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Subject: Medical Updates #5 to the International Space Station Probability Risk Assessment (PRA) Model Using the Integrated Medical Model

The Integrated Medical Model (IMM) Project has been developing a probabilistic risk assessment tool, the "IMM," to help evaluate in-flight crew health needs and impacts to the mission due to medical events. Based on our discussions, it is anticipated that the IMM can help support the ISS PRA Office in future medical risk assessments and updates to existing estimates of medical risk. This package is a follow-up to a data package provided in June 2009. The IMM currently represents 83 medical conditions and associated ISS resources required to mitigate medical events. IMM end state forecasts relevant to the ISS PRA model include evacuation (EVAC) and loss of crew life (LOCL). The current version of the IMM provides the basis for the operational version of IMM expected in the January 2011 timeframe. ***This data package should be used for informational and non-decisional purposes only until review and approval by the Space Medicine Configuration Control Board***.

The objectives of this data package are listed below:

1. To provide a preliminary understanding of medical risk data used to update the ISS PRA Model. The IMM has had limited validation and an initial characterization of maturity has been completed using NASA STD 7009 Standard for Models and Simulation. The IMM has been internally validated by IMM personnel but has not been validated by an independent body external to the IMM Project.

2. To support a continued dialogue between the ISS PRA and IMM teams. To ensure accurate data interpretation, and that IMM output format and content meets the needs of the ISS Risk Management Office and ISS PRA Model, periodic discussions are anticipated between the risk teams.

3. To help assess the differences between the current ISS PRA and IMM medical risk forecasts of EVAC and LOCL. Follow-on activities are anticipated based on the differences between the current ISS PRA medical risk data and the latest medical risk data produced by IMM.

The following data package provides the first step to updating the ISS PRA mission risk data due to medical events aboard the ISS, and includes a brief discussion on IMM background, methods, and summary results. Appendix A organizes all medical conditions by one of three categories to help communication with non-clinical personnel. Appendix B discusses the basis of the LOCL and EVAC data forecasted by IMM by comparing forecasted data with historical space flight data and appropriate analog ground data.

Background

The Integrated Medical Model (IMM) simulates medical events during space flight missions and estimates the impact of these events on crew health and mission success. The IMM is a stochastic model that uses Monte Carlo (MC) methodology to simulate missions.

The model 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 predefined probability distributions. Finally, total crew health and mission impact outcomes are summarized. For this report, the primary outcomes are crew evacuation and loss of crew life.

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.

Methods

ISS Reference Mission 1 (RFM1) was simulated using the IMM. The mission is six months in duration with six crew members, three extravehicular activities (EVA), and assumes medical resources from the current medical kit on the ISS. The medical resources are vital to understanding IMM output because insufficient resources will result in untreated medical conditions. Untreated medical conditions typically have an increased probability of evacuation and loss of crew life. Forty thousand missions were simulated.

Currently, eighty-three medical conditions are included in the model (See Appendix A for conditions, by category). The probabilities of medical events occurring during simulated missions are based on historical mission data, cohort data, and the opinion of Subject Matter Experts (SME).

In-flight mitigations are assumed to follow a specified protocol, and alternative mitigations such as untreated scenarios are considered. Mitigations for each condition are constrained by resource availability. For each condition, a set of medical resources are defined that are used to treat the condition. Medical conditions are not treated unless all essential resources are available for a specified mitigation.

The IMM end states include evacuation (EVAC), and loss of crew life (LOCL), as well as crew health index (CHI), which is a relative measure of crew impairment and useful when comparing crew health states for different mission profiles. "EVAC" in the context of IMM should be interpreted to mean an evacuation from the ISS would be considered. EVAC is considered as an end state result if any of the following criteria are met: 1) Potential LOCL; 2) Potential significant permanent impairment; or 3) Potential intractable pain. In addition, 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 could result in death of the affected crew member. These assumptions are anticipated to result in slightly conservative (high) IMM forecasts of EVAC and LOCL.

Analysis Software: SAS 9.1

The data analysis for this paper was generated using SAS software, Version 9.1 of the SAS System for Windows. SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.

Results

The simulation results for 40,000 trials of Reference Mission 1 (RFM1) are displayed in Table 1. An average of 93.2 medical conditions occurred per trial. When using current ISS medical resources, there was evacuation in 8.6% of the missions and loss of crew life in 1.3% of the missions. When considering a fully treated scenario, there was evacuation in 4.6% of the missions and loss of crew life in 1.1% of the missions.

The greatest percentage of evacuation and loss of crew life was due primarily to untreated conditions and/or worst-case scenarios. Conditions are untreated in the model when the essential resources for treatment are not available and are more likely to result in evacuation or loss of crew life. Once a condition occurs, it will follow either a best- or a worst-case scenario based on a probability distribution. Worst-case scenarios generally require more resources for treatment and have higher probabilities of ending in evacuation or loss of crew life.

Medical illnesses were associated with the greatest percentage of evacuations. The most common medical illnesses leading to evacuation in the treated scenario were dental abscess, sepsis, kidney stones, stroke, atrial fibrillation, and acute chest pain/angina. In the injury/trauma category, hypovolemic shock and wrist fracture were the most frequent. For the environmental category, smoke inhalation and toxic exposure predominated.

Environmental conditions were associated with the greatest percentage of loss of crew life. The most frequent environmental conditions leading to loss of crew life were smoke inhalation and toxic exposure. For the medical category, sepsis was the most frequent. In the injury/trauma category, head injury and hypovolemic shock predominated.

Table 1: Percent of missions with at least one evacuation (EVAC) or loss of crew life (LOCL), by condition category, level of resource availability, and 95% Confidence Interval (CI). Data are summarized for 100,000 simulated missions. Additional statistical data for the unlimited resources category are available in Appendix D.

ISS Resources

Category	Mean Probability of EVAC	95% CI		Mean Probability of LOCL	95% CI	
		Lower Bound	Upper Bound		Lower Bound	Upper Bound
All Conditions	8.59%	8.43%	8.78%	1.29%	1.22%	1.35%
Medical Illness	4.64%	4.50%	4.78%	0.46%	0.42%	0.50%
Injury/Trauma	2.73%	2.61%	2.83%	0.15%	0.12%	0.17%
Environmental	1.48%	1.40%	1.55%	0.69%	0.64%	0.74%

Unlimited ISS Resources

Category	Mean Probability of EVAC	95% CI		Mean Probability of LOCL	95% CI	
		Lower Bound	Upper Bound		Lower Bound	Upper Bound
All Conditions	4.61%	4.55%	4.68%	1.08%	1.06%	1.10%
Medical Illness	3.17%	3.11%	3.23%	0.34%	0.33%	0.36%
Injury/Trauma	0.66%	0.63%	0.69%	0.14%	0.13%	0.15%
Environmental	0.83%	0.83%	0.84%	0.60%	0.60%	0.61%

Assumptions

The model does not include a mission timeline, all conditions occur on day one. Medical conditions are independent of each other; a mission could end in more than one evacuation or loss of crew life being considered for the same crew member. Conditions are treated in order of incidence and crew member count (i.e., crew member one is treated before crew member two for any given condition). When there are insufficient *essential* medical resources to treat a condition, all available resources are consumed to reflect a partial treatment, and the treatment is considered untreated.

Comparison with the ISS PRA model

A potential use of the IMM is support of the ISS Probability Risk Assessment (PRA). The IMM ISS resources scenario does not take into account the availability of Russian medical resources or the ability to resupply depleted medical resources. The ISS PRA model assumes that medical resources are available at least 98 percent of the time. Therefore, the IMM unlimited resources scenario provides a more valid comparison of the IMM to the ISS PRA model. Table 2 is a comparison of the current estimates of EVAC and LOCL due to medical events for a 6-crew, 6-month mission from the IMM and the ISS PRA models. The IMM estimates for both EVAC and LOCL are consistently higher, by an order of magnitude, than the ISS PRA estimates. While this difference should be a point for further discussion, an initial literature review supports the validity of the higher IMM estimates (See *Internal Validation of the Integrated Medical Model Outputs of Evacuation and Loss of Crew Life*).

Table 2: Comparison of the estimates of EVAC and LOCL due to medical events for a 6-crew, 6-month ISS mission from the IMM unlimited resources scenario and the ISS PRA models.

Endstate	IMM	PRA	Factor Change
EVAC	4.61E-02	3.51E-03	13x
LOCL	1.08E-02	1.73E-03	6x

The categories of medical conditions that contribute to EVAC and LOCL are displayed in Figures 1 and 2. These categories are not standardized and direct comparison to the ISS PRA model may not be valid.

Figure 1: Ranking of contributors to EVAC by disease category for the 6-crew, 6-month ISS mission. Of the trials that ended in evacuation, 70% were due to a medical illness, and 14% and 16% were due to the injury/trauma and environmental categories respectively.

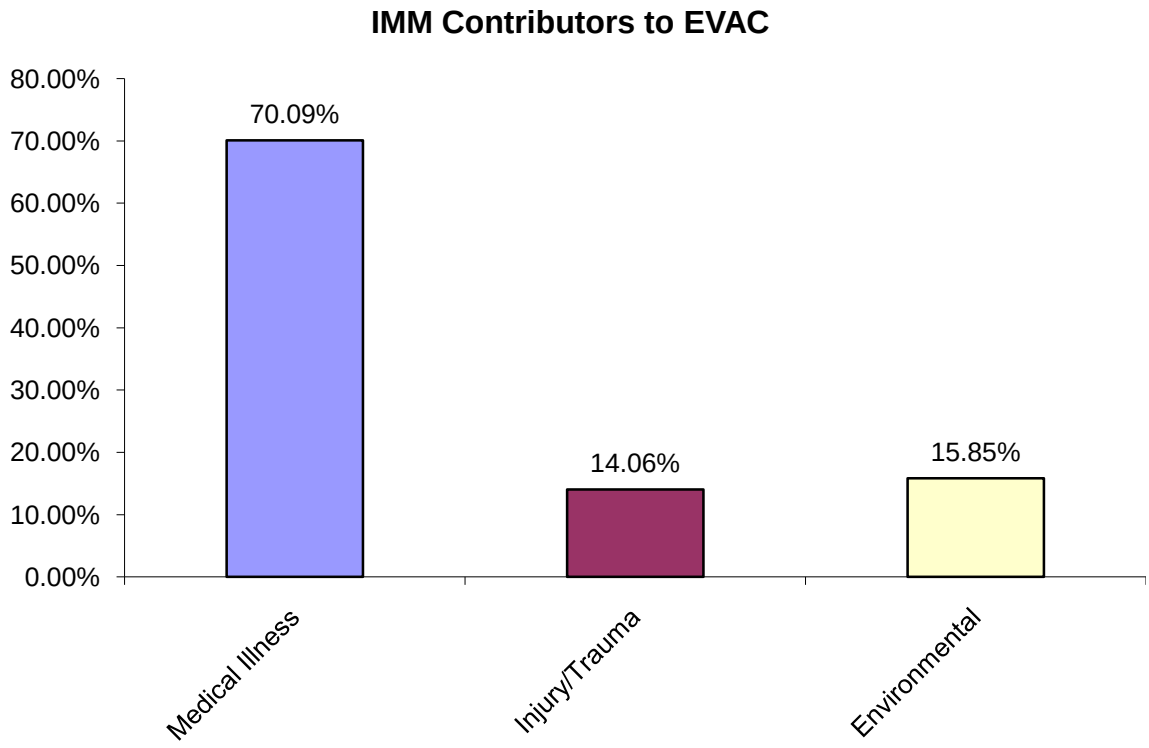
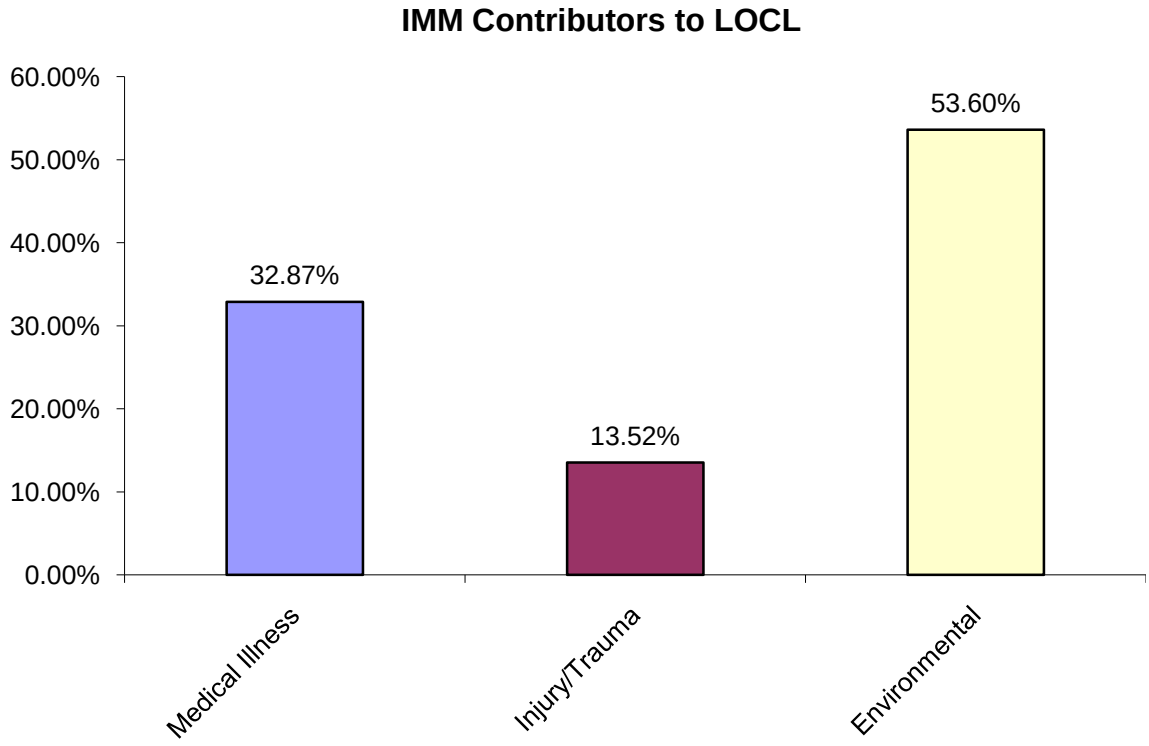


Figure 2a and 2b: Ranking of contributors to LOCL by disease category for the 6-crew, 6-month ISS mission. Of the trials that ended in loss of crew life, 54% were due to an environmental condition, and 33% and 14% were due to the medical illness and injury/trauma categories respectively.



Appendix A

Medical Conditions in IMM by Category

Environmental
Acute Radiation Syndrome
Altitude Sickness
Burns
Decompression Sickness (EVA)
Barotrauma (ear/sinus block)
Eye Chemical Burn
Headache (CO_2 induced)
Smoke Inhalation
Toxic Exposure (skin/eye/inhalation/ingestion)

Injury/Trauma
Abdominal Injury
Back Injury
Chest Injury/Pneumothorax
Eye Abrasion (foreign body)
Eye Penetration (foreign body)
Elbow Dislocation
Finger Dislocation
Shoulder Dislocation
Fingernail Delamination (EVA)
Hip/Proximal Femur Fracture
Lumbar Spine Fracture
Wrist Fracture
Head Injury (traumatic brain injury)
Neck Injury
Paresthesias/Hot Spots (EVA)
Hypovolemic Shock
Neurogenic Shock
Skin Abrasion/Laceration
Ankle Sprain/Strain
Elbow Sprain/Strain
Hip Sprain/Strain
Knee Sprain/Strain
Shoulder Sprain/Strain
Wrist Sprain/Strain

Medical Illness
Acute Chest Pain/Angina
Pharyngitis
Acute Prostatitis
Allergic Reaction (mild to moderate)
Anxiety
Appendicitis
Atrial Fibrillation
Back Pain (space adaptation)
Behavioral Emergency
Choking (foreign body inhalation)
Constipation (space adaptation)
Eye Corneal Ulcer
Cough (URI/bronchitis/pneumonia)
Dental: Crown Replacement
Depression
Diarrhea
Dental Abscess
Eye Infection (bacterial/viral/fungal)
Gastroenteritis
Headache (space adaptation)
Hemorrhoid
Herpes Zoster Reactivation (shingles)
Indigestion
Late Insomnia (non-space adaptation)
Early Insomnia (space adaptation)
Acute Glaucoma (angle-closure glaucoma)
Mouth Ulcer/Cold Sore
Nasal Congestion (space adaptation)
Nosebleed (space adaptation)
Otitis Externa
Otitis Media
Kidney Stones
Seizures
Anaphylaxis (severe allergic reaction)
Cardiogenic Shock
Sepsis
Sinus Infection
Skin Infection
Skin Rash
Medication Overdose/Misuse
Space Motion Sickness (space adaptation)
Stroke (cerebrovascular accident)
Sudden Cardiac Arrest (secondary to myocardial infarction)
Dental: Temporary Filling
Dental: Total Avulsion/Complete Tooth Loss
Dental: Toothache
Female Urinary Incontinence (space adaptation)
Urinary Retention (space adaptation)
Urinary Tract Infection
Vaginal Yeast Infection

Appendix B

Internal Validation of the Integrated Medical Model Outputs of Evacuation and Loss of Crew Life

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Acronym Definitions

EVAC: Evacuation[1]
IMM: Integrated Medical Model
ISS: International Space Station
LOCL: Loss of Crew Life[1]
LSAH: Longitudinal Study of Astronaut Health
PRA: Probabilistic Risk Assessment

[1] For the purposes of the Integrated Medical Model, the terms EVAC and LOCL refer to medical evacuation and crew death, respectively, due to illness or injury. Although environmental factors, such as toxic exposures are included as possible causes of EVAC and LOCL, catastrophic vehicle failures, such as the *Challenger* explosion and MMOD (micrometeorite and orbital debris) are not considered as possible causes of EVAC and LOCL.

Introduction

To date, there have been no episodes of EVAC or LOCL during an ISS mission. Therefore, either analogue population studies or modeling are required to estimate the probability of EVAC and LOCL for ISS missions. Both the ISS PRA and the IMM use modeling (computer simulations) to estimate EVAC and LOCL probabilities for ISS missions.

The IMM estimates of EVAC and LOCL are considerably higher than the ISS PRA estimates. To validate the IMM estimates of EVAC and LOCL, evidence-based literature was reviewed.

EVAC

The IMM forecasts a medical evacuation rate of 0.015 events per person-year in the fully treated scenario and a medical evacuation rate of 0.029 events per person-year in the ISS medical resources scenario for missions of six-months duration with a six-person crew.[2]

A review of the evidence-based literature reveals estimated medical evacuation rates for ISS missions ranging from a low of 0.01 events per person-year to a high of 0.072 events per person-year (1). These evacuation rates are based on analyses of medical emergency rates of the astronaut population both in-flight and terrestrially, as well as medical emergency rates of analogue populations. Analyses included studies of general population medical emergency rates, Antarctic McMurdo Station medical evacuation rates, United States submarine medical evacuation rates, Russian Space Program medical evacuation rates, and LSAH rates of serious illness and injury among the astronaut population.

The general population medical emergency rate is usually considered to be about 0.06 events per person-year (1). However, this rate may not be directly applicable to the current ISS program due to the stringent medical screening criteria for ISS astronauts.

Antarctic stations are useful analogues to study in preparation for space exploration programs since the general crew health and isolated environment may reflect the conditions faced by astronauts on space flight missions. Similar to space flight missions, Antarctic stations are so remote that they require stand-alone medical care capabilities. In addition, Antarctic populations are medically screened and have been shown to have epidemiological characteristics similar to the astronaut population. Antarctic McMurdo Station medical evacuation rates have been studied retrospectively from 1992 to 1996. Over five summer

deployments, each lasting 4 months and with 1,200 individuals, 71 medical evacuations occurred, resulting in an incidence rate of 0.036 events per person-year (2).

[2] The IMM forecasted EVAC rate for a six-month ISS mission with six crew members is based on the current ISS medical system. The ISS medical system redesign should result in a lower forecasted EVAC rate.

United States submarine crews are another useful analogue population since they are similar to the astronaut population in terms of general health and medical screening. They also require stand-alone medical care capabilities due to the isolated remote environment in which they operate. United States submarine medical evacuation rates from 1993 to 1996 ranged from 0.023 to 0.028 events per person-year (3).

Past space flight medical evacuations also may be useful for estimating the probability of future space flight medical evacuations. During the 41.5 person-years of space flight in the Russian Space Program, three cosmonauts have required medical evacuation (1). This results in a medical evacuation rate of 0.072 events per person-year. Limiting this assessment to only the Mir space station, one medical evacuation occurred in 31 person-years of space flight, resulting in a medical evacuation rate of 0.032 events per person-year (1). Considering that the total human space flight time to date is approximately 83 person-years, the estimated medical evacuation rate is 0.036 events per person-year.

A retrospective review of LSAH data conducted in 1999 estimated the incidence of illness and injury among astronauts while they were not on active duty. To predict the effect of each medical event on an ISS mission, illnesses and injuries were classified according to likelihood, medical treatment required, and mission impact if the illness or injury were to occur during space flight (1,4). This analysis provides valuable information regarding the probability of a medical event requiring evacuation from the ISS. After organizing the medical conditions into classes based on severity and likelihood of requiring evacuation, an anticipated medical evacuation incidence of 0.02 events per person-year was determined (1,4). It was assumed that the ISS Health Maintenance System could treat less severe medical conditions, reducing the probability of a medical evacuation to 0.01 events per person-year (1,4).

Initial medical risk assessments for Space Station Freedom performed in 1990 estimated significant medical illness occurrence rates of 1-3 per person-year with about 1 percent of these medical events requiring evacuation (5). This results in an estimated medical evacuation rate of 0.01 to 0.03 events per person-year.

A sensitivity analysis of the IMM output of EVAC indicated that medical illnesses were associated with the greatest percentage of ISS evacuations. This is consistent with the medical evacuations that have occurred in the Russian Space Program (6). There have been three medical evacuations in the Russian Space Program, two due to medical illnesses (urosepsis and cardiac arrhythmia), and one due to smoke inhalation (a combustion event causing intractable headaches). There also have been three close calls, in which medical evacuations were being considered, but were not required due to improvement of the medical condition. Two of these conditions were medical illnesses (kidney stone and dental abscess), and one was a toxic exposure (ethylene glycol). All of the medical conditions that have either resulted in evacuation or close calls were forecasted by the IMM as probable causes of EVAC.

LOCL

The IMM forecasts a LOCL rate of 0.0036 events per person-year in the fully treated scenario and a LOCL rate of 0.0043 events per person-year in the ISS medical resources scenario for a six-person, six-month ISS mission.

The IMM forecasted LOCL rates for ISS missions can be compared to general population mortality rates and age-specific mortality rates. The general population mortality rate is 0.0081 deaths per person-year (2006 CDC National Vital Statistics Reports). The age-specific mortality rate is 0.0047 for a 48-year old male and 0.0028 for a 48-year old female (2006 Social Security Period Life Table). Severe chronic

medical conditions and motor vehicle accidents are significant contributors to mortality in the terrestrial population. However, in the astronaut population, severe chronic medical conditions are disqualifying for ISS missions and motor vehicle accidents are not possible on the ISS. Therefore, these causes of mortality can be subtracted from the terrestrial general population mortality rate to obtain a more valid comparison mortality rate. Subtracting deaths caused by severe chronic diseases (i.e., chronic obstructive pulmonary disease and liver disease) and accidents from the terrestrial population ages 45 to 54 years, results in a mortality rate of 0.0031. Considering the current average astronaut age of 48, the IMM forecasted LOCL rates are consistent with these age-specific mortality rates.

Since the space flight environment is profoundly different from the terrestrial environment, and since the astronaut population is intensively selected and screened for preexisting illnesses, mortality rates of the general terrestrial population may not be directly applicable to mortality rates for space flight. Therefore analogue populations, such as Antarctic station populations may be useful in estimating mortality rates for space flight missions. An estimated overall mortality rate of 0.0054 deaths per person-year was determined from an Antarctic Station population of 7,700 between 1904 and 1964 (2). This rate is consistent with the IMM forecasted LOCL rates for ISS missions.

U.S. astronaut mortality data may be the most useful for estimating mortality rates for astronauts on ISS missions. There have been 32 astronaut deaths from January 1, 1980 through June 30, 2009 (7). Subtracting the 11 deaths within this population that were the result of catastrophic vehicle failure (*Challenger* explosion in 1986 and the *Columbia* accident in 2003) results in a mortality rate of 0.0034 deaths per person-year (21 deaths within 6144.8 person-years). Again, this rate is consistent with the IMM forecasted LOCL rates for ISS missions.

Summary

The EVAC rates forecasted by the IMM for a six-month, six-crew member ISS mission (0.015 events per person-year in the fully treated scenario and 0.029 events per person-year in the ISS medical resources scenario) are within the range of the estimated medical evacuation rates of the evidence-based literature (0.01 to 0.072 events per person-year). In addition, the medical conditions forecasted by the IMM as probable causes of EVAC on ISS missions are consistent with historical space flight medical events that have either resulted in medical evacuations or close calls.

The LOCL rates forecasted by IMM for a six-month ISS mission (0.0036 events per person-year in the fully treated scenario and 0.0043 events per person-year in the ISS medical resources scenario) are also within the range of the estimated mortality rates of the evidence-based literature (0.0028 to 0.0081 events per person-year).

Based on the IMM estimated EVAC rate of 0.029 events per person-year for a six-person, six-month ISS mission with the current ISS medical system, approximately one medical evacuation would be expected per 34 person-years. Assuming a 15-year operational life for ISS, with a three-person crew for the first 10 years and a six-person crew for the next 5 years, one to two medical evacuations would be expected. This estimate is consistent with a risk analysis based on crew size, work activities, analog populations, and previous space flight experience that projected one to two medical evacuations within the 15-year lifetime of the ISS (8).

Conclusion

A review of the evidence-based literature validates the IMM outputs of EVAC and LOCL.

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Appendix C: Additional Simulations for the ISS PRA Update

Table 3: Percent of missions with at least one evacuation (EVAC) or loss of crew life (LOCL), by condition category, level of resource availability, and 95% Confidence Interval (CI). Data are summarized for 40,000 simulated missions.

3-crew 6-month mission

Category	EVAC (%)	95% CI	LOCL (%)	95% CI
ISS Resources				
All Conditions	**2.64**	**2.50-2.81**	**0.68**	**0.60-0.76**
Medical Illness	1.81	1.69-1.94	0.26	0.21-0.31
Injury/Trauma	0.32	0.27-0.38	0.06	0.03-0.09
Environmental	0.52	0.45-0.59	0.35	0.30-0.41
Unlimited Resources				
All Conditions	**2.27**	**2.14-2.42**	**0.53**	**0.46-0.60**
Medical Illness	1.59	1.46-1.70	0.19	0.15-0.23
Injury/Trauma	0.29	0.23-0.34	0.06	0.04-0.09
Environmental	0.40	0.34-0.47	0.29	0.24-0.35

Table 4: Percent of missions with at least one evacuation (EVAC) or loss of crew life (LOCL), by condition category, level of resource availability, and 95% Confidence Interval (CI). Data are summarized for 40,000 simulated missions.

1-crew, 6-month mission

Category	EVAC (%)	95% CI	LOCL (%)	95% CI
ISS Resources				
All Conditions	**0.83**	**0.75-0.92**	**0.21**	**0.17-0.26**
Medical Illness	0.56	0.49-0.64	0.07	0.04-0.10
Injury/Trauma	0.15	0.11-0.19	0.03	0.02-0.05
Environmental	0.13	0.09-0.17	0.11	0.08-0.14
Unlimited Resources				
All Conditions	**0.81**	**0.72-0.90**	**0.18**	**0.15-0.22**
Medical Illness	0.53	0.47-0.61	0.05	0.03-0.08
Injury/Trauma	0.13	0.10-0.17	0.03	0.02-0.05
Environmental	0.14	0.11-0.18	0.10	0.07-0.13

Appendix D: Statistical Data for ISS PRA SAPHIRE

Two of the primary outcomes for the IMM, evacuation and loss of crew life, are calculated as point estimates for a given simulation (i.e., the probability of evacuation is 4.5%). This point estimate is generated from a 0/1 outcome for both evacuation and loss of crew life for a given trial in a simulation (i.e., either one or more EVAC or LOCL occur (1), or they do not occur (0)).

For the ISS PRA, a tolerance interval for and/or a histogram of the distributions of the probability of evacuation and loss of crew life was the preferred measures of uncertainty. To create the tolerance intervals and histograms, a set of medical events was randomly generated using the model incidence rate and occurrence probability distributions. For each unique set of events (referred to as a "batch"), the evacuation and loss of crew life outcomes were then randomly generated 5,000 times. This process generated a point estimate for the probability of evacuation and loss of crew life for each batch. One hundred thousand batches were then run, generating a distribution of evacuation and loss of crew life probabilities from which a 90% tolerance interval and histogram was generated (Table 1 and Figure 1). For the purposes of this analysis, a 90% tolerance interval was defined as the 5^{th} and 95^{th} percentiles of the distribution of the evacuation and loss of crew life probabilities generated by the model.

The histograms and their associated data tables for evacuation and loss of crew life for all conditions and by category are provided in a separate Excel file.

Table 5: Evacuation and Loss of Crew Probabilities for a 6-month, 6-crew ISS mission in **the Fully Treated Scenario.** 100,000 Batches of 5,000.

Category	**Mean Probability of Endstate**	**95% Confidence Interval**		**Variance**	**90% Tolerance Interval**	
EVAC		**Lower Bound**	**Upper Bound**		**5^{th} Percentile**	**95^{th} Percentile**
All Conditions	4.61E-02	4.55E-02	4.68E-02	1.11E-02	3.00E-03	2.62E-01
Medical Illness	3.17E-02	3.11E-02	3.23E-02	9.08E-03	8.00E-04	2.53E-01
Injury/Trauma	6.59E-03	6.29E-03	6.89E-03	2.30E-03	6.00E-04	4.40E-03
Environmental	8.33E-03	8.26E-03	8.40E-03	1.26E-04	0.00E+00	3.00E-02
LOCL						
All Conditions	1.08E-02	1.06E-02	1.10E-02	9.39E-04	0.00E+00	2.74E-02
Medical Illness	3.41E-03	3.27E-03	3.55E-03	5.10E-04	0.00E+00	5.20E-03
Injury/Trauma	1.41E-03	1.29E-03	1.53E-03	3.73E-04	0.00E+00	0.00E+00
Environmental	6.02E-03	5.97E-03	6.07E-03	7.14E-05	0.00E+00	2.44E-02

Associated Excel File: Histogram_Tables_01052011.

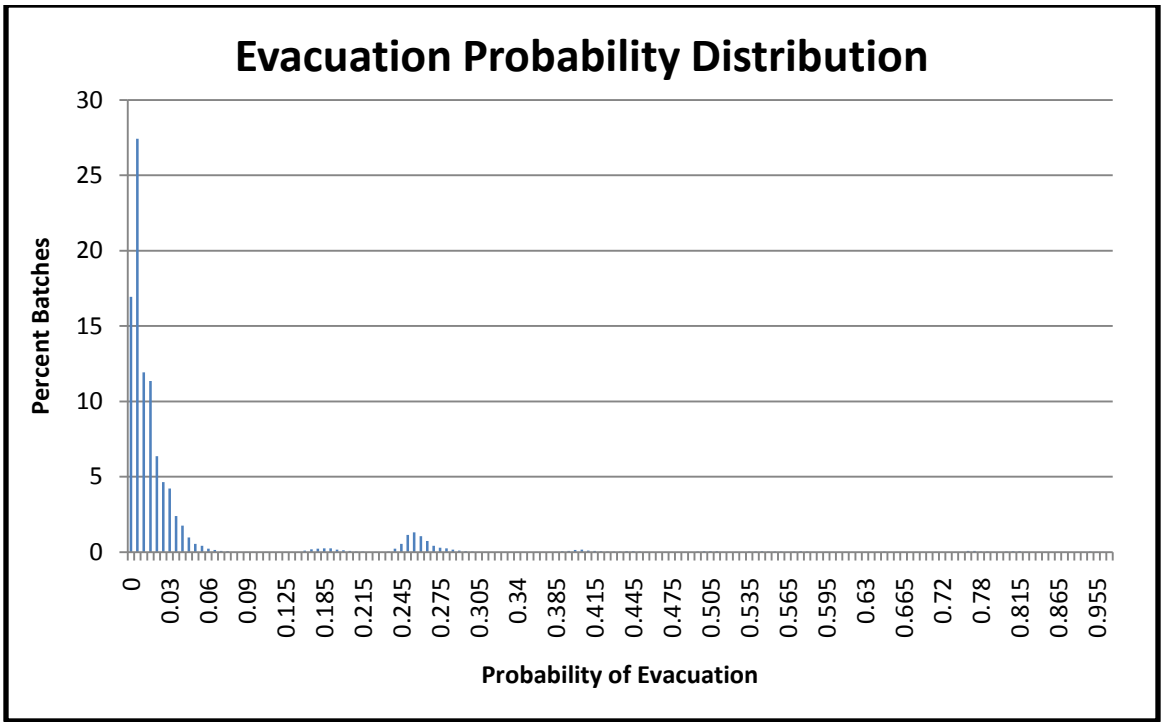

Figure 1: Example of histogram describing the distribution of the probability of evacuation for a 6-month, 6-crew mission. The bimodal distribution can be attributed to the divergence of the evacuation probabilities between best- and worst-case scenario conditions. Additional tables and histograms are in an attached Excel file.