Allergic Reaction (mild to moderate) Cliff

Branch Baseline

Allergic reactions are sensitivities to a specific substance, called an allergen that is contacted through the skin, inhaled into the lungs, swallowed, or injected (Medline Plus, 2008). Allergic reactions in space can have a significant impact on a mission. The most common cause for an allergic reaction on orbit is medication. It is well known that immune dysregulation occurs during spaceflight, thus increasing the risk of an allergic reaction.

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:	In-flight
Space Adaptation:	No
Incidence Type:	Rate

Distribution Data	
Incidence:	Gamma
Occurrence:	Poisson

Data Characteristics	
Events:	26
Person Years:	45.49
Space Flight Incidence Rate (Events / Person Years):	26 / 45.49 = 0.571554187733568

Incidence Comments

Of 11 events, 4 have been drug allergies; identified allergens were pneumococcal vaccine and PAH insulin. The remainders were mild reactions including sneezing, congestion, runny nose, watering of eyes and a swollen throat feeling (Walton, 2010).

The incidence data was updated to integrate the Real World System observed events including the person years from our validation data set. There was 15 (12 ISS and 3 STS) events and 18.17 person years added. This data set included the remaining Shuttle missions and ISS Expedition 31/32 through Expedition 39/40 (Saile, 2017).

Updated the Person-Years based on the revised real world system integrated incidence data. The integrated person years changed from 18.17 to 18.13 so the conditions person years changed from 45.53 to 45.49 (Saile L., 2017)

Information Regarding Prevention

Disqualifying conditions

Any medical condition that, in the judgment of the MSMB, may compromise mission operations, crew safety, or require urgent medical treatment while residents on the ISS may be disqualifying including a history of sensitivity or demonstrated allergy of sufficient severity so as to interfere with the mission. In skin: any skin disorder, acute or chronic, that is severe enough to cause interference with emergency egress, wearing of flight equipment, or successful mission completion. In lungs and chest: active asthma. Any history of asthma will require a full respiratory assessment and will be considered on an individual basis by the MSMB (International Space Station Program, 2009).

Other

Ground-testing of commonly used in-flight medications is performed in crew members pre-flight (International Space Station Program, 2009).

Immune dysregulation occurs in space flight. Numerous cellular and other changes lead to impaired cell-mediated immunity. Hypersensitivities, autoimmunity, and allergies are potential adverse clinical events that may be related to prolonged dysregulation of the immune system. (Williams, 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
Walton, 2010	1	Incidence
Saile L., 2017	1	Incidence

Incidence data not included in the model

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

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

Distribution Data	
Incidence:	Fixed
Occurrence:	Poisson

Data Characteristics	
Fixed Rate:	0.0038

Incidence Comments

The clinical epidemiology of acute allergic reactions in the emergency department (ED) is uncertain. Gaeta tried to characterize ED visits for acute allergic reactions and to evaluate national trends in ED management. The National Hospital Ambulatory Medical Care Survey was used to identify a nationally representative sample of ED visits between 1993 and 2004. Cases with a diagnosis of acute allergic reaction were identified by International Classification of Diseases, Ninth Revision (ICD-9) codes (9950, 9951, 9952, 9953, and 9956). A total of 12.4 million allergy-related ED visits occurred from 1993 to 2004, representing **1.0%**(95% confidence interval, 0.93%-1.10%) of all ED visits or 1.03 million ED visits per year. The number of allergy-related ED visits remained relatively stable, averaging **3.8 per 1,000** US population per year (95% confidence interval, 3.4-4.1; P for trend = .39). Although 63% of all visits were coded as urgent, only 4% required hospitalization. Anaphylaxis coding was rare (1%). ED staff prescribed medications in 87% of visits, especially histamine, blockers (62%; P for trend = .29). Increases were noted from 1993 to 2004 for corticosteroids (22% to 50%; P < .001), histamine2 blockers (7% to 18%; P < .001), and inhaled beta-agonists (2% to 6%; P = .008). Epinephrine use was infrequent and declining (19% to 7%; P = .04). The authors concluded that between 1993 and 2004, significant variability has occurred in ED management of acute allergic reactions. Results are confined to ED visits and not to all cases of allergic reactions in the general population. Gaeta study identified female incidence rate was 0.0047 while the male incidence rate was only 0.0028. The peak ages for females was 20-29 and the male peak age was 30-39. (Gaeta, 2007)

Alternative Incidence Data

The largest number of allergic reaction cases is among children and adolescents. Until age 15 there is a predilection for males. After 15 years for females (Lieberman, 2006).

A retrospective cross-referencing of computerized pharmacy printouts and concurrent manual medical record review in a northwestern hospital in the US reported that approximately 25% (470/1893) of the patients requiring antimicrobial therapy reported an allergy to at least 1 antimicrobial agent. The most commonly reported antimicrobial allergy was penicillin (295/1893 [15.6%]). Eighty-five patients (18.1%) reported having an allergy to 2 or more antimicrobial agents. Only 4% (27/601) of the reported antimicrobial allergies contained documentation as to the nature of the specific allergic reactions, while a manual medical record review revealed that 32% (23/73) of the antimicrobial allergies contained documentation of the specific allergic reaction. The authors concluded that the incidence of penicillin allergy at their institution exceeds population averages and there is limited documentation of drug allergies, These factors combined may lead to the prescribing of alternative antimicrobial agents that do not fit into institutional antimicrobial guidelines and, in some instances, may put the patient at risk for infection and/or colonization with resistant organisms. Use of these alternative agents may adversely impact the ability to manage emerging antimicrobial resistance (Lee, 2000).

A 10 year study in England reported on 59,718,694 total emergency hospital admissions and 557,978 admissions with a diagnostic code indicative of adverse drug reactions, (ADRs) 0.9%. Of these, 188,024 were primary diagnoses and 444,780 were of ‘external cause’. There were 26,399 in-hospital deaths in ADR admissions, a case-fatality rate of 4.7%. Most hospital admissions associated with adverse drug reactions occurred in older patients. In 2008–2009, 58.5% of hospital for ADR occurred in people aged 65 years and over. The median age of ADRs with an external code was 70. Younger patients tended to have ADRs from anesthetics and therapeutic gases (median age 44) or CNS stimulants (median age 49). For the year 2008–2009, ADR admission rate in England was 146 per 100,000 person-years = 0.00146. There was little gender difference in admissions with a primary code of ADR (51.4% men)

The main limitation of the study is that Hospital Episode Statistics data have the weaknesses associated with all routinely collected data; namely missing, incomplete or inaccurate data. Differences in coding practice between hospitals or populations covered make comparisons at hospital level difficult. ADRs given as a primary diagnosis, in the first episode of care, more likely occurred prior to admission and if given as a secondary diagnosis, then they likely occurred in hospital. However, this interpretation is limited, as there will be some considerable blurring between these two scenarios. ADRs are unwanted events following drug prescription and should be considered as part of a risk-benefit approach when prescribing medicines, Our data suggest that the number of ADR admissions may have increased at a greater rate than the increase in total hospital admissions, but it is unclear whether this could also be due to increased recording (Wu, 2010).

Maculopauplar exanthema are the most common cutaneous manifestation of drug allergy, 91.2%, and urticaria, 5.9%, is the second. Occurring within 24 hours of drug ingestion, it is most commonly caused by penicillins, sulfonamides and non-steroidal anti-inflammatory drugs. Drug-induced urticaria is seen in association with anaphylaxis, angioedema, and serum sickness (Hunziker, Kunzi, Braunschweig, Zehnder, & Hoigne, 1997). Diagnosis requires a detailed history, knowledge of the most likely agents sometimes supplemented with in vitro and skin testing. For mild reactions, avoidance of the causative drug and treatment with antihistamines will suffice. Immediate reactions occur within minutes after drug exposure and accelerated reactions occur hours or even days after drug administration (Shipley, 2001).

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 %: 92.59 - 96.3)	100	0.25	0 - 9	0.25 - 3.125 - 6	0	0	0
ISS-based Treatment (worst case scenario %: 3.7 - 7.41)	100	0.25	1 - 27	6 - 39 - 72	0 - 9	0	0
Untreated Best Case	0	0	1 - 27	0.25 - 3.125 - 6	0 - 9	0	0
Untreated Worst Case	0	0	11 - 42	6 - 39 - 72	1 - 42	0	0

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

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

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

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

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

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

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

Scenario Comments

The **best case scenario** describes a crewmember with an allergic reaction that is quickly relieved by one dose of oral medication.

The **worst case scenario** involves a crewmember with a more severe allergic reaction; able to be treated with oral medication, but requires multiple doses and a longer duration of treatment.

Best and worst case scenario: based on Real World System data set, there were 15 events and 1 of them were worst case. Since we now have worst case scenarios, which did not have before, we can use the empirical data so the worst case scenario would be 6.67% (1/15). Thus the best case scenarios would be 93.33% (14/15) (Saile L., 2017).

Mild to moderate cutaneous allergic reactions are addressed in the Skin Rash CliFF, as indicated in the ISS medical checklist (International Space Station Integrated Medical Group, 2006). Urticaria presenting with hypotension, angioedema or breathing difficulties is addressed in the Anaphylaxis CliFF (Severe allergic reaction)

We assumed that mild or moderate allergic reactions will cause respiratory symptoms or skin disorders, i.e. the two conditions would not be expected occur concomitantly. These functional impairments are not combined and have been graded with only air passage deficits impairment. Grading ranges in skin and air passage deficits are similar.

Best Case Comments

By definition Functional impairment (FI) in **Clinical Phase I is 100%** and duration is estimated in 15 minutes to follow the procedures indicated in the ISS Medical Checklist i.e., unstow the ambulatory medical pack, examine lungs with stethoscope and inspect skin for rash or hives. In **Clinical Phase II** FI is estimated to be 0 to 9%. **Class 0,** 0% air **passage deficits, table 11-6, p 267** occurs when there are no complaints of dyspnea at rest and minimal or no interference with any activities. **Class 1,** 1-9%, there are no complaints of dyspnea at rest and activities requiring intensive effort may be interfered with or require prophylactic restriction of activity or require medication to maintain optimal function (American Medical Association, 2008). Duration is estimated to be 15 minutes to 6 hours (Shipley, 2001).

In **Clinical Phase III** recovery is expected in the best case scenario and FI is estimated in 0% or Class 0, there are no complaints of dyspnea at rest and minimal or no interference with any activities (American Medical Association, 2008). Recovery is expected by avoidance of the allergen and anti-histamine treatment (Merck Manual, 2009). EVAC and LOCL are not expected. Respiratory symptoms probability is medium (rank 4 of 9) and its impact on crew health is low (rank 9 of 9) (Billica, 1996). Based in our in-flight compilation no EVAC has occurred for this condition (In-flight Compilation Lockdown revised, 2010)

Worst Case Comments

By definition Functional impairment (FI) in **Clinical Phase I is 100%** and duration is estimated in 15 minutes, similar to the best case scenario. In **Clinical Phase II**, FI is estimated in 1 to 27%. Class 1 or 1 to 9%, There are no complaints of dyspnea at rest and activities requiring intensive effort may be interfered with or require prophylactic restriction of activity or require medication to maintain optimal function. Class 2, 11 to 27%; there are no complaints of dyspnea at rest; dyspnea is produced by stress, prolonged exertion, hurrying, hill climbing, or recreational or similar activities except sedentary forms (American Medical Association, 2008). Duration is estimated to be 6 hours to 3 days (Shipley, 2001). In **Clinical Phase III**, FI is estimated to be 0 to 9%. **Class 0**, 0%; there are no complaints of dyspnea at rest and minimal or no interference with any activities. Class 1, 1 to 9%, There are no complaints of dyspnea at rest and activities requiring intensive effort may be interfered with or require prophylactic restriction of activity or require medication to maintain optimal function (American Medical Association, 2008). EVAC and LOCL are not expected (Billica, 1996).

Untreated Best Case Comments

In **Clinical Phase II**, FI is estimated in 1 to 27%, similar to the best case scenario but there is no treatment available. Class 1, 1 to 9%, there are no complaints of dyspnea at rest and activities requiring intensive effort may be interfered with, or require prophylactic restriction of activity. Class 2, 11 to 27%; There are no complaints of dyspnea at rest; dyspnea is produced by stress, prolonged exertion, hurrying, hill climbing, or recreational or similar activities except sedentary forms and there is no available treatment to maintain optimal function (American Medical Association, 2008). Duration is estimated to be 15 minutes to 6 hours (Shipley, 2001).

Symptoms may resolve or improve with avoidance of the irritant, thus in **Clinical Phase III**, FI is estimated to be 0 to 9%. Class 0, 0%, There is no dyspnea at rest and minimal or no interference with any activities. Class 1, 1 to 9%, There is no dyspnea at rest and activities requiring intensive effort may be interfered with or require prophylactic restriction of activity (American Medical Association, 2008). Recovery is expected by avoidance of the allergen in the best case scenario. EVAC and LOCL are not expected (Billica, 1996)

Untreated Worst Case Comments

During **Clinical Phase II**, FI is estimated in 11 to 42% when there is no treatment available. Class 2 or 11 to 27% when there are no complaints of dyspnea at rest; dyspnea is produced by stress, prolonged exertion, hurrying, and hill climbing, or recreational or similar activities except sedentary forms. Class 3, 30 to 42%; There are no complaints of dyspnea at rest; dyspnea is produced by walking more than 1 or 2 level blocks, climbing 1 flight of stairs even with periods of rest, or performance of other usual activities of daily living (American Medical Association, 2008). In **Clinical Phase III**, recovery may not occur without treatment, and FI is estimated to be 1 to 42%, same as in Phase II (American Medical Association, 2008). EVAC or LOCL are not expected (Billica, 1996).

Treatment and Options Level of Evidence (LOE)

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

Citation	LOE Value	LOE Category
American Medical Association, 2008	3	FI
Billica, 1996	4	EVAC
Saile L., 2017	1	BCWC

Additional Comments

We searched PubMed using the terms allergic reaction and incidence, allergic reaction and epidemiology, allergy and aerospace, and allergy and astronauts. We refined our search by relevance and date. Most of the results found include reports on anaphylaxis which are not included in this CliFF.

The Civil Aerospace Medical Institute's (CAMI's) Toxicology Database was examined for the presence of the first-generation antihistamines in pilot fatalities of civil aircraft accidents that occurred during a 16-yr (1990-2005) period. Of 5383 fatal aviation accidents from which CAMI received specimens, there were 338, (6.3%) accidents wherein pilot fatalities (cases) were found to contain brompheniramine, chlorpheniramine, diphenhydramine, doxylamine, pheniramine, phenyltoloxamine, promethazine, and triprolidine. Of the 338 accidents, 304 were general aviation accidents, and 175 of the 338 pilots held private pilot airman certificates. Antihistamines were detected alone in 103 fatalities (1.8%) (1 antihistamine in 94 and 2 antihistamines in 9. (Sen, 2007)

Mild to moderate cutaneous allergic reactions as well as skin reactions without any other symptoms are addressed in the Skin Rash CliFF. Urticaria presenting with hypotension, angioedema or breathing difficulties and severe allergic reactions are addressed in the Anaphylaxis CliFF (Severe allergic reaction).

The Resource Table (RT)

Resource	Units Required Best Case	Units Required Worst Case	Units Available At Start Of Mission	Consumable	Essential	Rationale
Benadryl 25 mg capsule	2	6	60	Yes	Yes	Anti allergic, for itching or drug-induced muscle-spasms
Prednisone 20 mg	0	10	40	Yes	Yes	Anti allergic, persistent symptoms
Refresh artificial tears (Carboxymethylcellulose) 0.5%, 0.4mL bottle	0	1	40	Yes	Yes	Relief dryness/irritation of the eyes
Stethoscope	1	1	2	No	Yes	To listen to lung,heart, and bowel sounds, to blood flow in arteries and veins

Resource Comments

Comparison between the Med Checklist and Urban treatment guidelines:

The Med Checklist addresses the immediate medical issues similarly as they would be addressed terrestrially (Wallace, 2008). Antihistamines cause drowsiness. Medications in the ISS checklist with drowsiness as a side effect include Diphenhydramine (Benadryl) and Loratadine (Claritin) (MOD, 2011).

Antihistamines cause drowsiness. Medications in the ISS checklist with drowsiness as a side effect include Diphenhydramine (Benadryl) and Loratadine (Claritin). The following drugs should not be used together as they may cause excessive drowsiness: Ambien, Ativan, Benadryl, Claritin, Demerol, Dilantin, Effexor, Grandaxin, Haldol, Morphine, Persen, Phenazepam, Phenergan, Phenibut, Radedorm, Relanium, Risperdal, Rudotel, Skelaxin, Sonata, Suprastin, Tavegil, Valium, Vicodin, Xanax, Zofran, Zoloft. ISS med checklist include possible allergic reactions with silvadene, tobradex ophthalmic, penicillin, Tarivid (Ofloxacin), amoxicillin, bactrim, aspirin, ibuprofen (motrin), diclofenac sodium, or misoprostol (contraindicated if allergic to aspirin), Polytrim ophthalmic, and erythromycin (International Space Station Program, 2009).

Required Resources Level of Evidence (LOE)

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

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

Level Of Evidence

Input Data	LOE Average
Incidence	1
Functional Impairment	3
Best Case / Worst Case	1
EVAC / LOCL	4
Resources	2
QUALITY OF EVIDENCE	**2.2**

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

Reference List

Reference
American Medical Association. Ear, Nose, Throat, and Related Structures. Guides to the Evaluation of Permanent Impairment. 6th ed. Chicago: American Medical Association Press; 2008. p. 247-79.
Billica RD, Simmons SC, Mathes KL, McKinley BA, Chuang CC, Wear ML, et al. Perception of the medical risk of spaceflight. Aviat Space Environ Med 1996 May;67(5):467-73.
Gaeta TJ, Clark S, Pelletier AJ, Camargo CA. National study of US emergency department visits for acute allergic reactions, 1993 to 2004. Ann Allergy Asthma Immunol 2007 Apr;98(4):360-5.
International Space Station Integrated Medical Group. Medical Checklist ISS- All Expeditions. Houston: National Aeronautics and Space Administration; 2008.
International Space Station Program. Medical Standards for ISS Crewmembers - MED Vol A. 3.2 ed. NASA; 2011.
Lee CE, Zembower TR, Fotis MA, Postelnick MJ, Greenberger PA, Peterson LR, et al. The incidence of antimicrobial allergies in hospitalized patients: implications regarding prescribing patterns and emerging bacterial resistance. Arch Intern Med 2000 Oct 9;160(18):2819-22.
Lieberman P, Camargo CA, Jr., Bohlke K, Jick H, Miller RL, Sheikh A, et al. Epidemiology of anaphylaxis: findings of the American College of Allergy, Asthma and Immunology Epidemiology of Anaphylaxis Working Group. Ann Allergy Asthma Immunol 2006 Nov;97(5):596-602.
Lopez V. In-flight medical events revised_Functional Impairment. 2010. Houston, Texas, NASA, Johnson Space Center.
Medline Plus. Allergic Reactions. Dugdale D, editor. Medline Plus . 4-28-2008. Bethesda, US National Library of Medicine; National Institutes of Health. 6-17-2010.
Merck Manual. Urticaria. Porter RS, editor. Merck Manuals Online Medical Library . 2009. Whitehouse Station, N.J, Merck Sharp & Dohme Corp.. 6-22-2010.
NASA Mission Operations Directorate (MOD). International Space Station Integrated Medical Group Medical Checklist. Mission Operations Directorate (MOD), Systems Operations Data File (SODF) . 6-24-2011. Houston, TX, National Aeronautics and Space Administration (NASA).
Saile L., Boley L, Kerstman E. Integration RWS ISS STS Observed Incidence V2. 2017.
Saile L., Boley L, Arellano J, Kerstman E. iMED Best and Worst Case Percentage Update. 2017.
Saile L, Boley L, Kerstman E. Integration RWS ISS STS Observed Incidence. 2017.
Sen A, Akin A, Craft KJ, Canfield DV, Chaturvedi AK. First-generation H1 antihistamines found in pilot fatalities of civil aviation accidents, 1990-2005. Aviat Space Environ Med 2007 May;78(5):514-22.
Shipley D, Ormerod AD. Drug-induced urticaria. Recognition and treatment. Am J Clin Dermatol 2001;2(3):151-8.
Wallace DV, Dykewicz MS, Bernstein DI, Blessing-Moore J, Cox L, Khan DA, et al. The diagnosis and management of rhinitis: an updated practice parameter. J Allergy Clin Immunol 2008 Aug;122(2 Suppl):S1-84.
Walton M, Kerstman E, IMM. In-flight Compilation v20100414_Incidence_calculation. 2010.
Williams D, Kuipers A, Mukai C, Thirsk R. Acclimation during space flight: effects on human physiology. CMAJ 2009 Jun 23;180(13):1317-23.
Wu TY, Jen MH, Bottle A, Molokhia M, Aylin P, Bell D, et al. Ten-year trends in hospital admissions for adverse drug reactions in England 1999-2009. J R Soc Med 2010 Jun;103(6):239-50.