EXECUTIVE SUMMARY

This service request determined the CHI, probability of EVAC and probability of LOCL for 5 design reference missions (DRM) using a medical capability (MedCap) that is baselined to ISS. These outcomes are reported in Tables 3-4. The top 10 influential conditions for EVAC and LOCL for the Treated scenario are reported in Tables 5-14. The probability of occurrence of one or more events for each condition for each DRM is provided in Tables 15-19.

BACKGROUND

The Integrated Medical Model (IMM) simulates medical events during space flight missions and estimates the impact of these events on crew health. The IMM is a stochastic model that uses Monte Carlo methodology to simulate missions. The IMM consists of a three-step process:

1. Design Reference Mission (DRM) and crew member characteristics are specified.
2. Medical events, treatment and outcomes for the DRM are randomly generated based on pre-defined probability distributions.
3. The crew health index, evacuation and loss of crew life outcomes, and resource utilization outcomes are summarized in a post-processing procedure.

METHODS

Crew and Mission Parameters

The DRMs were configured using a standard Mars crew profile, with mission length and number of EVAs established by the requestor. Tables 1 and 2 below show the 4 crew and 7 crew profiles for this service request respectively. DRMs with durations of 21 days, 42 days, 1 year and 2 years were specified with the 4 crew profile, and a duration of 14 days for the 7 crew profile.

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: 4 Crew Profile.

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

Table 2: 7 Crew Profile.

	Sex	CAC	Crowns	Contacts	Prior Abdominal Surgery	EVA
Crew 1	Male	No	Yes	No	No	No
Crew 2	Male	No	No	Yes	No	Yes(2)
Crew 3	Male	No	No	No	No	Yes(2)
Crew 4	Male	Yes	No	No	Yes	No
Crew 5	Female	No	Yes	No	No	No
Crew 6	Female	No	No	Yes	No	Yes(2)
Crew 7	Female	No	Yes	No	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 treat the medical condition. All medical condition data inputs to the model are pulled from the iMED by an SQL query written in MATLAB scripts. In-flight medical treatment is assumed to follow a specified protocol [5] or clinical practice guidelines for each medical condition and is constrained by resource availability on the ISS (*i.e.* the ISS medical capabilities (MedCap)).

In the current version of IMM, medical conditions are not treated unless all essential medical resources are available. Resources are classified as essential or non-essential, and as consumable, or non-consumable. Consumable resources are decremented as required to treat medical events; if an item is essential, but has been depleted, then the given medical condition will go untreated.

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].

CHI = (1- (QAMTL ÷ Mission Length)) x 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 LOCL for the given DRMs is the main objective 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. The initial quantities for the available resources are baselined to the ISS environment with 6 month resupply.

Modeling Approach

A simulation was run for each of the 5 provided DRMs using IMM version three (v3). 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 IMMV3ConvergenceReport.

IMM outcomes were determined for the DRMs under three scenarios: 1) ISS MedCap scenario where all conditions are treated until the essential resources of the ISS MedCap are depleted; 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].

Relevant IMM Assumptions and Limitations

1. The IMM is baselined to the ISS environment including medical capabilities.
2. All medical conditions are correctly diagnosed and all treatments are effective.
3. Conditions are treated in order of decreasing incidence and increasing crew member count (*i.e.* crew member one is treated before crew member two for any given condition) with Space Adaptation conditions treated first.
4. When there are insufficient *essential* medical resources to treat a condition, all available resources are consumed and the medical condition is considered untreated.
5. The IMM does not include a mission timeline. All conditions occur at launch on day one.
6. Medical conditions are independent of each other; i) a mission could end in more than one evacuation or loss of crew life being considered for the same crew member, and ii) additional medical conditions can occur in a crew member assigned an end state of EVAC or LOCL.
7. IMM source data in the iMED database undergo periodic updates to ensure best alignment to the real world system; this may affect the inclusion or exclusion of certain resources from the optimized MedCap, which would also effect resulting mass and volume.
8. Mass and volume for MedCap does not consider packaging materials.

RESULTS AND Discussion

The specified DRMs were assessed using the IMM as described in the Methods section above. One hundred thousand trials were simulated for each DRM with ISS MedCap to forecast IMM primary outcomes and resources required to treat each condition. The ISS MedCap is baselined to the ISS environment with 6 month resupply. Results of the main outcomes are reported in Tables 3-4 with the numbers for fully treated and completely untreated as reference. The top 10 influential conditions for EVAC and LOCL for each DRM are provided in Tables 5-14. Also, the total number of EVACs and LOCLs is over all 100,000 trials of the simulation. The probability of occurrence of one or more events for each condition for each DRM is provided in Tables 15-19.

Although it did not contribute to the top 10 influential conditions, during a review of the simulation results, it was observed that Otitis Media was contributing to LOCL when it went to the untreated worst case scenario. The untreated worst case LOCL is the result of this condition progressing into two other conditions. Otitis Media should have 0% LOCL. A change request (C2-20170309-384) has been entered to make the changes in iMED.

Table 3. Total Medical Events(TME) and CHI

3a. TME

Mission Length	TME	95% CI
14 days (7 crew)	31.42	(23 , 40)
21 days	19.15	(12 , 26)
42 days	25.59	(17 , 34)
1 year	124.39	(103 , 146)
2 years	236.05	(206 , 267)

3b. CHI

	Mission Length	CHI (%)	95% CI
Treated	14 days (7 crew)	93.67	(84.37 , 97.28)
	21 days	94.66	(80.31 , 98.43)
	42 days	95.11	(80.90 , 98.80)
	1 year	91.11	(74.18 , 98.22)
	2 years	85.99	(66.58 , 96.40)

Table 4. Probability of EVAC and LOCL

4a. EVAC

	Mission Length	pEVAC	95% CI	Odds
Treated	14 days (7 crew)	0.0203	(0.0194 , 0.0211)	1 in 49
	21 days	0.0129	(0.0123 , 0.0137)	1 in 78
	42 days	0.0153	(0.0145 , 0.0160)	1 in 65
	1 year	0.0541	(0.0526 , 0.0556)	1 in 18
	2 years	0.0943	(0.0926 , 0.0962)	1 in 11

4b. LOCL

	Mission Length	pLOCL	95% CI	Odds
Treated	14 days (7 crew)	0.0003	(0.0002 , 0.0005)	1 in 3333
	21 days	0.0004	(0.0003 , 0.0005)	1 in 2500
	42 days	0.0009	(0.0007 , 0.0011)	1 in 1111
	1 year	0.0069	(0.0064 , 0.0075)	1 in 145
	2 years	0.0126	(0.0120 , 0.0135)	1 in 79

Table 5. Cis-lunar 14 Days Influential Conditions for EVAC – Treated

Scenario	Treated	Medical Condition	Total EVAC	Percent Contribution	Cumulative Percent
WORST CASE	TREATED	VISUAL IMPAIRMENT AND/OR INCREASED INTRACRANIAL PRESSURE (VIIP)(SPACE ADAPTATION)	1751	85.54	85.54
WORST CASE	TREATED	NEPHROLITHIASIS	43	2.10	87.64
WORST CASE	TREATED	SMOKE INHALATION	28	1.37	89.01
WORST CASE	TREATED	URINARY RETENTION (SPACE ADAPTATION)	23	1.12	90.13
WORST CASE	TREATED	DENTAL ABSCESS	18	0.88	91.01
WORST CASE	TREATED	SEPSIS	13	0.64	91.65
WORST CASE	TREATED	WRIST FRACTURE	12	0.59	92.23
WORST CASE	TREATED	BACK SPRAIN/STRAIN	11	0.54	92.77
WORST CASE	TREATED	STROKE (CEREBROVASCULAR ACCIDENT)	8	0.39	93.16
WORST CASE	TREATED	ACUTE DIVERTICULITIS	8	0.39	93.55

Table 6. Cis-lunar 21 Days Influential Conditions for EVAC – Treated

Scenario	Treated	Medical Condition	Total EVAC	Percent Contribution	Cumulative Percent
WORST CASE	TREATED	VISUAL IMPAIRMENT AND/OR INCREASED INTRACRANIAL PRESSURE (VIIP)(SPACE ADAPTATION)	1010	77.57	77.57
WORST CASE	TREATED	NEPHROLITHIASIS	40	3.07	80.65
WORST CASE	TREATED	SEPSIS	27	2.07	82.72
WORST CASE	TREATED	DENTAL ABSCESS	24	1.84	84.56
WORST CASE	TREATED	SMOKE INHALATION	18	1.38	85.94
BEST CASE	TREATED	SMALL BOWEL OBSTRUCTION	17	1.31	87.25
BEST CASE	TREATED	ATRIAL FIBRILLATION/ ATRIAL FLUTTER	12	0.92	88.17
WORST CASE	TREATED	WRIST FRACTURE	10	0.77	88.94
WORST CASE	TREATED	BACK SPRAIN/STRAIN	9	0.69	89.63
BEST CASE	TREATED	ANGINA/MYOCARDIAL INFARCTION	9	0.69	90.32

Table 7. Cis-lunar 42 Days Influential Conditions for EVAC – Treated

Scenario	Treated	Medical Condition	Total EVAC	Percent Contribution	Cumulative Percent
WORST CASE	TREATED	VISUAL IMPAIRMENT AND/OR INCREASED INTRACRANIAL PRESSURE (VIIP)(SPACE ADAPTATION)	1002	65.23	65.23
WORST CASE	TREATED	NEPHROLITHIASIS	69	4.49	69.73
WORST CASE	TREATED	SMOKE INHALATION	37	2.41	72.14
WORST CASE	TREATED	DENTAL ABSCESS	37	2.41	74.54
WORST CASE	TREATED	SEPSIS	34	2.21	76.76
BEST CASE	TREATED	SMALL BOWEL OBSTRUCTION	31	2.02	78.78
WORST CASE	TREATED	WRIST FRACTURE	19	1.24	80.01
WORST CASE	TREATED	STROKE (CEREBROVASCULAR ACCIDENT)	19	1.24	81.25
BEST CASE	TREATED	ATRIAL FIBRILLATION/ ATRIAL FLUTTER	18	1.17	82.42
WORST CASE	TREATED	TRAUMATIC HYPOVOLEMIC SHOCK	17	1.11	83.53

Table 8. Cis-lunar 1 Year Influential Conditions for EVAC – Treated

Scenario	Treated	Medical Condition	Total EVAC	Percent Contribution	Cumulative Percent
WORST CASE	TREATED	VISUAL IMPAIRMENT AND/OR INCREASED INTRACRANIAL PRESSURE (VIIP)(SPACE ADAPTATION)	1019	18.31	18.31
WORST CASE	TREATED	NEPHROLITHIASIS	624	11.21	29.52
WORST CASE	TREATED	DENTAL ABSCESS	355	6.38	35.90
WORST CASE	TREATED	SEPSIS	326	5.86	41.76
WORST CASE	TREATED	SMOKE INHALATION	286	5.14	46.90
BEST CASE	TREATED	SMALL BOWEL OBSTRUCTION	188	3.38	50.28
WORST CASE	TREATED	WRIST FRACTURE	180	3.23	53.51
WORST CASE	TREATED	BACK SPRAIN/STRAIN	160	2.88	56.39
WORST CASE	TREATED	HIP/PROXIMAL FEMUR FRACTURE	149	2.68	59.07
BEST CASE	TREATED	STROKE (CEREBROVASCULAR ACCIDENT)	139	2.50	61.56

Table 9. Cis-lunar 2 Years Influential Conditions for EVAC – Treated

Scenario	Treated	Medical Condition	Total EVAC	Percent Contribution	Cumulative Percent
WORST CASE	TREATED	NEPHROLITHIASIS	1275	12.77	12.77
WORST CASE	TREATED	VISUAL IMPAIRMENT AND/OR INCREASED INTRACRANIAL PRESSURE (VIIP)(SPACE ADAPTATION)	985	9.86	22.63
WORST CASE	TREATED	DENTAL ABSCESS	683	6.84	29.47
WORST CASE	TREATED	SEPSIS	636	6.37	35.84
WORST CASE	TREATED	SMOKE INHALATION	586	5.87	41.71
BEST CASE	TREATED	SMALL BOWEL OBSTRUCTION	417	4.18	45.89
WORST CASE	TREATED	WRIST FRACTURE	386	3.87	49.75
WORST CASE	TREATED	HIP/PROXIMAL FEMUR FRACTURE	302	3.02	52.78
WORST CASE	TREATED	STROKE (CEREBROVASCULAR ACCIDENT)	296	2.96	55.74
WORST CASE	TREATED	BACK SPRAIN/STRAIN	273	2.73	58.48

Table 10. Cis-lunar 14 Days Influential Conditions for LOCL – Treated

Scenario	Treated	Medical Condition	Total LOCL	Percent Contribution	Cumulative Percent
WORST CASE	TREATED	SEPSIS	8	25.00	25.00
WORST CASE	TREATED	STROKE (CEREBROVASCULAR ACCIDENT)	6	18.75	43.75
WORST CASE	TREATED	TRAUMATIC HYPOVOLEMIC SHOCK	5	15.63	59.38
WORST CASE	TREATED	MEDICATION OVERDOSE/ADVERSE REACTION	2	6.25	65.63
WORST CASE	TREATED	SMOKE INHALATION	2	6.25	71.88
WORST CASE	TREATED	APPENDICITIS	2	6.25	78.13
WORST CASE	TREATED	CHOKING/OBSTRUCTED AIRWAY	1	3.13	81.25
WORST CASE	TREATED	DECOMPRESSION SICKNESS SECONDARY TO EXTRAVEHICULAR ACTIVITY	1	3.13	84.38
WORST CASE	TREATED	ACUTE RADIATION SYNDROME	1	3.13	87.50
WORST CASE	TREATED	ABDOMINAL INJURY	1	3.13	90.63

Table 11. Cis-lunar 21 Days Influential Conditions for LOCL – Treated

Scenario	Treated	Medical Condition	Total LOCL	Percent Contribution	Cumulative Percent
WORST CASE	TREATED	SEPSIS	11	30.56	30.56
WORST CASE	TREATED	MEDICATION OVERDOSE/ADVERSE REACTION	5	13.89	44.44
WORST CASE	TREATED	TRAUMATIC HYPOVOLEMIC SHOCK	5	13.89	58.33
WORST CASE	TREATED	STROKE (CEREBROVASCULAR ACCIDENT)	3	8.33	66.67
WORST CASE	TREATED	HEAD INJURY	2	5.56	72.22
WORST CASE	TREATED	SUDDEN CARDIAC ARREST	2	5.56	77.78
WORST CASE	TREATED	CHEST INJURY	2	5.56	83.33
WORST CASE	TREATED	APPENDICITIS	2	5.56	88.89
WORST CASE	TREATED	TOXIC EXPOSURE (AMMONIA)	2	5.56	94.44
WORST CASE	TREATED	SMOKE INHALATION	1	2.78	97.22

Table 12. Cis-lunar 42 Days Influential Conditions for LOCL – Treated

Scenario	Treated	Medical Condition	Total LOCL	Percent Contribution	Cumulative Percent
WORST CASE	TREATED	SEPSIS	20	23.53	23.53
WORST CASE	TREATED	TRAUMATIC HYPOVOLEMIC SHOCK	17	20.00	43.53
WORST CASE	TREATED	STROKE (CEREBROVASCULAR ACCIDENT)	12	14.12	57.65
WORST CASE	TREATED	MEDICATION OVERDOSE/ADVERSE REACTION	7	8.24	65.88
WORST CASE	TREATED	TOXIC EXPOSURE (AMMONIA)	5	5.88	71.76
WORST CASE	TREATED	CHEST INJURY	5	5.88	77.65
WORST CASE	TREATED	CHOKING/OBSTRUCTED AIRWAY	3	3.53	81.18
WORST CASE	TREATED	SMOKE INHALATION	3	3.53	84.71
WORST CASE	TREATED	SUDDEN CARDIAC ARREST	3	3.53	88.24
WORST CASE	TREATED	APPENDICITIS	3	3.53	91.76

Table 13. Cis-lunar 1 Year Influential Conditions for LOCL – Treated

Scenario	Treated	Medical Condition	Total LOCL	Percent Contribution	Cumulative Percent
WORST CASE	TREATED	SEPSIS	148	21.33	21.33
WORST CASE	TREATED	TRAUMATIC HYPOVOLEMIC SHOCK	118	17.00	38.33
WORST CASE	TREATED	MEDICATION OVERDOSE/ADVERSE REACTION	87	12.54	50.86
WORST CASE	TREATED	STROKE (CEREBROVASCULAR ACCIDENT)	75	10.81	61.67
WORST CASE	TREATED	SMOKE INHALATION	62	8.93	70.61
WORST CASE	TREATED	HEAD INJURY	40	5.76	76.37
WORST CASE	TREATED	CHEST INJURY	37	5.33	81.70
WORST CASE	TREATED	TOXIC EXPOSURE (AMMONIA)	37	5.33	87.03
WORST CASE	TREATED	APPENDICITIS	30	4.32	91.35
WORST CASE	TREATED	ABDOMINAL INJURY	18	2.59	93.95

Table 14. Cis-lunar 2 Years Influential Conditions for LOCL – Treated

Scenario	Treated	Medical Condition	Total LOCL	Percent Contribution	Cumulative Percent
WORST CASE	TREATED	SEPSIS	317	24.96	24.96
WORST CASE	TREATED	TRAUMATIC HYPOVOLEMIC SHOCK	187	14.72	39.69
WORST CASE	TREATED	MEDICATION OVERDOSE/ADVERSE REACTION	147	11.57	51.26
WORST CASE	TREATED	STROKE (CEREBROVASCULAR ACCIDENT)	142	11.18	62.44
WORST CASE	TREATED	SMOKE INHALATION	105	8.27	70.71
WORST CASE	TREATED	CHEST INJURY	81	6.38	77.09
WORST CASE	TREATED	HEAD INJURY	78	6.14	83.23
WORST CASE	TREATED	APPENDICITIS	58	4.57	87.80
WORST CASE	TREATED	TOXIC EXPOSURE (AMMONIA)	56	4.41	92.20
WORST CASE	TREATED	SUDDEN CARDIAC ARREST	30	2.36	94.57

Table 15. Cis-lunar 14 Days Probability by Case of 1 or more events

Medical Condition	Probability Zero	Probability >=1	Probability >=1 Best Case	Probability >=1 Worst Case
ABDOMINAL INJURY	1.0000	0.0000	0.0000	0.0000
ABDOMINAL WALL HERNIA	0.9999	0.0001	0.0001	0.0000
ABNORMAL UTERINE BLEEDING	0.9940	0.0060	0.0058	0.0001
ACUTE ANGLE-CLOSURE GLAUCOMA	1.0000	0.0000	0.0000	0.0000
ACUTE ARTHRITIS	0.9993	0.0007	0.0007	0.0000
ACUTE CHOLECYSTITIS/BILIARY COLIC	0.9997	0.0003	0.0002	0.0000
ACUTE COMPARTMENT SYNDROME	1.0000	0.0000	0.0000	0.0000
ACUTE DIVERTICULITIS	0.9996	0.0004	0.0003	0.0001
ACUTE PANCREATITIS	0.9999	0.0001	0.0001	0.0000
ACUTE PROSTATITIS	0.9992	0.0008	0.0007	0.0000
ACUTE RADIATION SYNDROME	0.9993	0.0007	0.0007	0.0000
ACUTE SINUSITIS	0.9429	0.0571	0.0526	0.0046
ALLERGIC REACTION (MILD TO MODERATE)	0.8977	0.1023	0.0982	0.0041
ALTITUDE SICKNESS	1.0000	0.0000	0.0000	0.0000
ANAPHYLAXIS	0.9999	0.0001	0.0001	0.0000
ANGINA/MYOCARDIAL INFARCTION	0.9998	0.0002	0.0001	0.0000
ANKLE SPRAIN/STRAIN	0.8944	0.1056	0.1035	0.0021
ANXIETY	0.9989	0.0011	0.0011	0.0000
APPENDICITIS	0.9997	0.0003	0.0002	0.0000
ATRIAL FIBRILLATION/ ATRIAL FLUTTER	0.9999	0.0001	0.0001	0.0000
BACK PAIN (SPACE ADAPTATION)	0.0055	0.9945	0.9796	0.0149
BACK SPRAIN/STRAIN	0.7302	0.2698	0.2644	0.0054
BAROTRAUMA (EAR/SINUS BLOCK)	0.7379	0.2621	0.2582	0.0039
BEHAVIORAL EMERGENCY	1.0000	0.0000	0.0000	0.0000
BURNS SECONDARY TO FIRE	0.9986	0.0014	0.0013	0.0000
CARDIOGENIC SHOCK SECONDARY TO MYOCARDIAL INFARCTION	1.0000	0.0000	0.0000	0.0000
CHEST INJURY	0.9999	0.0001	0.0000	0.0000
CHOKING/OBSTRUCTED AIRWAY	0.9710	0.0290	0.0288	0.0001
CONSTIPATION (SPACE ADAPTATION)	0.2709	0.7291	0.7254	0.0036
DECOMPRESSION SICKNESS SECONDARY TO EXTRAVEHICULAR ACTIVITY	0.9538	0.0462	0.0458	0.0005
DENTAL ABSCESS	0.9978	0.0022	0.0017	0.0005
DENTAL AVULSION (TOOTH LOSS)	0.9992	0.0008	0.0006	0.0002
DENTAL CARIES	0.9975	0.0025	0.0016	0.0009
DENTAL CROWN LOSS	0.9994	0.0006	0.0005	0.0001
DENTAL EXPOSED PULP	0.9946	0.0054	0.0042	0.0011
DENTAL FILLING LOSS	0.9986	0.0014	0.0012	0.0001

DEPRESSION	0.9991	0.0009	0.0008	0.0001
DIARRHEA	0.7235	0.2765	0.2723	0.0041
ELBOW DISLOCATION	1.0000	0.0000	0.0000	0.0000
ELBOW SPRAIN/STRAIN	0.8854	0.1146	0.1123	0.0023
EYE CHEMICAL BURN	0.9429	0.0571	0.0529	0.0043
EYE CORNEAL ULCER	0.9999	0.0001	0.0001	0.0000
EYE INFECTION	0.9521	0.0479	0.0440	0.0038
EYE IRRITATION/ABRASION	0.5034	0.4966	0.4942	0.0025
EYE PENETRATION (FOREIGN BODY)	1.0000	0.0000	0.0000	0.0000
FINGER DISLOCATION	0.9902	0.0098	0.0097	0.0000
FINGERNAIL DELAMINATION SECONDARY TO EXTRAVEHICULAR ACTIVITY	0.6691	0.3309	0.3127	0.0182
GASTROENTERITIS	0.9615	0.0385	0.0354	0.0031
HEAD INJURY	0.9999	0.0001	0.0001	0.0001
HEADACHE (CO_2 INDUCED)	0.8219	0.1781	0.1736	0.0045
HEADACHE (LATE)	0.6185	0.3815	0.3777	0.0038
HEADACHE (SPACE ADAPTATION)	0.0485	0.9515	0.8944	0.0571
HEARING LOSS	0.9486	0.0514	0.0321	0.0193
HEMORRHOIDS	0.9806	0.0194	0.0193	0.0001
HERPES ZOSTER REACTIVATION (SHINGLES)	0.9902	0.0098	0.0084	0.0014
HIP SPRAIN/STRAIN	0.9602	0.0398	0.0390	0.0008
HIP/PROXIMAL FEMUR FRACTURE	0.9999	0.0001	0.0000	0.0001
HYPERTENSION	0.9983	0.0017	0.0015	0.0002
INDIGESTION	0.9429	0.0571	0.0531	0.0040
INFLUENZA	0.9902	0.0098	0.0073	0.0024
INSOMNIA (SPACE ADAPTATION)	0.0152	0.9848	0.9799	0.0049
KNEE SPRAIN/STRAIN	0.9315	0.0685	0.0672	0.0014
LOWER EXTREMITY (LE) STRESS FRACTURE	0.9860	0.0140	0.0124	0.0016
LUMBAR SPINE FRACTURE	0.9999	0.0001	0.0000	0.0000
MEDICATION OVERDOSE/ADVERSE REACTION	0.9806	0.0194	0.0193	0.0001
MOUTH ULCER	0.9155	0.0845	0.0803	0.0042
NASAL CONGESTION (SPACE ADAPTATION)	0.0021	0.9979	0.9929	0.0050
NECK SPRAIN/STRAIN	0.9127	0.0873	0.0855	0.0017
NEPHROLITHIASIS	0.9989	0.0011	0.0006	0.0004
NEUROGENIC SHOCK	1.0000	0.0000	0.0000	0.0000
NOSE BLEED (SPACE ADAPTATION)	0.9384	0.0616	0.0594	0.0022
OTITIS EXTERNA	0.9710	0.0290	0.0286	0.0004
OTITIS MEDIA	0.9710	0.0290	0.0261	0.0029
PARESTHESIAS SECONDARY TO EXTRAVEHICULAR ACTIVITY	0.5131	0.4869	0.4723	0.0146
PHARYNGITIS	0.8977	0.1023	0.0977	0.0046
RESPIRATORY INFECTION	0.7235	0.2765	0.2723	0.0041
RETINAL DETACHMENT	1.0000	0.0000	0.0000	0.0000
SEIZURES	0.9999	0.0001	0.0001	0.0000

SEPSIS	0.9994	0.0006	0.0004	0.0002
SHOULDER DISLOCATION	1.0000	0.0000	0.0000	0.0000
SHOULDER SPRAIN/STRAIN	0.8000	0.2000	0.1960	0.0040
SKIN ABRASION	0.3978	0.6022	0.5691	0.0331
SKIN INFECTION	0.8803	0.1197	0.1155	0.0042
SKIN LACERATION	0.9902	0.0098	0.0024	0.0073
SKIN RASH	0.3978	0.6022	0.5992	0.0030
SLEEP DISORDER	0.2714	0.7286	0.7250	0.0036
SMALL BOWEL OBSTRUCTION	0.9998	0.0002	0.0002	0.0000
SMOKE INHALATION	0.9952	0.0048	0.0042	0.0007
SPACE MOTION SICKNESS (SPACE ADAPTATION)	0.0001	0.9999	0.8499	0.1500
STROKE (CEREBROVASCULAR ACCIDENT)	0.9998	0.0002	0.0001	0.0001
SUDDEN CARDIAC ARREST	1.0000	0.0000	0.0000	0.0000
TOXIC EXPOSURE (AMMONIA)	1.0000	0.0000	0.0000	0.0000
TRAUMATIC HYPOVOLEMIC SHOCK	0.9998	0.0002	0.0001	0.0001
URINARY INCONTINENCE (SPACE ADAPTATION)	0.8424	0.1576	0.1442	0.0134
URINARY RETENTION (SPACE ADAPTATION)	0.8192	0.1808	0.1537	0.0271
URINARY TRACT INFECTION	0.8345	0.1655	0.1572	0.0083
VAGINAL YEAST INFECTION	0.9566	0.0434	0.0369	0.0065
VISUAL IMPAIRMENT AND/OR INCREASED INTRACRANIAL PRESSURE (VIIP)(SPACE ADAPTATION)	0.0540	0.9460	0.8798	0.0662
WRIST FRACTURE	0.9994	0.0006	0.0005	0.0001
WRIST SPRAIN/STRAIN	0.9505	0.0495	0.0487	0.0007

Table 16. Cis-lunar 21 Days Probability by Case of 1 or more events

Medical Condition	Probability Zero	Probability >=1	Probability >=1 Best Case	Probability >=1 Worst Case
ABDOMINAL INJURY	1.0000	0.0000	0.0000	0.0000
ABDOMINAL WALL HERNIA	0.9999	0.0001	0.0001	0.0000
ACUTE ANGLE-CLOSURE GLAUCOMA	1.0000	0.0000	0.0000	0.0000
ACUTE ARTHRITIS	0.9996	0.0004	0.0003	0.0000
ACUTE CHOLECYSTITIS/BILIARY COLIC	0.9998	0.0002	0.0002	0.0000
ACUTE COMPARTMENT SYNDROME	1.0000	0.0000	0.0000	0.0000
ACUTE DIVERTICULITIS	0.9997	0.0003	0.0002	0.0001
ACUTE PANCREATITIS	0.9999	0.0001	0.0001	0.0000
ACUTE PROSTATITIS	0.9989	0.0011	0.0011	0.0001
ACUTE RADIATION SYNDROME	0.9994	0.0006	0.0006	0.0000
ACUTE SINUSITIS	0.9508	0.0492	0.0452	0.0039
ALLERGIC REACTION (MILD TO MODERATE)	0.9117	0.0883	0.0848	0.0035
ALTITUDE SICKNESS	1.0000	0.0000	0.0000	0.0000
ANAPHYLAXIS	0.9999	0.0001	0.0001	0.0000
ANGINA/MYOCARDIAL INFARCTION	0.9999	0.0001	0.0001	0.0000

ANKLE SPRAIN/STRAIN	0.9088	0.0912	0.0894	0.0018
ANXIETY	0.9996	0.0004	0.0004	0.0000
APPENDICITIS	0.9998	0.0002	0.0002	0.0000
ATRIAL FIBRILLATION/ ATRIAL FLUTTER	0.9998	0.0002	0.0001	0.0000
BACK PAIN (SPACE ADAPTATION)	0.0510	0.9490	0.9347	0.0142
BACK SPRAIN/STRAIN	0.7637	0.2363	0.2315	0.0047
BAROTRAUMA (EAR/SINUS BLOCK)	0.7706	0.2294	0.2260	0.0034
BEHAVIORAL EMERGENCY	1.0000	0.0000	0.0000	0.0000
BURNS SECONDARY TO FIRE	0.9988	0.0012	0.0012	0.0000
CARDIOGENIC SHOCK SECONDARY TO MYOCARDIAL INFARCTION	1.0000	0.0000	0.0000	0.0000
CHEST INJURY	0.9999	0.0001	0.0000	0.0000
CHOKING/OBSTRUCTED AIRWAY	0.9751	0.0249	0.0248	0.0001
CONSTIPATION (SPACE ADAPTATION)	0.4742	0.5258	0.5232	0.0026
DENTAL ABSCESS	0.9981	0.0019	0.0015	0.0004
DENTAL AVULSION (TOOTH LOSS)	0.9993	0.0007	0.0005	0.0002
DENTAL CARIES	0.9978	0.0022	0.0014	0.0008
DENTAL CROWN LOSS	0.9997	0.0003	0.0003	0.0000
DENTAL EXPOSED PULP	0.9954	0.0046	0.0036	0.0010
DENTAL FILLING LOSS	0.9988	0.0012	0.0011	0.0001
DEPRESSION	0.9993	0.0007	0.0006	0.0001
DIARRHEA	0.7578	0.2422	0.2386	0.0036
ELBOW DISLOCATION	1.0000	0.0000	0.0000	0.0000
ELBOW SPRAIN/STRAIN	0.9009	0.0991	0.0971	0.0020
EYE CHEMICAL BURN	0.9508	0.0492	0.0455	0.0037
EYE CORNEAL ULCER	0.9999	0.0001	0.0001	0.0000
EYE INFECTION	0.9588	0.0412	0.0379	0.0033
EYE IRRITATION/ABRASION	0.5552	0.4448	0.4426	0.0022
EYE PENETRATION (FOREIGN BODY)	1.0000	0.0000	0.0000	0.0000
FINGER DISLOCATION	0.9916	0.0084	0.0083	0.0000
GASTROENTERITIS	0.9669	0.0331	0.0304	0.0026
HEAD INJURY	0.9999	0.0001	0.0000	0.0001
HEADACHE (CO2 INDUCED)	0.8453	0.1547	0.1509	0.0039
HEADACHE (LATE)	0.6624	0.3376	0.3342	0.0034
HEADACHE (SPACE ADAPTATION)	0.1775	0.8225	0.7731	0.0493
HEARING LOSS	0.9558	0.0442	0.0276	0.0166
HEMORRHOIDS	0.9833	0.0167	0.0166	0.0001
HERPES ZOSTER REACTIVATION (SHINGLES)	0.9916	0.0084	0.0072	0.0012
HIP SPRAIN/STRAIN	0.9658	0.0342	0.0335	0.0007
HIP/PROXIMAL FEMUR FRACTURE	0.9999	0.0001	0.0000	0.0001
HYPERTENSION	0.9985	0.0015	0.0013	0.0002
INDIGESTION	0.9508	0.0492	0.0457	0.0034
INFLUENZA	0.9916	0.0084	0.0063	0.0021

INSOMNIA (SPACE ADAPTATION)	0.0913	0.9087	0.9042	0.0045
KNEE SPRAIN/STRAIN	0.9410	0.0590	0.0579	0.0012
LOWER EXTREMITY (LE) STRESS FRACTURE	0.9904	0.0096	0.0085	0.0011
LUMBAR SPINE FRACTURE	1.0000	0.0000	0.0000	0.0000
MEDICATION OVERDOSE/ADVERSE REACTION	0.9833	0.0167	0.0166	0.0001
MOUTH ULCER	0.9271	0.0729	0.0692	0.0036
NASAL CONGESTION (SPACE ADAPTATION)	0.0294	0.9706	0.9657	0.0049
NECK SPRAIN/STRAIN	0.9247	0.0753	0.0738	0.0015
NEPHROLITHIASIS	0.9991	0.0009	0.0006	0.0004
NEUROGENIC SHOCK	1.0000	0.0000	0.0000	0.0000
NOSE BLEED (SPACE ADAPTATION)	0.9643	0.0357	0.0344	0.0012
OTITIS EXTERNA	0.9751	0.0249	0.0245	0.0004
OTITIS MEDIA	0.9751	0.0249	0.0224	0.0025
PHARYNGITIS	0.9117	0.0883	0.0843	0.0040
RESPIRATORY INFECTION	0.7578	0.2422	0.2386	0.0036
RETINAL DETACHMENT	1.0000	0.0000	0.0000	0.0000
SEIZURES	0.9999	0.0001	0.0001	0.0000
SEPSIS	0.9994	0.0006	0.0004	0.0002
SHOULDER DISLOCATION	1.0000	0.0000	0.0000	0.0000
SHOULDER SPRAIN/STRAIN	0.8259	0.1741	0.1706	0.0035
SKIN ABRASION	0.4538	0.5462	0.5162	0.0300
SKIN INFECTION	0.8965	0.1035	0.0999	0.0036
SKIN LACERATION	0.9916	0.0084	0.0021	0.0063
SKIN RASH	0.4538	0.5462	0.5435	0.0027
SLEEP DISORDER	0.3269	0.6731	0.6697	0.0034
SMALL BOWEL OBSTRUCTION	0.9997	0.0003	0.0002	0.0000
SMOKE INHALATION	0.9959	0.0041	0.0036	0.0006
SPACE MOTION SICKNESS (SPACE ADAPTATION)	0.0053	0.9947	0.8455	0.1492
STROKE (CEREBROVASCULAR ACCIDENT)	0.9998	0.0002	0.0001	0.0001
SUDDEN CARDIAC ARREST	1.0000	0.0000	0.0000	0.0000
TOXIC EXPOSURE (AMMONIA)	1.0000	0.0000	0.0000	0.0000
TRAUMATIC HYPOVOLEMIC SHOCK	0.9999	0.0001	0.0001	0.0001
URINARY RETENTION (SPACE ADAPTATION)	0.9724	0.0276	0.0234	0.0041
URINARY TRACT INFECTION	0.9618	0.0382	0.0362	0.0019
VISUAL IMPAIRMENT AND/OR INCREASED INTRACRANIAL PRESSURE (VIIP)(SPACE ADAPTATION)	0.1887	0.8113	0.7545	0.0568
WRIST FRACTURE	0.9995	0.0005	0.0004	0.0001
WRIST SPRAIN/STRAIN	0.9575	0.0425	0.0419	0.0006

Table 17. Cis-lunar 42 Days Probability by Case of 1 or more events

Medical Condition	Probability Zero	Probability >=1	Probability >=1 Best Case	Probability >=1 Worst Case
ABDOMINAL INJURY	0.9999	0.0001	0.0001	0.0000
ABDOMINAL WALL HERNIA	0.9998	0.0002	0.0002	0.0000
ACUTE ANGLE-CLOSURE GLAUCOMA	1.0000	0.0000	0.0000	0.0000
ACUTE ARTHRITIS	0.9993	0.0007	0.0007	0.0000
ACUTE CHOLECYSTITIS/BILIARY COLIC	0.9996	0.0004	0.0003	0.0000
ACUTE COMPARTMENT SYNDROME	1.0000	0.0000	0.0000	0.0000
ACUTE DIVERTICULITIS	0.9993	0.0007	0.0005	0.0002
ACUTE PANCREATITIS	0.9999	0.0001	0.0001	0.0000
ACUTE PROSTATITIS	0.9977	0.0023	0.0021	0.0001
ACUTE RADIATION SYNDROME	0.9988	0.0012	0.0012	0.0000
ACUTE SINUSITIS	0.9041	0.0959	0.0883	0.0077
ALLERGIC REACTION (MILD TO MODERATE)	0.8312	0.1688	0.1621	0.0068
ALTITUDE SICKNESS	1.0000	0.0000	0.0000	0.0000
ANAPHYLAXIS	0.9998	0.0002	0.0002	0.0000
ANGINA/MYOCARDIAL INFARCTION	0.9997	0.0003	0.0002	0.0000
ANKLE SPRAIN/STRAIN	0.8259	0.1741	0.1706	0.0035
ANXIETY	0.9991	0.0009	0.0008	0.0000
APPENDICITIS	0.9996	0.0004	0.0004	0.0001
ATRIAL FIBRILLATION/ ATRIAL FLUTTER	0.9997	0.0003	0.0003	0.0001
BACK PAIN (SPACE ADAPTATION)	0.0510	0.9490	0.9347	0.0142
BACK SPRAIN/STRAIN	0.5833	0.4167	0.4084	0.0083
BAROTRAUMA (EAR/SINUS BLOCK)	0.5938	0.4062	0.4001	0.0061
BEHAVIORAL EMERGENCY	1.0000	0.0000	0.0000	0.0000
BURNS SECONDARY TO FIRE	0.9977	0.0023	0.0023	0.0000
CARDIOGENIC SHOCK SECONDARY TO MYOCARDIAL INFARCTION	1.0000	0.0000	0.0000	0.0000
CHEST INJURY	0.9999	0.0001	0.0000	0.0001
CHOKING/OBSTRUCTED AIRWAY	0.9508	0.0492	0.0489	0.0002
CONSTIPATION (SPACE ADAPTATION)	0.4742	0.5258	0.5232	0.0026
DENTAL ABSCESS	0.9963	0.0037	0.0030	0.0008
DENTAL AVULSION (TOOTH LOSS)	0.9987	0.0013	0.0010	0.0003
DENTAL CARIES	0.9957	0.0043	0.0027	0.0016
DENTAL CROWN LOSS	0.9994	0.0006	0.0005	0.0001
DENTAL EXPOSED PULP	0.9908	0.0092	0.0073	0.0019
DENTAL FILLING LOSS	0.9977	0.0023	0.0021	0.0002
DEPRESSION	0.9987	0.0013	0.0012	0.0001
DIARRHEA	0.5742	0.4258	0.4194	0.0064
ELBOW DISLOCATION	1.0000	0.0000	0.0000	0.0000
ELBOW SPRAIN/STRAIN	0.8117	0.1883	0.1846	0.0038

EYE CHEMICAL BURN	0.9041	0.0959	0.0888	0.0072
EYE CORNEAL ULCER	0.9998	0.0002	0.0002	0.0000
EYE INFECTION	0.9194	0.0806	0.0742	0.0064
EYE IRRITATION/ABRASION	0.3083	0.6917	0.6883	0.0035
EYE PENETRATION (FOREIGN BODY)	1.0000	0.0000	0.0000	0.0000
FINGER DISLOCATION	0.9833	0.0167	0.0166	0.0001
GASTROENTERITIS	0.9350	0.0650	0.0598	0.0052
HEAD INJURY	0.9998	0.0002	0.0001	0.0001
HEADACHE (CO2 INDUCED)	0.7145	0.2855	0.2784	0.0071
HEADACHE (LATE)	0.4388	0.5612	0.5556	0.0056
HEADACHE (SPACE ADAPTATION)	0.1775	0.8225	0.7731	0.0493
HEARING LOSS	0.9135	0.0865	0.0541	0.0324
HEMORRHOIDS	0.9669	0.0331	0.0329	0.0002
HERPES ZOSTER REACTIVATION (SHINGLES)	0.9833	0.0167	0.0143	0.0023
HIP SPRAIN/STRAIN	0.9328	0.0672	0.0659	0.0013
HIP/PROXIMAL FEMUR FRACTURE	0.9998	0.0002	0.0000	0.0002
HYPERTENSION	0.9970	0.0030	0.0026	0.0003
INDIGESTION	0.9041	0.0959	0.0892	0.0067
INFLUENZA	0.9833	0.0167	0.0125	0.0042
INSOMNIA (SPACE ADAPTATION)	0.0913	0.9087	0.9042	0.0045
KNEE SPRAIN/STRAIN	0.8854	0.1146	0.1123	0.0023
LOWER EXTREMITY (LE) STRESS FRACTURE	0.9809	0.0191	0.0169	0.0022
LUMBAR SPINE FRACTURE	0.9999	0.0001	0.0001	0.0000
MEDICATION OVERDOSE/ADVERSE REACTION	0.9669	0.0331	0.0329	0.0002
MOUTH ULCER	0.8596	0.1404	0.1334	0.0070
NASAL CONGESTION (SPACE ADAPTATION)	0.0294	0.9706	0.9657	0.0049
NECK SPRAIN/STRAIN	0.8551	0.1449	0.1420	0.0029
NEPHROLITHIASIS	0.9982	0.0018	0.0011	0.0007
NEUROGENIC SHOCK	1.0000	0.0000	0.0000	0.0000
NOSE BLEED (SPACE ADAPTATION)	0.9643	0.0357	0.0344	0.0012
OTITIS EXTERNA	0.9508	0.0492	0.0484	0.0007
OTITIS MEDIA	0.9508	0.0492	0.0443	0.0049
PHARYNGITIS	0.8312	0.1688	0.1612	0.0076
RESPIRATORY INFECTION	0.5742	0.4258	0.4194	0.0064
RETINAL DETACHMENT	0.9999	0.0001	0.0000	0.0000
SEIZURES	0.9999	0.0001	0.0001	0.0000
SEPSIS	0.9989	0.0011	0.0007	0.0004
SHOULDER DISLOCATION	1.0000	0.0000	0.0000	0.0000
SHOULDER SPRAIN/STRAIN	0.6821	0.3179	0.3115	0.0064
SKIN ABRASION	0.2059	0.7941	0.7504	0.0437
SKIN INFECTION	0.8037	0.1963	0.1894	0.0069
SKIN LACERATION	0.9833	0.0167	0.0042	0.0125
SKIN RASH	0.2059	0.7941	0.7901	0.0040

SLEEP DISORDER	0.1069	0.8931	0.8886	0.0045
SMALL BOWEL OBSTRUCTION	0.9994	0.0006	0.0005	0.0001
SMOKE INHALATION	0.9917	0.0083	0.0071	0.0012
SPACE MOTION SICKNESS (SPACE ADAPTATION)	0.0053	0.9947	0.8455	0.1492
STROKE (CEREBROVASCULAR ACCIDENT)	0.9995	0.0005	0.0003	0.0002
SUDDEN CARDIAC ARREST	1.0000	0.0000	0.0000	0.0000
TOXIC EXPOSURE (AMMONIA)	0.9999	0.0001	0.0000	0.0001
TRAUMATIC HYPOVOLEMIC SHOCK	0.9997	0.0003	0.0002	0.0001
URINARY RETENTION (SPACE ADAPTATION)	0.9724	0.0276	0.0234	0.0041
URINARY TRACT INFECTION	0.9252	0.0748	0.0711	0.0037
VISUAL IMPAIRMENT AND/OR INCREASED INTRACRANIAL PRESSURE (VIIP)(SPACE ADAPTATION)	0.1887	0.8113	0.7545	0.0568
WRIST FRACTURE	0.9989	0.0011	0.0009	0.0002
WRIST SPRAIN/STRAIN	0.9167	0.0833	0.0820	0.0012

Table 18. Cis-lunar 1 Year Probability by Case of 1 or more events

Medical Condition	Probability Zero	Probability >=1	Probability >=1 Best Case	Probability >=1 Worst Case
ABDOMINAL INJURY	0.9993	0.0007	0.0005	0.0002
ABDOMINAL WALL HERNIA	0.9982	0.0018	0.0016	0.0002
ACUTE ANGLE-CLOSURE GLAUCOMA	0.9999	0.0001	0.0001	0.0000
ACUTE ARTHRITIS	0.9939	0.0061	0.0059	0.0002
ACUTE CHOLECYSTITIS/BILIARY COLIC	0.9969	0.0031	0.0028	0.0003
ACUTE COMPARTMENT SYNDROME	0.9997	0.0003	0.0001	0.0002
ACUTE DIVERTICULITIS	0.9943	0.0057	0.0042	0.0014
ACUTE PANCREATITIS	0.9988	0.0012	0.0010	0.0002
ACUTE PROSTATITIS	0.9806	0.0194	0.0181	0.0013
ACUTE RADIATION SYNDROME	0.9896	0.0104	0.0104	0.0001
ACUTE SINUSITIS	0.4159	0.5841	0.5373	0.0467
ALLERGIC REACTION (MILD TO MODERATE)	0.2003	0.7997	0.7678	0.0320
ALTITUDE SICKNESS	0.9998	0.0002	0.0002	0.0000
ANAPHYLAXIS	0.9980	0.0020	0.0020	0.0000
ANGINA/MYOCARDIAL INFARCTION	0.9975	0.0025	0.0021	0.0004
ANKLE SPRAIN/STRAIN	0.1895	0.8105	0.7943	0.0162
ANXIETY	0.9924	0.0076	0.0072	0.0003
APPENDICITIS	0.9963	0.0037	0.0031	0.0007
ATRIAL FIBRILLATION/ ATRIAL FLUTTER	0.9972	0.0028	0.0023	0.0006
BACK PAIN (SPACE ADAPTATION)	0.0510	0.9490	0.9347	0.0142
BACK SPRAIN/STRAIN	0.0092	0.9908	0.9710	0.0198
BAROTRAUMA (EAR/SINUS BLOCK)	0.0108	0.9892	0.9744	0.0148
BEHAVIORAL EMERGENCY	0.9999	0.0001	0.0001	0.0000
BURNS SECONDARY TO FIRE	0.9800	0.0200	0.0199	0.0001

CARDIOGENIC SHOCK SECONDARY TO MYOCARDIAL INFARCTION	1.0000	0.0000	0.0000	0.0000
CHEST INJURY	0.9990	0.0010	0.0004	0.0007
CHOKING/OBSTRUCTED AIRWAY	0.6449	0.3551	0.3533	0.0018
CONSTIPATION (SPACE ADAPTATION)	0.4742	0.5258	0.5232	0.0026
DENTAL ABSCESS	0.9679	0.0321	0.0254	0.0067
DENTAL AVULSION (TOOTH LOSS)	0.9884	0.0116	0.0089	0.0027
DENTAL CARIES	0.9631	0.0369	0.0233	0.0137
DENTAL CROWN LOSS	0.9948	0.0052	0.0043	0.0008
DENTAL EXPOSED PULP	0.9227	0.0773	0.0610	0.0162
DENTAL FILLING LOSS	0.9798	0.0202	0.0184	0.0018
DEPRESSION	0.9885	0.0115	0.0106	0.0009
DIARRHEA	0.0080	0.9920	0.9771	0.0149
ELBOW DISLOCATION	0.9998	0.0002	0.0002	0.0000
ELBOW SPRAIN/STRAIN	0.1629	0.8371	0.8204	0.0167
EYE CHEMICAL BURN	0.4159	0.5841	0.5402	0.0438
EYE CORNEAL ULCER	0.9983	0.0017	0.0017	0.0000
EYE INFECTION	0.4814	0.5186	0.4771	0.0415
EYE IRRITATION/ABRASION	0.0000	1.0000	0.9950	0.0050
EYE PENETRATION (FOREIGN BODY)	1.0000	0.0000	0.0000	0.0000
FINGER DISLOCATION	0.8640	0.1360	0.1353	0.0007
GASTROENTERITIS	0.5572	0.4428	0.4074	0.0354
HEAD INJURY	0.9983	0.0017	0.0008	0.0009
HEADACHE (CO_2 INDUCED)	0.0537	0.9463	0.9226	0.0237
HEADACHE (LATE)	0.0008	0.9992	0.9892	0.0100
HEADACHE (SPACE ADAPTATION)	0.1775	0.8225	0.7731	0.0493
HEARING LOSS	0.4553	0.5447	0.3405	0.2043
HEMORRHOIDS	0.7465	0.2535	0.2523	0.0013
HERPES ZOSTER REACTIVATION (SHINGLES)	0.8640	0.1360	0.1170	0.0190
HIP SPRAIN/STRAIN	0.5461	0.4539	0.4448	0.0091
HIP/PROXIMAL FEMUR FRACTURE	0.9983	0.0017	0.0001	0.0016
HYPERTENSION	0.9745	0.0255	0.0226	0.0029
INDIGESTION	0.4159	0.5841	0.5432	0.0409
INFLUENZA	0.8640	0.1360	0.1020	0.0340
INSOMNIA (SPACE ADAPTATION)	0.0913	0.9087	0.9042	0.0045
KNEE SPRAIN/STRAIN	0.3469	0.6531	0.6400	0.0131
LOWER EXTREMITY (LE) STRESS FRACTURE	0.8454	0.1546	0.1369	0.0178
LUMBAR SPINE FRACTURE	0.9992	0.0008	0.0007	0.0001
MEDICATION OVERDOSE/ADVERSE REACTION	0.7465	0.2535	0.2523	0.0013
MOUTH ULCER	0.2683	0.7317	0.6952	0.0366
NASAL CONGESTION (SPACE ADAPTATION)	0.0294	0.9706	0.9657	0.0049
NECK SPRAIN/STRAIN	0.2564	0.7436	0.7287	0.0149
NEPHROLITHIASIS	0.9843	0.0157	0.0095	0.0062

NEUROGENIC SHOCK	1.0000	0.0000	0.0000	0.0000
NOSE BLEED (SPACE ADAPTATION)	0.9643	0.0357	0.0344	0.0012
OTITIS EXTERNA	0.6449	0.3551	0.3497	0.0053
OTITIS MEDIA	0.6449	0.3551	0.3196	0.0355
PHARYNGITIS	0.2003	0.7997	0.7638	0.0360
RESPIRATORY INFECTION	0.0080	0.9920	0.9771	0.0149
RETINAL DETACHMENT	0.9995	0.0005	0.0002	0.0003
SEIZURES	0.9989	0.0011	0.0009	0.0002
SEPSIS	0.9904	0.0096	0.0063	0.0032
SHOULDER DISLOCATION	0.9999	0.0001	0.0000	0.0001
SHOULDER SPRAIN/STRAIN	0.0359	0.9641	0.9448	0.0193
SKIN ABRASION	0.0000	1.0000	0.9450	0.0550
SKIN INFECTION	0.1495	0.8505	0.8208	0.0298
SKIN LACERATION	0.8640	0.1360	0.0340	0.1020
SKIN RASH	0.0000	1.0000	0.9950	0.0050
SLEEP DISORDER	0.0000	1.0000	0.9950	0.0050
SMALL BOWEL OBSTRUCTION	0.9952	0.0048	0.0042	0.0006
SMOKE INHALATION	0.9302	0.0698	0.0600	0.0098
SPACE MOTION SICKNESS (SPACE ADAPTATION)	0.0053	0.9947	0.8455	0.1492
STROKE (CEREBROVASCULAR ACCIDENT)	0.9961	0.0039	0.0026	0.0013
SUDDEN CARDIAC ARREST	0.9999	0.0001	0.0000	0.0001
TOXIC EXPOSURE (AMMONIA)	0.9993	0.0007	0.0000	0.0007
TRAUMATIC HYPOVOLEMIC SHOCK	0.9974	0.0026	0.0015	0.0010
URINARY RETENTION (SPACE ADAPTATION)	0.9724	0.0276	0.0234	0.0041
URINARY TRACT INFECTION	0.5084	0.4916	0.4670	0.0246
VISUAL IMPAIRMENT AND/OR INCREASED INTRACRANIAL PRESSURE (VIIP)(SPACE ADAPTATION)	0.1887	0.8113	0.7545	0.0568
WRIST FRACTURE	0.9906	0.0094	0.0075	0.0019
WRIST SPRAIN/STRAIN	0.4695	0.5305	0.5226	0.0080

Table 19. Cis-lunar 2 Years Probability by Case of 1 or more events

Medical Condition	Probability Zero	Probability >=1	Probability >=1 Best Case	Probability >=1 Worst Case
ABDOMINAL INJURY	0.9987	0.0013	0.0010	0.0003
ABDOMINAL WALL HERNIA	0.9964	0.0036	0.0032	0.0004
ACUTE ANGLE-CLOSURE GLAUCOMA	0.9998	0.0002	0.0002	0.0000
ACUTE ARTHRITIS	0.9878	0.0122	0.0119	0.0003
ACUTE CHOLECYSTITIS/BILIARY COLIC	0.9939	0.0061	0.0055	0.0006
ACUTE COMPARTMENT SYNDROME	0.9994	0.0006	0.0002	0.0004
ACUTE DIVERTICULITIS	0.9887	0.0113	0.0084	0.0029
ACUTE PANCREATITIS	0.9975	0.0025	0.0020	0.0004
ACUTE PROSTATITIS	0.9616	0.0384	0.0359	0.0025
ACUTE RADIATION SYNDROME	0.9792	0.0208	0.0207	0.0001

ACUTE SINUSITIS	0.1730	0.8270	0.7608	0.0662
ALLERGIC REACTION (MILD TO MODERATE)	0.0401	0.9599	0.9215	0.0384
ALTITUDE SICKNESS	0.9996	0.0004	0.0004	0.0000
ANAPHYLAXIS	0.9961	0.0039	0.0039	0.0000
ANGINA/MYOCARDIAL INFARCTION	0.9950	0.0050	0.0043	0.0008
ANKLE SPRAIN/STRAIN	0.0359	0.9641	0.9448	0.0193
ANXIETY	0.9849	0.0151	0.0144	0.0007
APPENDICITIS	0.9926	0.0074	0.0061	0.0013
ATRIAL FIBRILLATION/ ATRIAL FLUTTER	0.9943	0.0057	0.0046	0.0011
BACK PAIN (SPACE ADAPTATION)	0.0510	0.9490	0.9347	0.0142
BACK SPRAIN/STRAIN	0.0001	0.9999	0.9799	0.0200
BAROTRAUMA (EAR/SINUS BLOCK)	0.0001	0.9999	0.9849	0.0150
BEHAVIORAL EMERGENCY	0.9999	0.0001	0.0001	0.0000
BURNS SECONDARY TO FIRE	0.9605	0.0395	0.0393	0.0002
CARDIOGENIC SHOCK SECONDARY TO MYOCARDIAL INFARCTION	0.9999	0.0001	0.0000	0.0001
CHEST INJURY	0.9980	0.0020	0.0007	0.0013
CHOKING/OBSTRUCTED AIRWAY	0.4159	0.5841	0.5811	0.0029
CONSTIPATION (SPACE ADAPTATION)	0.4742	0.5258	0.5232	0.0026
DENTAL ABSCESS	0.9368	0.0632	0.0499	0.0133
DENTAL AVULSION (TOOTH LOSS)	0.9769	0.0231	0.0178	0.0053
DENTAL CARIES	0.9275	0.0725	0.0457	0.0268
DENTAL CROWN LOSS	0.9897	0.0103	0.0087	0.0016
DENTAL EXPOSED PULP	0.8515	0.1485	0.1173	0.0312
DENTAL FILLING LOSS	0.9599	0.0401	0.0365	0.0036
DEPRESSION	0.9771	0.0229	0.0211	0.0018
DIARRHEA	0.0001	0.9999	0.9849	0.0150
ELBOW DISLOCATION	0.9996	0.0004	0.0004	0.0001
ELBOW SPRAIN/STRAIN	0.0265	0.9735	0.9540	0.0195
EYE CHEMICAL BURN	0.1730	0.8270	0.7650	0.0620
EYE CORNEAL ULCER	0.9966	0.0034	0.0033	0.0000
EYE INFECTION	0.2318	0.7682	0.7068	0.0615
EYE IRRITATION/ABRASION	0.0000	1.0000	0.9950	0.0050
EYE PENETRATION (FOREIGN BODY)	0.9999	0.0001	0.0000	0.0000
FINGER DISLOCATION	0.7465	0.2535	0.2523	0.0013
GASTROENTERITIS	0.3105	0.6895	0.6343	0.0552
HEAD INJURY	0.9966	0.0034	0.0015	0.0019
HEADACHE (CO2 INDUCED)	0.0029	0.9971	0.9722	0.0249
HEADACHE (LATE)	0.0000	1.0000	0.9900	0.0100
HEADACHE (SPACE ADAPTATION)	0.1775	0.8225	0.7731	0.0493
HEARING LOSS	0.2073	0.7927	0.4955	0.2973
HEMORRHOIDS	0.5572	0.4428	0.4406	0.0022
HERPES ZOSTER REACTIVATION (SHINGLES)	0.7465	0.2535	0.2180	0.0355

HIP SPRAIN/STRAIN	0.2982	0.7018	0.6877	0.0140
HIP/PROXIMAL FEMUR FRACTURE	0.9967	0.0033	0.0002	0.0031
HYPERTENSION	0.9496	0.0504	0.0446	0.0058
INDIGESTION	0.1730	0.8270	0.7691	0.0579
INFLUENZA	0.7465	0.2535	0.1901	0.0634
INSOMNIA (SPACE ADAPTATION)	0.0913	0.9087	0.9042	0.0045
KNEE SPRAIN/STRAIN	0.1204	0.8796	0.8620	0.0176
LOWER EXTREMITY (LE) STRESS FRACTURE	0.7146	0.2854	0.2526	0.0328
LUMBAR SPINE FRACTURE	0.9984	0.0016	0.0013	0.0003
MEDICATION OVERDOSE/ADVERSE REACTION	0.5572	0.4428	0.4406	0.0022
MOUTH ULCER	0.0720	0.9280	0.8816	0.0464
NASAL CONGESTION (SPACE ADAPTATION)	0.0294	0.9706	0.9657	0.0049
NECK SPRAIN/STRAIN	0.0657	0.9343	0.9156	0.0187
NEPHROLITHIASIS	0.9688	0.0312	0.0189	0.0123
NEUROGENIC SHOCK	1.0000	0.0000	0.0000	0.0000
NOSE BLEED (SPACE ADAPTATION)	0.9643	0.0357	0.0344	0.0012
OTITIS EXTERNA	0.4159	0.5841	0.5753	0.0088
OTITIS MEDIA	0.4159	0.5841	0.5256	0.0584
PHARYNGITIS	0.0401	0.9599	0.9167	0.0432
RESPIRATORY INFECTION	0.0001	0.9999	0.9849	0.0150
RETINAL DETACHMENT	0.9990	0.0010	0.0004	0.0006
SEIZURES	0.9978	0.0022	0.0019	0.0003
SEPSIS	0.9810	0.0190	0.0126	0.0064
SHOULDER DISLOCATION	0.9997	0.0003	0.0000	0.0003
SHOULDER SPRAIN/STRAIN	0.0013	0.9987	0.9787	0.0200
SKIN ABRASION	0.0000	1.0000	0.9450	0.0550
SKIN INFECTION	0.0223	0.9777	0.9434	0.0342
SKIN LACERATION	0.7465	0.2535	0.0634	0.1901
SKIN RASH	0.0000	1.0000	0.9950	0.0050
SLEEP DISORDER	0.0000	1.0000	0.9950	0.0050
SMALL BOWEL OBSTRUCTION	0.9904	0.0096	0.0084	0.0012
SMOKE INHALATION	0.8653	0.1347	0.1158	0.0189
SPACE MOTION SICKNESS (SPACE ADAPTATION)	0.0053	0.9947	0.8455	0.1492
STROKE (CEREBROVASCULAR ACCIDENT)	0.9922	0.0078	0.0051	0.0027
SUDDEN CARDIAC ARREST	0.9997	0.0003	0.0001	0.0002
TOXIC EXPOSURE (AMMONIA)	0.9987	0.0013	0.0000	0.0013
TRAUMATIC HYPOVOLEMIC SHOCK	0.9949	0.0051	0.0030	0.0021
URINARY RETENTION (SPACE ADAPTATION)	0.9724	0.0276	0.0234	0.0041
URINARY TRACT INFECTION	0.2584	0.7416	0.7045	0.0371
VISUAL IMPAIRMENT AND/OR INCREASED INTRACRANIAL PRESSURE (VIIP)(SPACE ADAPTATION)	0.1887	0.8113	0.7545	0.0568
WRIST FRACTURE	0.9813	0.0187	0.0149	0.0038
WRIST SPRAIN/STRAIN	0.2204	0.7796	0.7679	0.0117

SUMMARY

This service request provides estimates of the TME, CHI, probability of EVAC and LOCL for 5 DRMs using a MedCap that is baselined to the ISS. The main outcomes and top 10 Influential Conditions for EVAC and LOCL for the Treated, Untreated, and MedCap scenarios are reported for each DRM. The IMM is baselined to the ISS environment. Therefore, caution should be used when using the IMM to assess Cis-lunar medical risk.

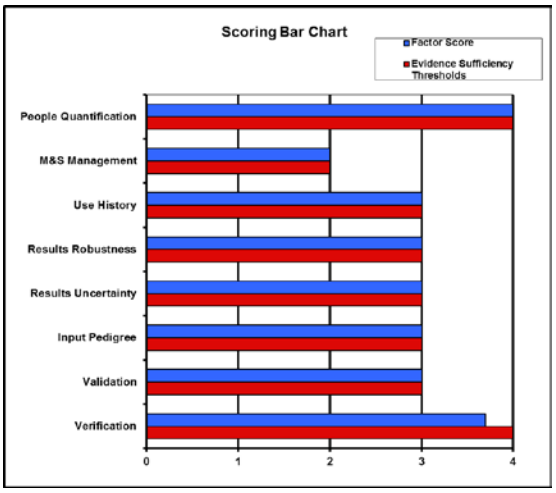
REFERENCES

1. Integrated Medical Model Project. Integrated Medical Model Operations Plan. JSC-66114. 2011. Houston, TX, NASA, Johnson Space Center, (document update in progress).
2. Integrated Medical Model Project. Integrated Medical Model Functional Requirements Document. JSC-66110. 2011. Houston, Texas, NASA, Johnson Space Center, (document update in progress).
3. Integrated Medical Model Project. Integrated Medical Model v3 Technical Description Report. JSC-xxxxx. 2015. Houston, TX, NASA JSC, (document update in progress).
4. NASA technical standard for models and simulations 7009 (NASA STD 7009). 1-58. 7-11-2008 (reapproved 7-10-2013). Washington D.C., NASA.
5. ISS Medical Checklist (Med CL), 04 June 2014, NASA Johnson Space Center, Medical Operations Group.

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 v3.0 MATLAB status of IMM validation for each IMM element listed.



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.

Compliant	Compliance Incomplete	Not applicable
36	5	5

Current NASA-Standard-7009 credibility assessment score

IMM Credibility Matrix: The following table shows the overall IMM v3.0 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.

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	

Legend from NASA-STD-7009	
	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***

Additional verification and validation information applicable to this analysis

none

Integrated Medical Evidence Database (iMED) code version and date accessed

iMED Lockdown ID: (26), created on (2/21/2017)

IMM version and code version

Data analysis for this report was generated using IMM v3.0 with release 2014a 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: LIST OF THE CURRENT 100 MEDICAL CONDITIONS USED IN THE IMM.

ENVIRONMENTAL
Acute Radiation Syndrome
Altitude Sickness
Barotrauma (ear/sinus block)
Burns secondary to Fire
Decompression Sickness Secondary to EVA
Eye Chemical Burn
Headache (CO_2 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 (LE) 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 adaption)
Urinary Retention (space adaptation)
Urinary Tract Infection
Vaginal Yeast Infection
Visual Impairment and Increased Intracranial Pressure (VIIIP) (space adaptation)