.8765E-01	2.8576E-03
RETINAL DETACHMENT	9.9998E-01	1.6164E-05	6.7889E-06	9.3752E-06
SEIZURES	9.9995E-01	4.7309E-05	4.0686E-05	6.6233E-06
SEPSIS	9.9958E-01	4.2045E-04	2.7918E-04	1.4127E-04
SHOULDER DISLOCATION	9.9999E-01	6.5235E-06	2.2832E-07	6.2952E-06
SHOULDER SPRAIN/STRAIN	8.6438E-01	1.3562E-01	1.3291E-01	2.7124E-03
SKIN ABRASION	5.4771E-01	4.5229E-01	4.2741E-01	2.4876E-02
SKIN INFECTION	9.2012E-01	7.9885E-02	7.7089E-02	2.7960E-03

SKIN LACERATION	9.9362E-01	6.3839E-03	1.5960E-03	4.7879E-03
SKIN RASH	5.4771E-01	4.5229E-01	4.5003E-01	2.2614E-03
SLEEP DISORDER	4.2666E-01	5.7334E-01	5.7048E-01	2.8667E-03
SMALL BOWEL OBSTRUCTION	9.9979E-01	2.1024E-04	1.8396E-04	2.6281E-05
SMOKE INHALATION	9.9684E-01	3.1630E-03	2.7202E-03	4.4282E-04
SPACE MOTION SICKNESS (SPACE ADAPTATION)	5.2879E-03	9.9471E-01	8.4551E-01	1.4921E-01
STROKE (CEREBROVASCULAR ACCIDENT)	9.9985E-01	1.4542E-04	9.5253E-05	5.0171E-05
SUDDEN CARDIAC ARREST	9.9999E-01	6.3518E-06	1.1751E-06	5.1767E-06
TOXIC EXPOSURE (AMMONIA)	9.9997E-01	2.8736E-05	0.0000E+00	2.8736E-05
TRAUMATIC HYPOVOLEMIC SHOCK	9.9989E-01	1.1231E-04	6.6825E-05	4.5486E-05
URINARY INCONTINENCE (SPACE ADAPTATION)	8.9198E-01	1.0802E-01	9.8843E-02	9.1821E-03
URINARY RETENTION (SPACE ADAPTATION)	8.7959E-01	1.2041E-01	1.0235E-01	1.8062E-02
URINARY TRACT INFECTION	8.7556E-01	1.2444E-01	1.1822E-01	6.2220E-03
VAGINAL YEAST INFECTION	9.6673E-01	3.3272E-02	2.8281E-02	4.9908E-03
VISUAL IMPAIRMENT AND/OR INCREASED INTRACRANIAL PRESSURE (VIIP)(SPACE ADAPTATION)	1.8870E-01	8.1130E-01	7.5451E-01	5.6791E-02
WRIST FRACTURE	9.9959E-01	4.1344E-04	3.2868E-04	8.4755E-05
WRIST SPRAIN/STRAIN	9.6742E-01	3.2581E-02	3.2092E-02	4.8871E-04

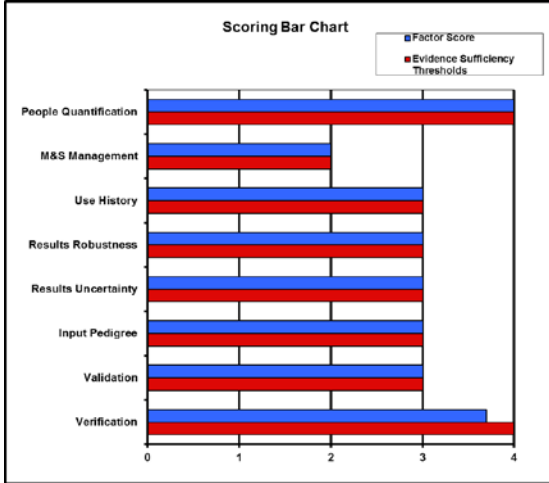
Table 11: 4 crew-42 days probability of occurrence

Medical Condition	Probability == 0	Probability >= 1	Probability >= 1 Best Case	Probability >= 1 Worst Case
ABDOMINAL INJURY	9.9992E-01	7.5577E-05	5.6683E-05	1.8894E-05
ABDOMINAL WALL HERNIA	9.9979E-01	2.0723E-04	1.8237E-04	2.4868E-05
ABNORMAL UTERINE BLEEDING	9.8811E-01	1.1888E-02	1.1650E-02	2.3775E-04
ACUTE ANGLE-CLOSURE GLAUCOMA	9.9998E-01	1.9272E-05	1.5418E-05	3.8544E-06
ACUTE ARTHRITIS	9.9878E-01	1.2159E-03	1.1855E-03	3.0396E-05
ACUTE CHOLECYSTITIS/BILIARY COLIC	9.9953E-01	4.6882E-04	4.2194E-04	4.6882E-05
ACUTE COMPARTMENT SYNDROME	9.9998E-01	1.8398E-05	6.9913E-06	1.1407E-05
ACUTE DIVERTICULITIS	9.9935E-01	6.5293E-04	4.8643E-04	1.6650E-04
ACUTE PANCREATITIS	9.9986E-01	1.4138E-04	1.1664E-04	2.4742E-05
ACUTE PROSTATITIS	9.9887E-01	1.1263E-03	1.0531E-03	7.3207E-05
ACUTE RADIATION SYNDROME	9.9879E-01	1.2066E-03	1.2006E-03	6.0331E-06
ACUTE SINUSITIS	9.0405E-01	9.5948E-02	8.8272E-02	7.6758E-03
ALLERGIC REACTION (MILD TO MODERATE)	8.3117E-01	1.6883E-01	1.6208E-01	6.7533E-03
ALTITUDE SICKNESS	9.9998E-01	2.4975E-05	2.4601E-05	3.7463E-07
ANAPHYLAXIS	9.9977E-01	2.2581E-04	2.2469E-04	1.1291E-06
ANGINA/MYOCARDIAL INFARCTION	9.9975E-01	2.5295E-04	2.1500E-04	3.7942E-05
ANKLE SPRAIN/STRAIN	8.2590E-01	1.7410E-01	1.7062E-01	3.4821E-03
ANXIETY	9.9793E-01	2.0677E-03	1.9746E-03	9.3045E-05
APPENDICITIS	9.9957E-01	4.2997E-04	3.5472E-04	7.5245E-05
ATRIAL FIBRILLATION/ ATRIAL FLUTTER	9.9978E-01	2.1731E-04	1.7493E-04	4.2375E-05
BACK PAIN (SPACE ADAPTATION)	5.1025E-02	9.4898E-01	9.3474E-01	1.4235E-02
BACK SPRAIN/STRAIN	5.8328E-01	4.1672E-01	4.0838E-01	8.3343E-03
BAROTRAUMA (EAR/SINUS BLOCK)	5.9384E-01	4.0616E-01	4.0007E-01	6.0925E-03
BEHAVIORAL EMERGENCY	9.9999E-01	6.5774E-06	5.8868E-06	6.9063E-07
BURNS SECONDARY TO FIRE	9.9768E-01	2.3155E-03	2.3039E-03	1.1578E-05
CARDIOGENIC SHOCK SECONDARY TO MYOCARDIAL INFARCTION	1.0000E+00	2.9391E-06	3.8209E-07	2.5570E-06
CHEST INJURY	9.9988E-01	1.1794E-04	4.1279E-05	7.6661E-05
CHOKING/OBSTRUCTED AIRWAY	9.5082E-01	4.9183E-02	4.8937E-02	2.4592E-04
CONSTIPATION (SPACE ADAPTATION)	4.7417E-01	5.2583E-01	5.2320E-01	2.6291E-03
DENTAL ABSCESS	9.9080E-01	9.2026E-03	7.2700E-03	1.9325E-03
DENTAL AVULSION (TOOTH LOSS)	8.7111E-01	1.2889E-01	8.1201E-02	4.7690E-02
DENTAL CARIES	9.8948E-01	1.0523E-02	8.3134E-03	2.2099E-03
DENTAL CROWN LOSS	9.9866E-01	1.3422E-03	1.0335E-03	3.0870E-04
DENTAL EXPOSED PULP	9.9881E-01	1.1906E-03	1.0001E-03	1.9049E-04
DENTAL FILLING LOSS	9.9765E-01	2.3476E-03	2.1363E-03	2.1129E-04
DEPRESSION	9.9851E-01	1.4937E-03	1.3742E-03	1.1950E-04

DIARRHEA	5.7420E-01	4.2580E-01	4.1941E-01	6.3870E-03
ELBOW DISLOCATION	9.9998E-01	2.3964E-05	2.0848E-05	3.1153E-06
ELBOW SPRAIN/STRAIN	8.1166E-01	1.8834E-01	1.8458E-01	3.7669E-03
EYE CHEMICAL BURN	9.0405E-01	9.5948E-02	8.8752E-02	7.1961E-03
EYE CORNEAL ULCER	9.9967E-01	3.2514E-04	3.2189E-04	3.2514E-06
EYE INFECTION	9.1938E-01	8.0621E-02	7.4171E-02	6.4497E-03
EYE IRRITATION/ABRASION	3.0826E-01	6.9174E-01	6.8828E-01	3.4587E-03
EYE PENETRATION (FOREIGN BODY)	1.0000E+00	4.2919E-06	2.1459E-06	2.1459E-06
FINGER DISLOCATION	9.8333E-01	1.6671E-02	1.6587E-02	8.3354E-05
GASTROENTERITIS	9.3497E-01	6.5034E-02	5.9832E-02	5.2027E-03
HEAD INJURY	9.9981E-01	1.9432E-04	8.7446E-05	1.0688E-04
HEADACHE (CO2 INDUCED)	7.1446E-01	2.8554E-01	2.7840E-01	7.1385E-03
HEADACHE (LATE)	4.3878E-01	5.6122E-01	5.5561E-01	5.6122E-03
HEADACHE (SPACE ADAPTATION)	1.7752E-01	8.2248E-01	7.7314E-01	4.9349E-02
HEARING LOSS	9.1349E-01	8.6511E-02	5.4069E-02	3.2442E-02
HEMORRHOIDS	9.6694E-01	3.3064E-02	3.2898E-02	1.6532E-04
HERPES ZOSTER REACTIVATION (SHINGLES)	9.8333E-01	1.6671E-02	1.4337E-02	2.3339E-03
HIP SPRAIN/STRAIN	9.3281E-01	6.7195E-02	6.5851E-02	1.3439E-03
HIP/PROXIMAL FEMUR FRACTURE	9.9988E-01	1.2198E-04	7.9289E-06	1.1405E-04
HYPERTENSION	9.9703E-01	2.9669E-03	2.6257E-03	3.4120E-04
INDIGESTION	9.0405E-01	9.5948E-02	8.9231E-02	6.7163E-03
INFLUENZA	9.8333E-01	1.6671E-02	1.2503E-02	4.1677E-03
INSOMNIA (SPACE ADAPTATION)	9.1306E-02	9.0869E-01	9.0415E-01	4.5435E-03
KNEE SPRAIN/STRAIN	8.8539E-01	1.1461E-01	1.1232E-01	2.2922E-03
LOWER EXTREMITY (LE) STRESS FRACTURE	9.7524E-01	2.4756E-02	2.1909E-02	2.8470E-03
LUMBAR SPINE FRACTURE	9.9991E-01	8.5945E-05	7.1764E-05	1.4181E-05
MEDICATION OVERDOSE/ADVERSE REACTION	9.6694E-01	3.3064E-02	3.2898E-02	1.6532E-04
MOUTH ULCER	8.5959E-01	1.4041E-01	1.3339E-01	7.0206E-03
NASAL CONGESTION (SPACE ADAPTATION)	2.9421E-02	9.7058E-01	9.6573E-01	4.8529E-03
NECK SPRAIN/STRAIN	8.5512E-01	1.4488E-01	1.4198E-01	2.8975E-03
NEPHROLITHIASIS	9.9832E-01	1.6774E-03	1.0149E-03	6.6259E-04
NEUROGENIC SHOCK	1.0000E+00	2.4019E-06	1.2009E-06	1.2009E-06
NOSE BLEED (SPACE ADAPTATION)	9.6434E-01	3.5658E-02	3.4410E-02	1.2480E-03
OTITIS EXTERNA	9.5082E-01	4.9183E-02	4.8446E-02	7.3775E-04
OTITIS MEDIA	9.5082E-01	4.9183E-02	4.4265E-02	4.9183E-03
PHARYNGITIS	8.3117E-01	1.6883E-01	1.6124E-01	7.5975E-03
RESPIRATORY INFECTION	5.7420E-01	4.2580E-01	4.1941E-01	6.3870E-03
RETINAL DETACHMENT	9.9996E-01	4.2430E-05	1.7821E-05	2.4610E-05
SEIZURES	9.9988E-01	1.2418E-04	1.0680E-04	1.7385E-05
SEPSIS	9.9890E-01	1.1033E-03	7.3259E-04	3.7071E-04
SHOULDER DISLOCATION	9.9998E-01	1.7124E-05	5.9934E-07	1.6525E-05
SHOULDER SPRAIN/STRAIN	6.8210E-01	3.1790E-01	3.1154E-01	6.3579E-03
SKIN ABRASION	2.0592E-01	7.9408E-01	7.5041E-01	4.3674E-02
SKIN INFECTION	8.0369E-01	1.9631E-01	1.8944E-01	6.8710E-03

SKIN LACERATION	9.8333E-01	1.6671E-02	4.1677E-03	1.2503E-02
SKIN RASH	2.0592E-01	7.9408E-01	7.9011E-01	3.9704E-03
SLEEP DISORDER	1.0689E-01	8.9311E-01	8.8864E-01	4.4655E-03
SMALL BOWEL OBSTRUCTION	9.9945E-01	5.5180E-04	4.8282E-04	6.8975E-05
SMOKE INHALATION	9.9172E-01	8.2816E-03	7.1222E-03	1.1594E-03
SPACE MOTION SICKNESS (SPACE ADAPTATION)	5.2879E-03	9.9471E-01	8.4551E-01	1.4921E-01
STROKE (CEREBROVASCULAR ACCIDENT)	9.9962E-01	3.8169E-04	2.5001E-04	1.3168E-04
SUDDEN CARDIAC ARREST	9.9998E-01	1.6673E-05	3.0846E-06	1.3589E-05
TOXIC EXPOSURE (AMMONIA)	9.9992E-01	7.5430E-05	0.0000E+00	7.5430E-05
TRAUMATIC HYPOVOLEMIC SHOCK	9.9971E-01	2.9479E-04	1.7540E-04	1.1939E-04
URINARY INCONTINENCE (SPACE ADAPTATION)	8.9198E-01	1.0802E-01	9.8843E-02	9.1821E-03
URINARY RETENTION (SPACE ADAPTATION)	8.7959E-01	1.2041E-01	1.0235E-01	1.8062E-02
URINARY TRACT INFECTION	7.0550E-01	2.9450E-01	2.7977E-01	1.4725E-02
VAGINAL YEAST INFECTION	9.1501E-01	8.4994E-02	7.2245E-02	1.2749E-02
VISUAL IMPAIRMENT AND/OR INCREASED INTRACRANIAL PRESSURE (VIIP)(SPACE ADAPTATION)	1.8870E-01	8.1130E-01	7.5451E-01	5.6791E-02
WRIST FRACTURE	9.9892E-01	1.0849E-03	8.6251E-04	2.2241E-04
WRIST SPRAIN/STRAIN	9.1672E-01	8.3276E-02	8.2027E-02	1.2491E-03

Appendix A: IMM Status at Time of Service Request Report

Validation status for IMM	IMM V&V Matrix: The following bar chart shows the IMM v4.1 MATLAB status of IMM validation for each IMM element listed. Scoring Bar Chart <table><thead><tr><th>Element</th><th>Factor Score</th><th>Evidence Sufficiency Thresholds</th></tr></thead><tbody><tr><td>People Quantification</td><td>4</td><td>4</td></tr><tr><td>M&S Management</td><td>2</td><td>2</td></tr><tr><td>Use History</td><td>3</td><td>3</td></tr><tr><td>Results Robustness</td><td>3</td><td>3</td></tr><tr><td>Results Uncertainty</td><td>3</td><td>3</td></tr><tr><td>Input Pedigree</td><td>3</td><td>3</td></tr><tr><td>Validation</td><td>3</td><td>3</td></tr><tr><td>Verification</td><td>3.7</td><td>4</td></tr></tbody></table>	Element	Factor Score	Evidence Sufficiency Thresholds	People Quantification	4	4	M&S Management	2	2	Use History	3	3	Results Robustness	3	3	Results Uncertainty	3	3	Input Pedigree	3	3	Validation	3	3	Verification	3.7	4																															
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Compliance with NASA-Standard-7009 requirements	IMM Compliance Matrix: The IMM has no waivers to any of the requirements in the NASA-Standard-7009 for Models and Simulations (6); however there are certain requirements that are not applicable to the IMM and other requirements where IMM compliance has not yet been fully attained. <table><thead><tr><th>Compliant</th><th>Compliance Incomplete</th><th>Not applicable</th></tr></thead><tbody><tr><td>36</td><td>5</td><td>5</td></tr></tbody></table>	Compliant	Compliance Incomplete	Not applicable	36	5	5																																																				
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36	5	5																																																									
Current NASA-Standard-7009 credibility assessment score	IMM Credibility Matrix: The following table shows the overall IMM v4.1 MATLAB credibility assessment score (CAS), individual factor CAS, customer-specified sufficiency thresholds, and weighted scores. Legend depicts CAS score designated range and color assignments from NASA-Standard-7009. <table><thead><tr><th>Factor</th><th>Sufficiency Thresholds</th><th>Factor Score</th><th>Weighted Scores</th><th>Overall Score</th></tr></thead><tbody><tr><td>Verification</td><td>4</td><td>3.7</td><td>0.28</td><td></td></tr><tr><td>Validation</td><td>3</td><td>3</td><td>0.45</td><td></td></tr><tr><td>Input Pedigree</td><td>3</td><td>3</td><td>0.53</td><td></td></tr><tr><td>Results Uncertainty</td><td>3</td><td>3</td><td>0.60</td><td>3.06</td></tr><tr><td>Results Robustness</td><td>3</td><td>3</td><td>0.45</td><td></td></tr><tr><td>Use History</td><td>3</td><td>3</td><td>0.45</td><td></td></tr><tr><td>M&S Management</td><td>2</td><td>2</td><td>0.10</td><td></td></tr><tr><td>People Qualification</td><td>4</td><td>4</td><td>0.20</td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td></tr></tbody></table> Legend from NASA-STD-7009 <table><tbody><tr><td></td><td>CAS Score > Threshold Exceeds credibility requirements</td></tr><tr><td></td><td>Threshold ≥ CAS Score ≥ (Threshold-0.5) Ready for use</td></tr><tr><td></td><td>Threshold-0.5 > CAS Score ≥ Threshold-1.0 Use with caution</td></tr><tr><td></td><td>CAS Score < Threshold - 1.0 Use not recommended or to be used with EXTREME CAUTION by subject matter experts only</td></tr></tbody></table>	Factor	Sufficiency Thresholds	Factor Score	Weighted Scores	Overall Score	Verification	4	3.7	0.28		Validation	3	3	0.45		Input Pedigree	3	3	0.53		Results Uncertainty	3	3	0.60	3.06	Results Robustness	3	3	0.45		Use History	3	3	0.45		M&S Management	2	2	0.10		People Qualification	4	4	0.20								CAS Score > Threshold Exceeds credibility requirements		Threshold ≥ CAS Score ≥ (Threshold-0.5) Ready for use		Threshold-0.5 > CAS Score ≥ Threshold-1.0 Use with caution		CAS Score < Threshold - 1.0 Use not recommended or to be used with EXTREME CAUTION by subject matter experts only
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Additional verification and validation information applicable to this analysis	none																																																										
Integrated Medical Evidence Database (iMED) code version and date accessed	iMED Lockdown ID: (6), created on (11/18/2015)																																																										
IMM version and code version	Data analysis for this report was generated using IMM v4.1 with release 2016a of MATLAB software. MATLAB and all other MathWorks product or service names are registered trademarks or trademarks of MathWorks, Natick, MA, USA.																																																										
Modifications made to the code for analysis	None																																																										

Appendix B: Medical Conditions in iMED by Category (iMED_20151118)**ENVIRONMENTAL**

Acute Radiation Syndrome
 Altitude Sickness
 Barotrauma (ear/sinus block)
 Burns secondary to Fire
 Decompression Sickness Secondary to EVA
 Eye Chemical Burn
 Headache (CO₂ induced)
 Smoke Inhalation
 Toxic Exposure: Ammonia

INJURY/TRAUMA

Abdominal Injury
 Acute Compartment Syndrome
 Ankle Sprain/Strain
 Back Sprain/Strain
 Chest Injury
 Dental: Avulsion (tooth loss)
 Elbow Dislocation
 Elbow Sprain/Strain
 Eye Irritation/Abrasion
 Eye Penetration (foreign body)
 Finger Dislocation
 Fingernail Delamination Secondary to EVA
 Head Injury
 Hip Sprain/Strain
 Hip/Proximal Femur Fracture
 Knee Sprain/Strain
 Lower Extremity Stress Fracture
 Lumbar Spine Fracture
 Neck Sprain/Strain
 Neurogenic Shock
 Paresthesias Secondary to EVA
 Shoulder Dislocation
 Shoulder Sprain/Strain
 Skin Abrasion
 Skin Laceration
 Traumatic Hypovolemic Shock
 Wrist Fracture
 Wrist Sprain/Strain

MEDICAL ILLNESS

Abdominal Wall Hernia
 Abnormal Uterine Bleeding
 Acute Angle-Closure Glaucoma
 Acute Arthritis
 Acute Cholecystitis/Biliary Colic
 Acute Diverticulitis
 Acute Pancreatitis
 Acute Prostatitis
 Acute Sinusitis
 Allergic Reaction (mild to moderate)
 Anaphylaxis
 Angina/Myocardial Infarction

MEDICAL ILLNESS (continued)

Anxiety
 Appendicitis
 Atrial Fibrillation/Atrial Flutter
 Back Pain (space adaptation)
 Behavioral Emergency
 Cardiogenic Shock Secondary to Myocardial infarction
 Choking/Obstructed Airway
 Constipation (space adaptation)
 Dental: Exposed Pulp
 Dental Caries
 Dental: Abscess
 Dental: Crown Loss
 Dental: Filling Loss
 Depression
 Diarrhea
 Eye Corneal Ulcer
 Eye Infection
 Gastroenteritis
 Headache (Late)
 Headache (space adaptation)
 Hearing Loss
 Hemorrhoids
 Herpes Zoster Reactivation (shingles)
 Hypertension
 Indigestion
 Influenza
 Insomnia (space adaptation)
 Medication Overdose/Adverse Reaction
 Mouth Ulcer
 Nasal Congestion (space adaptation)
 Nephrolithiasis
 Nose bleed (space adaptation)
 Otitis Externa
 Otitis Media
 Pharyngitis
 Respiratory Infection
 Retinal Detachment
 Seizures
 Sepsis
 Skin Infection
 Skin Rash
 Sleep Disorder
 Small Bowel Obstruction
 Space Motion Sickness (space adaptation)
 Stroke (Cerebrovascular Accident)
 Sudden Cardiac Arrest
 Urinary Incontinence (space adaptation)
 Urinary Retention (space adaptation)
 Urinary Tract Infection
 Vaginal Yeast Infection
 Visual Impairment and Increased Intracranial Pressure (VIIP) (space adaptation)

Appendix C: Report References

1. ISS PRA Model v3.2.0 Fire and Ammonia Model Contributions to the Integrated Medical Model. 9-25-2015.
Ref Type: Memo
 2. Integrated Medical Model Project. Integrated Medical Model Operations Plan. JSC-66114. 2011. Houston, TX, NASA, Johnson Space Center. *Ref Type: Report*
 3. Integrated Medical Model Project. Integrated Medical Model Software Requirements Specification. IMM-SFTWR-008. 2017. Houston, Texas, KBRwyle Integrated Science, Technology and Engineering. *Ref Type: Report*
 4. Integrated Medical Model Project. Integrated Medical Model version 4 Assumptions and Limitations. IMM-GEN-300. 2017. Houston, Texas, KBRwyle Integrated Science and Engineering Space Medicine Information Technology. *Ref Type: Report*
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