Nose bleed (space adaptation) Cliff

Branch Baseline

Most nosebleeds (epistaxis) resolve spontaneously and do not need advanced medical attention. Profuse or prolonged nosebleeds, however, could be life-threatening as usually seen in elderly or debilitated patients.

Anterior epistaxis is the most common type, accounting for about 90% of nosebleeds. Bleeding is usually visible on inspection and typically occurs in Little's Area in the anterior half of the nasal septum. This area contains numerous vessels called Kiesselbach's plexus. In the majority of cases, anterior epistaxis can be controlled by compressing (pinching) the cartilaginous part of the nose.

Posterior epistaxis accounts for 10% of nosebleeds. Bleeding may be profuse because of the larger vessels in that location (usually, the sphenopalatine artery). In general, posterior epistaxis occurs in older patients, who have fragile vessels because of hypertension, atherosclerosis, coagulopathies, or weakened tissue. Posterior epistaxis requires aggressive treatment and hospitalization.(Waters, 2011)

Mortality is rare. Between 1999 and 2007 there have been a total 42 deaths, with an annual rate of 0.0 per year. (ICD10Data.com, 2011)

At the onset of microgravity there is a cephalad fluid shift resulting in fullness in the head followed by nasal congestion. This is attributed to increased blood volume and intravascular pressure. This effect reaches equilibrium in 3-5 days. Risk factors for nosebleeds in the SAS setting are cephalad fluid shift and low relative humidity. Additional risk factors throughout the flight include recent nasal infection, the frequent use of nasal decongestants or nasal trauma. (Marshburn, 2008)

The Space Shuttle normal temperature range is 24-27C (75-80F), average 25.5C (77.9F) depending on the phase of the flight. Relative humidity is 25-70%, average 47.5%. Humidity is kept low to prevent condensation in electronic hardware and to prevent the overgrowth of microorganisms such as mold.(Bacal, 2008)

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:	Yes
Incidence Type:	Proportion

Distribution Data	
Incidence:	Beta
Occurrence:	Bernoulli

Data Characteristics	
Occurrence Hour Range:	24 to 144
Peak Occurrence Hours:	24
Events:	6
Persons At Risk:	807
Space Flight Incidence Rate (Events / Persons at Risk):	6 / 807 = 0.00743494423791822

Incidence Comments

There have been 14 cases of nose bleeds reported in flight, all in STS. Six cases occurred between days 1 to 5 which is our model incidence. Six cases had no information on start day. One of them had end day reported as day 8. Based on IMM's assumptions (IMM, 2009)space adaptation conditions occur between days 1 and 5, If we add both, days 1 to 5 events and unknown date, the total incidence would be 12 for STS. Two events occurred after the fifth day. One of them reported repeated bleed. The repeated case have been counted as one event (Walton, 2010).

Epistaxis incidence terrestrially is slightly higher among males than females not taking anticoagulation meds 61.1% vs. 57.8% (Nash, 2008)

Only one case among all in flight events reported has been a female crew member.

The incidence data from the real world system incidence information for persons at risk was increased by 144 (Saile, 2017).

Updated the Persons at Risk based on the revised real world system integrated incidence data. The integrated RWS persons at risk from 144 to 143 so the conditions integrated iMED value went from 808 to 807. (Saile L., 2017)

Information Regarding Prevention

Selection criteria

Causes of rejection for selection or flight include: Deformities, injuries, or destructive diseases of the mouth, nose, throat, pharynx, or larynx that interfere with breathing, speech, mastication, and/or the swallowing of ordinary food, unless surgically corrected with normal function restored. Deviation of the nasal septum, enlarged turbinates, or other obstructions to ventilation that significantly restrict nasal breathing, unless medically or surgically corrected with normal function restored. Chronic rhinitis of any cause that may interfere with the performance of duties. Perforation of the nasal septum if accompanied by recurrent epistaxis, an intrusive whistling sound, or if a sign of organic disease. Nasal polyps or a history of nasal polyps, unless at least one year after surgical removal, and there is no evidence of recurrence (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
Walton, 2010	1	Incidence
Saile L., 2017	1	Incidence

Alternative Incidence Data

A Canadian epidemiological study in the Emergency Department (ED) consisted of all patients with a primary diagnosis of epistaxis who presented from September 1, 2005 to August 31, 2006 at the ED of the Queen Elizabeth II Health Sciences Centre (Nash, 2008). A total of 222 charts were reviewed. Mean patient age was 65.9 years. Atraumatic injuries accounted for 73.4% of cases and traumatic injuries for 10.8%. Current anticoagulant therapy was documented in 40.5 % of patients and preexisting hypertension in 43.7%. An otolaryngologist was consulted in 16.6% of cases, and 11.7% of patients were hospitalized. In 23.8% of cases, the patient had visited the ED at least once before for epistaxis. Of note, the Canadian estimate for epistaxis cases searching for medical attention is estimated at 6%. The under-50-year age group and the 50-64-year age group each accounted for 21.7% of the subgroup of patients with repeated visits. More than half the patients (51.4%) that required an ENT consult were receiving at least one anticoagulant drug. To make a better comparison with our astronaut population, we discounted subjects using anticoagulants: 11.7- 6 (51.4%) = 5.69%

A US study of epistaxis in the ED from 1992 to 2001, based on National Hospital Ambulatory Medical Care Survey (NHAMCS) statistics reported an incidence of 1.7 (95% CI 1.5 to 1.9) ED visits for epistaxis occurred annually per 1,000 population or 0.0017. The age-related frequency was bimodal, with peaks among those younger than 10 years (4.0 per 1,000 visits = 0.004 person-years) and aged 70 to 79 years (12.0 per 1,000 visits = 0.012 person-years). 6% (95% CI 5% to 7%) of patients were hospitalized. There is no report of medication usage or comorbidities. The NHAMCS databases do not contain information on procedures relevant to the treatment of epistaxis. (Pallin, 2005) It is noted that the bimodal peaks are in populations younger and older than our astronaut population.

Analog Populations

One severe epistaxis has been reported by LSAH as a ground medical event requiring hospitalization for the astronaut.(Johnston, 2008) (Davis JR, 2011)

Three epistaxes have been reported in Polaris submarines between 1963-1973, with a total of 12 sick days. In the Ear Nose and Throat (ENT) Diseases group a total of 165 events were reported, which makes a proportion of 1.08 epistaxis events (3/165) (Tansey, 1979)

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 %: 93 - 100)	100	0.3 - 0.5	0 - 17	0.5 - 0.5 - 0.5	0	0	0
ISS-based Treatment (worst case scenario %: 0 - 7)	100	0.5 - 2	2 - 34	3 - 25.5 - 48	0	0 - 6	0
Untreated Best Case	0	0	2 - 34	0.5 - 0.5 - 0.5	0	0	0
Untreated Worst Case	0	0	24 - 57	3 - 25.5 - 48	24 - 57	100	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

Best case nosebleed is defined as an anterior nosebleed that resolves with minimal or no treatment.

Worst case nosebleed is defined as a posterior nosebleed that requires nasal packing and possibly surgical treatment.

Probability of Best and Worst Case Scenario

Percentages of how often best versus worst case scenarios occur were estimated using the in flight data. (Walton, 2010) 14 cases, space adaptation, unknown date or after, have been best cases. If the next case is a worst case (1/15) the estimated percentage would be 7%. If the next case is a best case, the percentage would be 0%, hence our estimated range of 0 to 7% for worst case

Best Case Comments

Nose bleed functional impairments (FI) calculation follows the IMM space adaptation template, except in the untreated worst case. Air passage deficit is based on Table 11-6, p.267 (American Medical Association, 2008). Bleeding Disorders is based on Table 9-11, p.205 (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). For further information on impairment grading and calculation refer to the CliFF Appendix A.

By definition in Clinical Phase I, FI is 100%. Duration to follow procedures specified in ISS checklist, i.e. nasal exam, pinching nose and applying silver nitrate for the best case scenario, is estimated in 20 to 30 minutes. During Clinical Phase II, FI is estimated in 0 to 17%. Duration is estimated in half hour for observation. In Clinical Phase III, full recovery is expected and FI is 0%. By definition EVAC and LOCL would not be expected for the best case scenario.

Worst Case Comments

Nose bleed functional impairments (FI) calculation follows the IMM space adaptation template, except for the untreated worst case scenario. Air passage deficit is based on Table 11-6, p.267 (American Medical Association, 2008). Bleeding Disorders is based on Table 9-11, p.205 (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). For further information on impairment grading and calculation refer to the CliFF Appendix A.

By definition in Clinical Phase I, FI is 100%. Duration to follow procedures specified in ISS checklist, i.e. nasal exam, silver nitrate stick, ointment, and posterior nasal packing to contain bleeding for the worst case scenario, is estimated in half to 2 hours. During Clinical Phase II, FI is estimated in 2 to 34%. Duration is estimated in 3 to 48 hours. In Clinical Phase III, by definition full recovery is expected for a space adaptation condition and FI is 0%.

Severe epistaxis is a Class IIa medical event, manageable with the HMS and not likely to require evacuation or affect mission duration (Johnston, 2008). Terrestrially 6% of nose bleedings require hospitalization (Pallin, 2005); therefore to allow for uncertainty our EVAC estimate is 0 to 6%. In our population LOCL is not expected.

Untreated Best Case Comments

Nose bleed functional impairments (FI) calculation follows the IMM space adaptation template, except for the untreated worst case scenario. Air passage deficits are based on Table 11- 6, p.267 (American Medical Association, 2008 2659 /id. Bleeding Disorders is based on Table 9-11, p.205 {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). For further information on impairment grading and calculation refer to the CliFF Appendix A.

During Clinical Phase II, FI is estimated in 2 to 34%. Duration is half hour, similar to the treated best case scenario. In Clinical Phase III, By definition, best case epistaxis is expected to resolve and FI is 0%. Based on severity of injury and pain, EVAC is estimated in 0 to 100% for the untreated best case. By definition EVAC and LOCL are not expected for the best case scenario.

Untreated Worst Case Comments

Nose bleed functional impairments (FI) calculation follows the IMM space adaptation template, except for the untreated worst case scenario. Recovery from a posterior epistaxis without treatment is unlikely and the course unpredictable.

Air passage deficit is based on Table 11-6, p.267 (American Medical Association, 2008). Bleeding Disorders is based on Table 9-11, p.205 (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). For further information on impairment grading and calculation refer to the CliFF Appendix A.

During Clinical Phase II, FI is estimated at 24 to 57%. Duration is 3 to 48 hours, similar to the treated worst case scenario. In Clinical Phase III, recovery is unlikely and FI remains 24-57%. EVAC is estimated in 100%, considering the risk for a crew member with unstoppable bleeding.

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
American Medical Association, 2008	3	FI
American Medical Association, 2008	3	FI
Johnston, 2008	2	EVAC
Pallin, 2005	4	EVAC
Walton, 2010	1	BCWC

Additional Comments

PubMed searches for untreated epistaxis and untreated posterior epistaxis yielded no results.

The Resource Table (RT)

Resource	Units Required Best Case	Units Required Worst Case	Units Available At Start Of Mission	Consumable	Essential	Rationale
Afrin (Oxymetazoline) 0.05% 15mL bottle	0.1	0.2	10	Yes	Yes	Relief of nasal congestion (topical)
BZK wipes	0	2	60	Yes	No	Clean injured or contaminated tissues. Clean contaminated instruments.
CMRS	0	1	1	No	No	Restrain crew member to ensure safety
Cotton balls	3	6	40	Yes	No	to control anterior nosebleeds
Disposable Otoscope Specula (regular, small)	3	3	90	Yes	No	Nasal and aural exams
Mupirocin (Bactroban) 2%, 22 gm tube	0	0.1	2	Yes	Yes	anti infective - topical
Nasal Packing (posterior nasal packing)	0	1	10	Yes	Yes	to control posterior nose bleeds
Nitrile gloves (large, medium, and small) (pair)	1	1	30	Yes	No	Personal Protective Equipment for CMO
Otoscope (Head, Handle, and USB cable)	1	1	1	No	Yes	Light source for nasal, oral, aural, and eye exams.
Silver nitrate stick 75%/25%	0	1	10	Yes	Yes	for cauterizing wounds and ulcerations
Smooth Forceps	0	1	1	No	Yes	grasping and holding objects To insert Pope Otowic
Tylenol (Acetaminophen) 325 mg	0	4	150	Yes	Yes	Pain relief

Resource Comments

Hypovolemic shock secondary to severe or refractory bleeding and sepsis secondary to prolonged nasal packing are addressed in the Hypovolemic Shock and Sepsis CliFFs respectively.

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Treatment for epistaxis follows the procedures indicated in the ISS Med checklist (MOD, 2011).

ISS procedures are very similar to terrestrial guidelines (Kucik, 2005); (Manes, 2010)

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	3
Resources	2
QUALITY OF EVIDENCE	**2**

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

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