

Behavioral Emergency Cliff

Branch Baseline

NASA considers any behavioral condition or psychiatric disorder that causes serious behavioral or cognitive symptoms leading to incapacitation and/or severe mission impact as a behavioral emergency. Examples include the development of delirium due to a head injury, or a brief psychotic disorder following a tragic event such as the death of a family member or an international catastrophe. To date, no behavioral emergencies have occurred before, during or after any U.S. space flight. As the length of space missions increases, the probability of a behavioral and psychiatric emergency occurring also increases. (Slack, 2009)

Incidence Data Included in the Model

The model imports the following incidence information from the IMM database: incidence data category, space adaption status, incidence data, incidence and occurrence distribution data and incidence data characteristics. Data category defines the type of data available for incidence calculations (i.e. raw data vs. fixed data). Space adaptation identifies medical events that onset occurs in the first 5 days of flight and does not reoccur. Incidence values vary by data category and define the number of medical events per person-year or medical events per person-at-risk for each medical condition. Incidence values can be modified by crew characteristics such as gender. Modifying characteristics are noted below and incidence values are listed individually for each characteristic. Distributions are assigned to medical events incidence values and occurrences in the model. For each crew member in a given trial, the incidence and number of occurrences of each medical condition are randomly selected from these probability distributions. Detailed descriptions of the distributions are included in the IMM Technical Description Document.

Incidence

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

Distribution Data

Incidence:	Fixed
Occurrence:	Poisson

Data Characteristics

Fixed Rate:	1.43E-05
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Incidence Comments

No incidents have occurred in space flight. (Walton, 2010) Lacking phenomenological data, we searched for conditions that could be similar or cause serious behavioral or cognitive symptoms leading to incapacitation and severe mission impact that could be referred as a behavioral emergency.

There is sparse data on mental health conditions in general and in transient disorders specifically. Some US military recruits who are subjected to relatively uniform levels of stress in a monitored environment over a specified time period develop transient, severe psychotic symptoms consistent with a diagnosis of brief reactive psychosis. Six cases were found among 557 consecutive psychiatric admissions between January 1, 1988, and January 1, 1991 (annual incidence = 1.43 cases per 100,000 recruits). An apparent temporal relationship was found between the onset of the stressor (basic military training) and the development of psychosis. (Beighley, 1992). Annual incidence per person is 0.0000143

Information Regarding Prevention

Selection criteria

Disqualifying conditions include: Any behavior or mental condition that in the opinion of the MSMB makes or is likely to make the individual a hazard to flight safety, crew coordination, or mission execution. The following disorders or history thereof are permanently disqualifying for ISS duties: psychotic, bipolar, dissociative, impulse control, somatoform, factitious hallucinogen persisting perceptual disorder, paraphilia, abuse or neglect of a child or adult. Disorders that interfere with social or occupational functioning or that require ongoing treatment, Narcolepsy, and Personality Disorder. Delirium, Dementia, Amnesia. Adjustment Disorder, if the episode exceeded 6 months, hospitalization was required, three or more episodes have occurred, and use of psychiatric medications (other than symptomatic use of anxiolytics or hypnotics for a period of less than 30 days). Gender Identity Disorder. Substance Abuse or Dependence. (Note: Nicotine-related Disorders are not necessarily disqualifying.) History of a Substance Abuse or Dependence. (Note: Consideration for waiver requires completion of an approved treatment program, total abstinence for at least 90 days after the program, and active participation in an after-care program.) Characterological behaviors that show evidence of immaturity, instability, impulsiveness, lack of judgment, or an impaired capacity to adapt to stressful situations. (International Space Station Program, 2009)

Incidence Level of Evidence (LOE)

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

Citation	LOE Value	LOE Category
Beighley, 1992	2	Incidence

Incidence data not included in the model

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

Incidence

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

Distribution Data

Incidence:	Pert
Occurrence:	Poisson

Data Characteristics

Minimum:	8.7E-05
Maximum:	0.000324
Most Likely:	0.0002055

Information Regarding Prevention

Selection criteria

Disqualifying conditions include: Any behavior or mental condition that in the opinion of the MSMB makes or is likely to make the individual a hazard to flight safety, crew coordination, or mission execution. The following disorders or history thereof are permanently disqualifying for ISS duties: psychotic, bipolar, dissociative, impulse control, somatoform, factitious hallucinogen persisting perceptual disorder, paraphilia, abuse or neglect of a child or adult. Disorders that interfere with social or occupational functioning or that require ongoing treatment, Narcolepsy, and Personality Disorder. Delirium, Dementia, Amnesia. Adjustment Disorder, if the episode exceeded 6 months, hospitalization was required, three or more episodes have occurred, and use of psychiatric medications (other than symptomatic use of anxiolytics or hypnotics for a period of less than 30 days). Gender Identity Disorder. Substance Abuse or Dependence. (Note: Nicotine-related Disorders are not necessarily disqualifying.) History of a Substance Abuse or Dependence. (Note: Consideration for waiver requires completion of an approved treatment program, total abstinence for at least 90 days after the program, and active participation in an after-care program.) Characterological behaviors that show evidence of immaturity, instability, impulsiveness, lack of judgment, or an impaired capacity to adapt to stressful situations. (International Space Station Program, 2009)

Alternative Incidence Data

Analog Populations

An analysis of 10 years of data collected on Polaris submarine patrols over the ten year period 1963-1973 reported a total of 1685 medical events treated. Illness rates are indicated as new/cases/1000 man-days. There were a total of 58 psychiatric diseases during the 1963-73 period with an illness rate of 0.002 and 0.038; for the 1963-67 and 1968-73 periods respectively. There were total 4 behavioral emergency events, one psychosis, unspecified; causing 22 sick days, and three suicide gesture, causing 23 sick days, average per event (Table A6). There were 3 EVACs and one death, but no information on which conditions caused these events. Illness rate and rate of days lost were significantly higher than those observed in the surface population ($P < 0.05$) (Tansey, 1979).

Rates per person year are 0.00073 and 0.01387 (0.002 and 0.038 *365 / 1000). The average of these two incidence rates is 0.0073 per person-years. Behavioral emergencies accounted for 6.8% (4/58) of total psychiatric events, or a rate of 0.000503. Three EVACs occurred but there is no information by condition.

There were 4 situational reactions, not described, causing 18 sick days, average 4.5 days per event (Tansey, 1979). Rate for these events is 0.000503, similar to the psychosis and suicide gestures group.

Epidemiology of psychiatric illnesses experienced by soldiers in combat was obtained by retrospective review of casualty rosters and electronic medical records. Population consisted of 4122 soldiers, 3797 men and 325 women. Age range 18-52, average 27. There were 308 psychiatric casualties, overall 59.8 per 100 soldier combat-years which represented 23% of all disease and non-battle injury (DNBI). 88% were treated and returned to duty. 11% were medically evacuated and 1% died. (Goodman, 2011)

All incidence rates are per 1000 at risk combat-years. There were 8 **psychosis** events. 88% of psychosis casualties MEDEVAC or died. Overall incidence rate was 1.7. By gender, incidence rate was 0 for females and 1.6 for males per 1000 person-years. There were 14 **homicidal/suicidal** events of which 93% MEDEVAC or died. Homicidal suicidal ideation incidence rate was overall 3.1; female 2.5 and male 3.2. (Goodman, 2011) Psychosis rates per person year are 0.0017 overall, 0 female, and 0.0016 male. Homicidal/suicidal rates are 0.0031 overall, 0.0025 female, and 0.0032 male

By age, 35 years old and older had the lowest adjusted rate ratio while the 18-23 cohort had the highest; 1 and 1.8; 95% Confidence Interval (CI) 1.21-2.69. By gender, adjusted rate ratio for males was higher than females; 1 and 1.9; 95% CI 1.39-2.63. Trends are similar to civilian population trends. (Goodman, 2011)

Due to the psychological rigors of war, these rates are higher than the United States and submariners populations.

Non Analog Populations

From 1992 to 2001, there were 53 million mental health-related visits, representing an increase from 4.9 percent to 6.3 percent of all emergency department visits and an increase from 17.1 to 23.6 visits per 1,000 U.S. population across the decade. The most prevalent diagnoses were substance-related disorders (22 percent of visits), mood disorders (17 percent), and anxiety disorders (16 percent).

An estimated 17 million visits were for a mental health-related primary complaint (that is, as conveyed to the clinician by the patient), but many more involved a psychiatric diagnosis (that is, the assessment of the patient's condition by the clinician). Among the estimated 53 million mental health-related visits overall, the most common diagnoses were substance-related disorders (30 percent), mood disorders (23 percent), and anxiety disorders (21 percent). Psychoses constituted 10 percent and suicide attempts 7 percent of all documented mental health-related visits. These five major subgroups accounted for 79 percent of all mental health-related visits. The mean age of patients who made mental health-related visits was 39.5 years. Incidence rates of mental health-related emergency department visits are per 1,000 U.S. population, by disorder category, period 2000-2001, overall 22.3; 95% CI 20.5-24.1; age cohort 15-69, 25.0, 95% CI 22.4-27.7. Incidence increased with age. (Larkin, 2005).

Rates were 0.025, 95% CI 0.0224-0.0277 per person-years. We estimated 17% of the above percentages for behavioral emergencies (psychosis and suicide attempts) 0.00425 (25/1000 *17%)

Treatment and Outcomes

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

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

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

	Clinical Phase I Diagnosis & Initial Treatment ¹		Clinical Phase II On-going Treatment / Convalescence ²		Clinical Phase III Recovered / Mission End State ³		
	FI* (%)	Duration (hrs)	FI* (%)	Duration (hrs) (Min - ML - Max)	FI* (%)	EVAC** (%)	LOCL** (%)
ISS-based Treatment (best case scenario %: 84 - 95)	100	0.5	10 - 36	0 - 4 - 8	0	0	0
ISS-based Treatment (worst case scenario %: 5 - 16)	100	1	19 - 51	24 - 48 - 72	0 - 51	0 - 5	0
Untreated Best Case	0	0	19 - 51	0 - 4 - 8	0 - 36	0 - 100	0
Untreated Worst Case	0	0	36 - 75	24 - 48 - 72	36 - 75	100	0

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

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

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

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

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

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

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

Scenario Comments

Best case scenario is defined as a brief behavioral emergency that resolves with a short course of medication.

Worst case scenario is defined as a behavioral emergency that lasts more than 24 hours and requires a course of medication for at least several days.

Worst versus Best case percentages

The percentage of worst versus best cases was estimated using analog data.

Among US Navy submariners, there was one case of psychotic depression versus 23 cases of neurotic depression, or 4.5%. There were 9 psychotic events of all psychiatric syndromes, or 15.5% (9/58). (Tansey, 1979) To allow for uncertainty 5-16% is the estimated worst case percentage. Thus 84 to 95% are best cases.

Best Case Comments

The functional impairments (FI) calculation for Behavioral Emergency follows the IMM severe non-space adaptation template. Impairment Score of Brief Psychiatric Rating Scale (PBRs) ratings are based on Table 14-9, p.357; Global Assessment of Functional Scale ratings are based on Table 14-10, p.358. (American Medical Association, 2008) Combined FI ratings are calculated combining the mentioned tables using the Combined Values Chart as indicated in Appendix A, pp 604-606. (American Medical Association, 2008)

By definition in Clinical Phase I, FI is 100%. Duration of physical exam as described in ISS medical checklist for the best case scenario is estimated in 30 minutes. During Clinical Phase II, FI is estimated in 10 to 36%. Duration is estimated in 0 to 8 hours. In Clinical Phase III, full recovery is expected and FI is 0%. By definition EVAC and LOCL are not expected for the best case scenario.

Worst Case Comments

The functional impairments (FI) calculation for Behavioral Emergency follows the IMM severe non-space adaptation template. Impairment Score of Brief Psychiatric Rating Scale (PBRs) ratings are based on Table 14-9, p.357; Global Assessment of Functional Scale ratings are based on Table 14-10, p.358. (American Medical Association, 2008) Combined FI ratings are calculated combining the mentioned tables using the Combined Values Chart as indicated in Appendix A, pp 604-606. (American Medical Association, 2008)

By definition in Clinical Phase I, FI is 100%. Duration of physical exam and medication as described in ISS medical checklist is estimated in 60 minutes. During Clinical Phase II, FI is estimated in 19 to 51%. Duration is estimated in 24 to 72 hours. In Clinical Phase III, full recovery may or may not occur and FI is estimated at 0-51%. EVAC has occurred in analog populations (Tansey, 1979); (Goodman, 2011)) To allow for uncertainty EVAC is estimated at 0-5%. By definition, LOCL is not expected for this condition.

Untreated Best Case Comments

The functional impairments (FI) calculation for Behavioral Emergency follows the IMM severe non-space adaptation template. Impairment Score of Brief Psychiatric Rating Scale (PBRs) ratings are based on Table 14-9, p.357; Global Assessment of Functional Scale ratings are based on Table 14-10, p.358. (American Medical Association, 2008) Combined FI ratings are calculated combining the mentioned tables using the Combined Values Chart as indicated in Appendix A, pp 604-606. (American Medical Association, 2008)

During Clinical Phase II, FI is estimated at 19 to 51%. Duration is 0 to 8 hours, similar to the treated best case scenario. In Clinical Phase III, recovery may or may not occur without treatment. FI is estimated at 0-36%. To allow for uncertainty, EVAC is estimated at 0-100%. LOCL are not expected for this condition.

Untreated Worst Case Comments

The functional impairments (FI) calculation for Behavioral Emergency follows the IMM severe non-space adaptation template. Impairment Score of Brief Psychiatric Rating Scale (PBRs) ratings are based on Table 14-9, p.357; Global Assessment of Functional Scale ratings are based on Table 14-10, p.358. (American Medical Association, 2008) Combined FI ratings are calculated combining the mentioned tables using the Combined Values Chart as indicated in Appendix A, pp 604-606. (American Medical Association, 2008)

During Clinical Phase II, FI is estimated at 36 to 75%. Duration is estimated in 24-72 hours, similar to the treated worst case scenario. In Clinical Phase III, recovery is unlikely and FI is estimated at 36-75%. Without treatment EVAC is estimated at 100%. LOCL is not expected for this scenario.

Treatment and Options Level of Evidence (LOE)

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

Citation	LOE Value	LOE Category
Tansey, 1979	2	EVAC
	2	BCWC
American Medical Association, 2008	3	FI
American Medical Association, 2008	3	FI
Goodman, 2011	2	EVAC

The Resource Table (RT)

Resource	Units Required Best Case	Units Required Worst Case	Units Available At Start Of Mission	Consumable	Essential	Rationale
Ativan (Lorazepam) 1 mg tablet	4	0	30	Yes	Yes	Anti-anxiety / Sedative, first line
Blood Pressure Cuff (regular, large)	0	1	2	No	Yes	Measure blood pressure
Blood Pressure Monitor	0	1	1	No	Yes	Measure blood pressure
BZK wipes	0	3	60	Yes	No	Cleanse skin.
Needle (23G)	0	9	20	Yes	Yes	For medication administration
Nitrile gloves (large, medium, and small) (pair)	0	1	30	Yes	No	Personal protection for CMO
Sharps container	0	1	40	No	No	To dispose of medical waste such as used medical needles, scalpels, IV catheters, razors, vials
Sterile water 10 mL vial	0	2	2	No	No	To reconstitute Geodon for injection
Syringe (3cc)	0	9	20	Yes	Yes	For medication administration
Thermometer	0	1	1	No	No	To measure temperature
Valium (Diazepam) 5 mg/mL, 2 mL syringe	0	6	2	Yes	Yes	Anti-anxiety / Sedative, second line
Ziprasidone (Geodon 20mg/mL)	0	2	2	Yes	Yes	Replacing Abilify 7.5mg/mL injectable

Resource Comments

The table was revised on 8/25/201. Haloperidol, non sterile gloves, Carpuject and gray tape were added.

The ISS medical checklist (International Space Station Integrated Medical Group, 2008) includes a procedure for a Behavioral Emergency. All resources are available on board.

Comparison of clinical guidelines versus ISS Medical Checklist

Clinical Guidelines recommend calming the patient, not to interview a volatile patient alone, and tranquilizers. Restraints are used as a last resort. (Ramadan, 2009) The ISS medical checklist recommends the same treatment, with the major difference being the early use of restraints. All crew members and spacecraft safety come first.

Required Resources Level of Evidence (LOE)

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

Citation	LOE Value	LOE Category
International Space Station Integrated Medical Group, 2008	2	Resources

Level Of Evidence

Input Data	LOE Average	Description	Range
Incidence	2	Excellent	1-2
Functional Impairment	3	Good	2.1-3
Best Case / Worst Case	2	Fair	3.1-4
EVAC / LOCL	2	Poor	4.1-5
Resources	2		
QUALITY OF EVIDENCE	2.2		

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