Clinical Finding Form (CliFF)

Branch Baseline

ICL38_Epistaxis

Epistaxis, or nosebleeds, are regular events and often do not require medical treatment. Only six percent of people who experience an epistaxis event will ever seek additional expertise (Seikaly, 2021). Although nearly all nosebleeds will resolve with minimal involvement, the severity of the bleed can be complicated by the location, coagulation abnormalities, platelet dysfunction, and cardiovascular disease. Most bleeds are 'anterior bleeds' and occur along the septum from the Kiesselbach plexus in Little's area. This vascular supply is formed by terminal branches of the internal carotid artery and external carotid artery. Anterior bleeds are typically simpler to manage as the area is visible and compressible. Frequently, nasal compression and topical vasoconstrictors are all that is necessary; albeit cauterization, topical hemostasis agents and anterior packs are commonly used as well. Posterior bleeds comprise of 10-20% of cases and occur along the posterior septum, the lateral nasal wall, or the nasal floor (Krulewitz et al., 2019). These areas are supplied by the sphenopalatine and ascending pharyngeal arteries and often result in brisk bleeds warranting immediate intervention to prevent aspiration and hemorrhagic shock (Womack et al, 2018). Posterior packing is painful both upon insertion and in situ. This type of packing is associated with a higher risk of complications such as otitis media, sinusitis, pressure necrosis, airway obstruction, vagal nerve stimulation, cavernous sinus thrombosis, and toxic shock syndrome (Feusi et al., 2005; Morgan et al. 2014). There have been several epistaxis events in spaceflight. Nosebleeds occurring in the first five days of a mission are associated with space adaptation epistaxis. These are typically attributed to the cephalad fluid shift secondary to increased blood volume and intravascular pressure (Barratt et al., 2019). Space adaption epistaxis is covered separately in another CLiFF. Events that occur after five days are covered in this condition and can be attributed to the low relative humidity of the mission craft, overuse of decongestants, trauma, sinusitis or upper respiratory infections.

INCIDENCE DATA INCLUDED IN THE MODEL

The model imports the following incidence information from the MEDPRAT Evidence Library Database: incidence data category, space adaption status, EVA status, incidence data type, 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. adjusted data). Space adaptation identifies medical events that where onset occurs in the first 5-7 days of flight and does not reoccur. EVA-related incidence values identify medical events that occur only during an EVA. Incidence values types vary by data category and define the number of medical events per person-year (rates) or medical events per person at-risk (proportion) for each medical condition. Incidence values can be modified by crew characteristics such as gender sex and certain crew medical history characteristics. 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 crewmember 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 MEDPRAT Technical Description Document.

INCIDENCE DATA

SPACEFLIGHT LITERATURE

Per the LSAH project data from Walton,2010, there have been 14 incidences of epistaxis in total. 5/14 occured before 5 days with 8/14 occuring after 5 days of mission time. These data remain the most relevent. Three data incidence points were found through the search that were specific to space travel. This encompassed post-flight medical debriefings and many years of data from ISS, Mir, and the Space Shuttle Program. Post-flight medical debriefings gave an overall incidence of epistaxis of 2.2%. There were 6 events of epistaxis recorded on the Space Shuttle, Mir, and ISS in total. Also, data up to ISS expedition 40 has a calculated 0.14 person-year incidence. There were no recorded occurances meeting the worst case definition of this condition in flight.

ANALOG LITERATURE

One relevant paper (thomas, 2003) reviewed incidence of epistaxis in otherwise healthy US submariners. This demonstrated an incidence of 0.002 occurances per year (11 occurances in 5357.6 person years).

TERRESTRIAL LITERATURE

One article described incidence of epistaxis in a closed population independent of hospital presentation. This study was done in a Brazillian town and used a self report survey of 1174 people to determine incidence of epistaxis over the preceedign 6 motnhs. This study showed 56 occurances yielding an incidence of 0.048 occurances per person per 6 months or 0.095 occurances per person-year. This survey included some individuals on anticoagulation as well as individuals suffering from various chronic diseases. These were not in the majority of cases but may increase the incidence of epistaxis reported in this trial. Other terrestrial incidence data idenfied incidence only among those presenting to the emergency department ED visits in the United States, Dynamed, which is at least one order of magnitude higher than population estimates. Given that Tunkel, 2020 references an earlier study showing that only 10% of epistaxis patients seek care, this makes sense and also means the data from these studies is not relevent to this project.

OVERALL INCIDENCE SUMMARY

INCIDENCE

0.1161 person-years SD: 0.05823

INCIDENCE SUMMARY

Incidence distribution is Gamma(shape=3.975, rate=34.24) mean:0.1161 and SD:0.05823. This is the Bayesian posterior distribution for the incidence rate using the spaceflight data of 4 cases over 34.44 person-years using an uninformative prior. Epistaxis needed to be defined for two types: those related to space adaptation (occurring within the first 5 days of the mission, see separate CLiFF) and those attributed to non-space adaption events (included in this CLiFF). We used inflight data to inform these distributions. From the LSAH data requests (Walton 2010 and Saile 2014), there have been a total of 14 cases, 6 known to occur in the first 5 days, 2 known to occur after 5 days, and 6 with unknown onset. To impute where those 6 with unknown onset should be applied, we split them according to the proportions of the known cases (0.75 related to space adaptation, and 0.25 after). This meant 4.5 would be expected to be in the space adaptation. In order to not underestimate overall risk across both conditions, 4 were attributed to space adaption, and 2 to this condition. This resulted in 4 cases over 34.44 person-years (45.49 – (807*5/365.25)) for non-SAS epistaxis. Analog and terrestrial references reported proportions and could not be used to estimate incidence rates. The exception was Pallin et al who estimated a rate of 0.0017 per person-year which is much reduced from spaceflight and limited to only emergency room visits for epistaxis (more severe). Since the terrestrial reference likely underestimate the rate, we have chosen not to include it.

TABLE 1. INCIDENCE MODEL

Incidence Details

Incidence Type
General

Segment
All

Env. Exposure
NA

Sex
Any

Crowns
Any

Contacts
Any

Pregnancy
Any

Incidence Distribution

Occurrence Dist
Poisson

Incidence Dist.
Gamma

Mean
0.116092

SD
0.0582284

Gamma
(Shape): 3.975
(Rate): 34.24

TABLE 2. INCIDENCE LEVEL OF CONFIDENCE (LOC)

Citation	Source	LOC Value
Walton, 2010	Spaceflight	4
Saile et al., 2017	Spaceflight	4
Antonsen et al., 2017	Spaceflight	4
Tansey et al., 1979	Analog	2
Prasad, 2011	Analog	1
Kesapli et al. 2015	Analog	1
Chaaban et al., 2017	Terrestrial	1
Fuchs et al., 2003	Terrestrial	1

Citation	Source	LOC Value
Pallin et al, 2005	Terrestrial	1

Spaceflight incidence data was rated the highest as analog and terrestrial studies did not accurately reflect the highly screened crewmembers or the spaceflight environmental conditions. Further, there was concern that analog and terrestrial studies would exert an overwhelming influence on the final incidence distribution given their large number of poorly representative subjects.

CREWMEMBER SELECTION/PREVENTION

DISQUALIFYING CONDITIONS

Refer to Medical Evaluation Documents (MED) Volume A, Medical Standards for ISS Crewmembers, International Space Station Program, Rev 3.4 (2016).

PREFLIGHT PREVENTATIVE MEASURES

Crewmembers undergo preflight clinical laboratory testing at: L-90/30 days which includes Blood: Hematology – CBC w/differential, reticulocytes; Chemistry profile – glucose, BUN, creatinine, AST, ALT, GGTP, alkaline phosphatase, total bilirubin, total protein, electrolytes, calcium, magnesium, phosphorus, LDH, uric acid, albumin; Ionized calcium; Thyroid function – free T4, TSH; Iron profile – iron, iron binding capacity, transferrin saturation, ferritin; Special chemistry – C-reactive protein, Serum lipids (total cholesterol, LDL, HDL, Triglycerides)Mouse IgE Allergen Panel Inflight, at the discretion of the crew medical officer, crewmembers are scheduled for blood chemistries L+180 days All astronauts must undergo annual medical examination that includes a medical history review and clinical laboratory testing.

BEST CASE SCENARIO DEFINITION

An anterior nosebleed that resolves with minimal or no treatment.

WORSE CASE SCENARIO DEFINITION

A posterior nosebleed that requires nasal packing and possibly surgical treatment.

CONDITIONS INCLUDED, BUT NOT EXPLICITLY STATED (CNES)

Space Adapation Epistaxis is covered in a different CLiFF and epistaxis events that occured in the first 5 days are excluded from this CLiFF's incidence calculation.

BEST CASE/WORST CASE PROBABILITY COMMENTS

There have been no worst-case events recorded in spaceflight and analog studies did not attempt to categorize types of epistaxis occurrences. Therefore, terrestrial data was used to determine the probability of the worst-case. In Viducich et al. 2016, a review of Akron City Hospital emergency department medical records was conducted between January 1, 1987, and January 31, 1993. One thousand seven hundred episodes of epistaxis were identified and 81 patients (5%), ranging from 27 to 96 years of age (mean: 64.3 years) experienced a posterior bleed. In Sethi et al. 2018, a retrospective review of the United States Nationwide Emergency Sample (NEDS) from 2009-2011 was queried for a primary diagnosis of 'epistaxis.' Of the 243,268 epistaxis associated visits, 17,789 (7.3%) patients (average age 64.4 years) had both anterior and posterior packing placed. Lastly, in the INTEGRATE (The National ENT Trainee Research Network) 2016, 113 registered emergency department sites across the United Kingdom were audited for the diagnosis of 'epistaxis' during a 30-day window. Although this study did not mention posterior epistaxis bleeds, it did determine that transfusion of blood products was performed in 4.5% of all the cases. Since both Sethi et al. and INTEGRATE possessed ambiguity in how posterior epistaxis bleeds were defined, data from Viducich et al. was used to represent the worst-case scenario. Importantly, the terrestrial data is likely an overestimation of cases expected to be seen in spaceflight as these datasets included patients with comorbid conditions not seen in spaceflight crewmembers. Further, the cephalad fluid shifts that occur initially in flight (responsible for space adaption epistaxis) have largely reached equilibrium for this CliFF condition.

TABLE 3.BEST/WORST CASE PROBABILITY LEVEL OF CONFIDENCE (LOC)

Citation	Source	LOC Value
Viducich et al., 1995	Terrestrial	2
Sethi et al, 2019	Terrestrial	0
INTEGRATE, 2016	Terrestrial	0

Only terrestrial data were obtainable to determine the worst-case probability. Of the available studies, only one study (Viducich et al., 2016) defined the worst-case similarly and provided prevalence data. As such, the other studies were excluded but listed here to help develop context.

TABLE 4. CLIFF TREATMENT & OUTCOME TABLE BY CLINICAL PHASE

Case Scenario	Composite Incidence	Condition Probability %	CP1: Diagnosis		CP2: Treatment			CP3: Condition End State				
			TI%	Duration	TI%	Duration		TI%	RTDC		LOCL	
			Preset	Preset	Preset	Min	Max	Preset	Min%	Max%	Min%	Max%
Treated Best Case (TBC)	0.1161 person-years SD: 0.05823	95 - 95	100	0.56	6.655	0.0833333	0.58	0	0	0	0	0
Treated Worst Case (TWC)		5 - 5	100	1.12	50	24	96	0	5.6	18	0	0
Untreated Best Case (UTBC)	N/A	N/A	N/A	0.56	6.655	0.0833333	0.58	0	0	0	0	0
Untreated Worst Case (UTWC)	N/A	N/A	N/A	1.12	100	24	912	100	18	100	0	0

TABLE 4 KEY

Composite Incidence: The same composite incidence will be used for both TBC and TWC. For EVA conditions: events per EVA (events/EVA). For space adaptation conditions: events per person (events/person). For non-spaceflight conditions: events per person year (events/py).

Condition Probability: The probability that CLiFF condition progresses to a worst case scenario. Best case scenario: 100%-Worst Case.

Clinical Phase General Comments:

- TI% = Task Impairment %. Task Impairment is the % of tasks that the crewmember is incapable of performing without impairment secondary to the medical condition.
- Durations are defined in hours.
- Removal to Definitive Care (RTDC): The probability the entire crew aborts the mission and returns to earth. This is considered as a condition end state result if any of the following criteria are met: 1) the potential for LOCL, 2) potential for significant permanent task impairment, or 3) potential for intractable pain.
- Loss of Crew Life (LOCL): The probability of death of affected crewmember due to medical condition.

Clinical Phase 1: Initial Assessment and Diagnosis:

- Covers only the initial assessment and diagnosis of the affected crewmember to define his or her medical condition. While the affected crewmember is being assessed, he or she is not able to perform any assigned tasks, thus Task Impairment (TI) during this phase is considered 100%. In the untreated case, there is no diagnosis performed, therefore Task Impairment and Duration will always be " not applicable."

Clinical Phase 2: Stabilization, Treatment, and Convalescence:

- The affected crewmember is receiving any appropriate initial or follow-on treatment for his or her medical condition to allow the crewmember to recover as much as he or she is able to recover in the spaceflight environment. Clinical phase 2 also encompasses relapses or recurrences of the same original medical condition in Clinical Phase 1. The duration of Clinical Phase 2 is expressed as minimum and maximum hours.

Clinical Phase 3: Condition End State:

- Reached once the affected crewmember has recovered from the medical condition as much as he or she is able to recover in the spaceflight environment amongst treated and untreated best and worst case scenarios. This may or may not be recovery from the given medical condition to the full extent possible. If this “recovered” state results in Removal to Definitive Care (RTDC) or Loss of Crew Life (LOCL) this will be noted in the condition end state results.

SCENARIO OVERVIEW COMMENTS

The best case is a nosebleed that resolves with no or limited treatment. In terrestrial scenarios, patients that experience the best case might not event seek medical care. The worst case, a posterior bleed, is at the minimum treated in the emergency department, often with subspecialist help. The RTDC surrogate used for the CLiFF was hospitalization or unresolving hemorrhage

TREATED BEST CASE (TBC) SCENARIO COMMENTS

Determining the duration of the treated best case (TBC) scenario is difficult as this definition is an episode that can be self-resolving. In a multidisciplinary epistaxis clinical practice guideline for the American Academy of Otolaryngology- Head and Neck Surgery Foundation (Tunkel et al., 2020), the statement: “firm and sustained pressure to the lower third of the nose, with or without assistance of the patient or caregiver, for 5 minutes or longer” received a strong recommendation (0.08 hours). Outpatient recommendations from other disciplines are similar (Womack et al., 2018; Morgan et al., 2014). The same authors also endorsed that even when active bleeding has ceased, patients should be monitored for next 30 minutes to ensure that epistaxis does not reoccur (0.08 hour + 0.50 hour = 0.58 hours). By definition, events that would lead to RTDC and LOCL are not expected for this condition. This is further supported as only one-tenth of patients that experience nosebleeds will pursue any treatment from a medical provider (Viehweg et al., 2006).

TREATED WORST CASE SCENARIO (TWC) COMMENTS

The treated worst-case definition involves a posterior nosebleed that requires packing and may require surgical treatment. Duration of the condition will be limited by the length of treatment. In this case, nasal packing--by means of either an inflatable pack or a foley balloon would be expected. Nasal packing can be removed in as little as 24 hours or left for as long as 72 hours. Longer durations are associated with pressure necrosis of nasal tissues (Seikaly, 2021; Krulewitz et al., 2019). However, in cases of refractory bleeding, some articles mention leaving packs in place for as much as 96 hours, but with the additional recommendation of initiating antibiotics for toxic shock syndrome (Viducich et al., 1995, Spielmann et al., 2012). “Severe epistaxis” is considered a Class IIa medical event: an incident that can be managed using the International Space Station (ISS) Health Maintenance System (HMS) and not likely to necessitate evacuation or affect mission length (Barratt et al., 2019). However a small number of patients in terrestrial conditions experience refractory bleeds not responsive to local measures. Out of 933 patients that required admission for epistaxis at NHS hospitals in England and Wales over a three-month period, 52 patients (5.6%) required general anesthesia and surgical intervention for refractory bleeding (Kotecha et al., 1996). In another retrospective review, 16 out 88 (18%) patients who presented to the emergency department for posterior epistaxis failed emergency medicine provider packing and required surgical intervention (Viducich et al., 1995). Of note, many of these patients were on anticoagulants, had diagnosed liver disease or thrombocytopenia. Mortality in the treated best case is rare: in one study 43 patients that required surgical intervention all survived their perioperative period (Abdelkader et al., 2007) and in another over a 15-year study period and a total of 141 interventions, there were no mortalities reported in the operative or perioperative period (Tessler et al., 2020).

UNTREATED BEST CASE (UTBC) SCENARIO COMMENTS

Similar to the rationale used in in the treated best case, the untreated best case is still a self-limited illness. To our knowledge, there are no studies detailing the time necessary to form a nasal clot without intervention. Consequently, duration was set to be identical to the treated best-case condition. By definition RTDC and LOCL are not expected for the treated or untreated best-case scenario.

UNTREATED WORST CASE (UTWC) SCENARIO COMMENTS

Defining parameters for the untreated worst case is difficult as the terrestrial standard of care is to attempt tamponade of any active nasal hemorrhage. Mortality from epistaxis primarily results from airway compromise or hemorrhagic shock, albeit other pathologies such as disseminated intravascular coagulation are possible as well. The first stage of hemorrhagic shock can occur with as little as 750 mL of blood loss and patients can exsanguinate in as little as two hours (median) without resuscitation from massive hemorrhage (Cannon, 2018). However, respiratory arrest and hemorrhagic shock are not covered in this condition but rather in another CliFF. Consequently, the minimum duration for the untreated worst case is estimated to be no less than the treated worst case (24 hours); albeit in actuality, the condition might proceed rapidly to the hemorrhagic shock condition. Literature to gather the maximum duration was limited to dated case-studies. Most described intermittent massive hemorrhages lasting several days (Quinn, 1961). One case described a 20-year-old miner who was struck in the face during an occupational accident in Colorado. He developed severe epistaxis repeatedly which subsequently resolved but reoccurred. After 38 days, the patient died of hemorrhagic shock (Levy, 1896). The minimum RTDC would be the maximum amount of the treated worst-case condition as the untreated version is presumed to have a higher rate of hospitalization or persistent bleeding. The maximum RTDC is estimated in 100%, considering the risk for a crew member with unstoppable bleeding.

TABLE 5. CLINICAL PHASE II DURATION LEVEL OF CONFIDENCE (LOC)

Citation	Source	LOC Value
Tunkel et al., 2020	Terrestrial	2
Womack et al., 2018	Terrestrial	
Morgan et al., 2014	Terrestrial	
Seikaly, 2021	Terrestrial	
Krulewitz et al., 2019	Terrestrial	
Viducich et al., 1995	Terrestrial	
Spielmann et al. 2021	Terrestrial	
Levy, 1896	Terrestrial	

Available studies to determine durations for treated cases involved clinical practice guidelines, systematic reviews, and retrospective studies. Due to the increasingly more rigourous Institutional Review Board guidelines of American institutions, literature for untreated best and worst cases were limited to extrapolation from dated case studes.

TABLE 6. RTDC LEVEL OF CONFIDENCE (LOC)

Citation	Source	LOC Value
Viehweg et al., 2006	Terrestrial	2
Kotecha et al., 1996	Terrestrial	
Viducich et al., 1995	Terrestrial	

RTDC percentages for the TBC and UTBC are expected to be zero given the conditions' definitions; as such articles were not reviewed for these conditions. In the TWC, RTDC was determined from retrospective reviews. The UTWC RTDC used the same studies as the TWC along with subject matter expert consensus given the lack of available literature detailing this scenario.

TABLE 7. LOCL LEVEL OF CONFIDENCE (LOC)

Citation	Source	LOC Value
Viehweg et al., 2006	Terrestrial	1
Abdelkader et al., 2007	Terrestrial	
Tessler et al., 2020	Terrestrial	

Based on the definitions, loss of crew life is not expected for any of the conditions. However, to validate the assumption that mortality was neglible a literature search was still conducted. A narrative review along with two small retrospective studies do provide negligiable mortality rates for hospitalized patients.

CAPABILITY RESOURCE TABLE (CRT) OVERVIEW

ICL - 38, Epistaxis
Definitions:
Best Case: An anterior nosebleed that resolves with minimal or no treatment.
Worst Case: A posterior nosebleed that requires nasal packing and possibly surgical treatment.

Capabilities and Resourcing Scope

Overview
Epistaxis, or nosebleeds, are common terrestrial occurrences with only approximately 6% of events requiring care by a medical provider.(Krulewitz et al. 2019) Most events resolve spontaneously or with gentle pressure to the bilateral nares. Albeit less frequent, severe events can result in hemorrhage, airway compromise and even hypovolemic shock. Causes of bleeding can range from dry or arid conditions, trauma, intranasal medications, infections, inflammation, malignancy, and systemic pathologies (such as clotting or platelet disorders); however, in many cases, no obvious precipitant is identified.(Seikaly 2021) Epistaxis is frequently classified by the anatomic source of bleeding as either anterior or posterior. (Tunkel et al. 2020; Womack et al. 2018) Anterior bleeds usually arise from Kiesselbach's plexus: a vascular network of the five arteries that supply

the nasal septum. Anterior bleeds, somewhat less frequently, can be traced to the inferior or middle turbinates as well. Generally, anterior bleeds are less difficult to treat as the source of bleeding is more readily visible (and therefore amenable to spot treatments such as cautery) and the area is compressible. Approximately 10% of epistaxis occurrences will be from posterior bleeds.(Seikaly 2021) Classically these bleeds arise from branches of the sphenopalatine artery and are more profuse in flow. Although they are most likely to occur from the posterior septum, they can also arise from the posterior nasal floor or lateral nasal wall. These areas are difficult to visualize without endoscopy and often require nasal packing, otolaryngology consultation, surgical management, and even intensive care admission.

In this CRT, the best-case refers to an anterior nosebleed that is easily resolved. Terrestrially, patients that experience the best-case scenario may not even seek medical care. Conversely, given the already inherent dangers of spaceflight and lack of access to immediate definitive care, resources are allocated to ensure that even a minor epistaxis does not reoccur. The worst-case condition refers to a posterior bleed that requires treatment. Even though the definition states that this condition may require surgical management, missions are not likely to carry the equipment necessary to definitively treat. Consequently it is feasible that without adequate treatment this condition may progress to more severe pathologies such as respiratory arrest. This CRT does not include resources for these downstream conditions as they are provided for in other CRTs. Also of importance, nosebleeds that occur within the first five days of spaceflight are covered in a different, but similar CRT entitled ‘Space Adaption Syndrome (SAS) Epistaxis.’

Diagnostic Scope and Resourcing

In the best case, diagnosis will be made via history and physical exam. Given the benign nature of this condition, it was decided by CRT group consensus not to allocate a tongue depressor or gloves for the exam. In the worst-case scenario, profuse nasal bleeding is expected and as such, personal protective equipment is allocated along with diagnostic equipment for the nasal sand oropharyngeal exams. Although in terrestrial conditions an otolaryngologist might be expected to visualize the bleed with fiberoptic rhinoscopy(Seikaly 2021), this is likely beyond the capabilities of onboard crew members and accordingly, an endoscopic rhinoscope was not resourced in this CRT. Profuse bleeding might result in a hematocrit decrease, but since hypovolemic shock is covered in a different CRT, a complete blood count was thought unnecessary by group CRT consensus for this condition.

Clinical Phase 1 Duration and Rationale

This version of IMPACT presumes physician level knowledge, skill, and ability will be present on the mission. The CRT working group SME consensus duration is as follows:

CP1 BC (Treated or Untreated): 0.56 hours

This is the longest reasonable time to complete the task for an experienced clinician (adjusted for being in the spaceflight environment) 1) to remove a crewmember from duties 2) obtain a history and 3) examine the patient.

CP1 WC (Treated or Untreated): 1.12 hours

This is the longest reasonable time to complete the task for an experienced clinician (adjusted for being in the spaceflight environment) 1) to remove a crewmember from duties 2)obtain a history 3) perform hand hygiene 4) don personal protective equipment 5) examine the patient 6) establish ground communications. Additional time for the nasal and oropharyngeal exams were apportioned to this worst-case condition.

The highest scope of practice code used in this CRT which includes interpretation of diagnosis, performing diagnostic tests and performing treatment (particularly inserting posterior packing) would be a five: this is at the experienced procedural trained generalist attending (emergency medicine attending).

Treatment Scope and Resourcing

In the best-case scenario, treatment is limited to non-invasive procedures and medications. Resources are also allocated to preventing recurrence. By its definition, the worst-case scenario requires intervention. The type of involvement will vary by the clinical scenario and resources are allocated for medications, hemostatic agents, and nasal packing. Although the definition does state that this is likely a posterior bleed, spot treatments (silver nitrate, tranexamic acid) are still allocated for the worst case as these would be important (and important to have on missions) in profuse anterior bleeds not amenable to simple compression—a case somewhat in the middle of the best and worst scenarios. In missions where access to definitive care is not immediately accessible, removal of nasal packing would be expected anywhere between three to six days after placement. Removal of packing would likely use the same resources as placement (syringe, etc.) and it would be expected to reuse these resources to limit waste. Similar to the best case, resources to prevent recurrence of epistaxis are also provided in the worst case.

Communications and Support Needs

In the best-case scenario, diagnosis and course of treatment is uncomplicated and likely within the scope of care of onboard crew members. In the worst-case condition, ground communications are necessary as there may be uncertainty regarding packing placement and other course of care.

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IMM CLIFF RECONCILATION COMMENTS

This CLiFF is the successor to the previous IMM CLiFF entitled "Nose bleed (space adaptation)." Of most importance, in this CLiFF effort, Space Adaptation Epistaxis and (conventional) Epistaxis were separated into two different conditions and calculated incidence rates reflect this. There is also some concern that the person-years for the LSAH data gathering (Walton M 2010; Saile L. 2017) was calculated incorrectly. Further a previous NASA internal whitepaper (Antonsen et al. 2017) had a table mislabeled as ‘ISS through Exp 40’ when in actuality, the data included in the table was for only expeditions nine, and 14 through 40. Thus, the spaceflight incidence in this CLiFF does differ from what was reported previously.

LIMITATIONS SUMMARY

• The separation of 'day 5' for space adaption epistaxis versus this condition is largely based on anecdotal experience. • The exact start dates of several inflight occurrences of epistaxis are unknown. • Literature regarding the untreated worst-case scenario was extremely limited and several parameters are based from subject matter expert opinion.

TABLE 8. TASK IMPAIRMENT CALCULATION BASED ON AFFECTED HUMAN SYSTEMS TASK CATEGORIES (HSTC)

Clinical Phase 2: Treatment												
	Affected HSTCs											
	Cognitive - Simple	Cognitive - Complex	Communications	Inter-personal Skills	Vision	Hearing	Cardio-pulmonary	Dentition	GI	GU		
Treated Best Case (TBC)	0	0	0	0	0	0	145	0	13	0		
Untreated Best Case (UTBC)	0	0	0	0	0	0	145	0	13	0		
Treated Worst Case (TWC)	223	664	113	89	854	44	145	5	13	6		
Untreated Worst Case (UTWC)	223	664	113	89	854	44	145	5	13	6		
	Affected HSTCs (Continued)								TI Calculation			TI Score
	Hand (Dom)	Hand (Any)	Upper Extremity	Lower Extremity	Ambul & Standing (g)	Translation & Stabilization (microgravity)	Don/Doff Equipment	Pressure Ops	Total Tasks Impaired By Condition	Total Human System Category Tasks Full Mission	TI Decimal	TI %
Treated Best Case (TBC)	132	0	0	0	0	0	0	211	501	3763	0.133138	13.3138
Untreated Best Case (UTBC)	132	0	0	0	0	0	0	211	501	3763	0.133138	13.3138
Treated Worst Case (TWC)	132	564	414	22	196	34	34	211	3763	3763	1	100
Untreated Worst Case (UTWC)	132	564	414	22	196	34	34	211	3763	3763	1	100

Clinical Phase 3: Condition End State												
	Affected HSTCs											
	Cognitive - Simple	Cognitive - Complex	Communications	Inter-personal Skills	Vision	Hearing	Cardio-pulmonary	Dentition	GI	GU		
Treated Best Case (TBC)	0	0	0	0	0	0	0	0	0	0		
Untreated Best Case (UTBC)	0	0	0	0	0	0	0	0	0	0		
Treated Worst Case (TWC)	0	0	0	0	0	0	0	0	0	0		
Untreated Worst Case (UTWC)	223	664	113	89	854	44	145	5	13	6		
	Affected HSTCs (Continued)								TI Calculation			TI Score

	Hand (Dom)	Hand (Any)	Upper Extremity	Lower Extremity	Ambul & Standing (g)	Translation & Stabilization (microgravity)	Don/Doff Equipment	Pressure Ops	Total Tasks Impaired By Condition	Total Human System Category Tasks Full Mission	TI Decimal	TI %
Treated Best Case (TBC)	0	0	0	0	0	0	0	0	0	3763	0	0
Untreated Best Case (UTBC)	0	0	0	0	0	0	0	0	0	3763	0	0
Treated Worst Case (TWC)	0	0	0	0	0	0	0	0	0	3763	0	0
Untreated Worst Case (UTWC)	132	564	414	22	196	34	34	211	3763	3763	1	100

TABLE 8 KEY

Human System Task Category (HSTC) Definitions: Cognitive-Simple: Tasks requiring simple cognitive involvement (low levels of attention, following simple checklists, and not requiring extensive decision making) in conjunction with inputs from other systems. Cognitive-Complex: Tasks requiring complex cognitive involvement (requiring constant attention, frequent interpretation of outside stimuli to inform real-time situations) in conjunction with inputs from other systems. Communication: Tasks requiring primarily communication, via hearing and speaking. Interpersonal Skills: Tasks requiring interpersonal, social interaction between crew including complex technical tasks that require extended crew interaction. Vision: Tasks in which visual information is required. Hearing: Tasks in which primarily auditory information is required, excluding communication, e.g. hearing alarms, medical auscultation, OOHAs. Cardiopulmonary: Tasks requiring greater-than-baseline cardiopulmonary effort, e.g. physically strenuous activities. Dentition: Tasks requiring use of teeth for mastication. GI (Gastrointestinal): Tasks requring use of the alimentary sytem, e.g. solids/liquids consumption and solids excretion. GU (Genitourinary): Tasks requiring use of the male/female genitourinary systems. Hand (Dominant): Tasks performed using primarily the hand, requiring use of the dominant hand (piloting, medical procedures, dental procedures). Hand (Any): Tasks performed using primarily the hand(s), with no preference for dominance, with equivalent bilateral effectiveness. Upper Extremity: Tasks requiring specific use of the upper extremities, excluding hands. Lower Extremity: Tasks requiring specific use of the lower extremities (excluding ambulation and standing in the presence of gravity), e.g. using exercise equipment. Ambulation and Standing (g): Tasks requiring use of both lower extremities to accomplish ambulation or standing in the presence of gravity. Translation and Stabilization (microgravity): Tasks requiring use of either the upper or lower extremities to accomplish translational movement and stabilization (securing oneself to remain stationary) in the setting of microgravity. Don/Doff Equipment: Tasks requiring the donning of personal equipment (including pressure suit, exercise harness, EVA equipment, etc). Pressure Ops: EVA/contingency tasks performed while pressurized in a suit.

Criteria for Assignment of Conditions to HSTCs (any of the following):

1) Is affected crew member physically incapable of performing the human system task category, without impairment, with the condition?
2) Would the treatment (e.g. medications) impair the crewmember's ability to perform the human system task category? (Does not apply to UTx)
3) Does the condition have a high likelihood of causing a significant aeromedical contraindication with an associated human system task category
4) Would performing tasks in an associated task category worsen the condition? (If so, it is affected).
5) Does pain associated with the condition impair any further human system categories?

TASK IMPAIRMENT COMMENTS

No comments

EVIDENCE COLLECTION PROCESS

Mesh terms that most closely resembled the best-case and worst-case scenarios, and associated Conditions Included but Not Explicitly Stated (CNES), were utilized to build incidence, duration, RTDC, and LOCL searches by best- and worst-case.

Incidence:

Databases searched for spaceflight and analog incidence data included: PubMed, Google Scholar, NASA Technical Reports Server (NTRS) public search, Defense Technical Information Center (DTIC), and Barratt MR, Baker E, Pool SL. Principles of Clinical Medicine for Space Flight. New York, NY: Springer; 2019. 2nd Edition. Databases searched for terrestrial incidence included: DynaMed, PubMed, and Google Scholar.

Duration, RTDC, LOCL:

Databases searched for duration, RTDC, and LOCL included: Dynamed, Cochrane, PubMed, and Google Scholar. Note, that if duration, RTDC, or LOCL data was found in a DynaMed search, the other search engines were not included. Relevant articles were selected and reviewed. If applicable, the article was included in the CLiFF.

LEVEL OF CONFIDENCE (LOC) SCORING

Articles obtained to update the evidence behind this CLiFF were scored by ExMC editors, based on their applicability to the Exploration Spaceflight environment using the following grading scale:

4 – Confident
3 – Somewhat confident
2 – Neutral
1 – Somewhat unconfident
0 – Not confident

The following considerations factor into the grading scale above:

• How closely does the paper describe the medical condition as defined by the IMPACT 1.0 Condiltion List (relevance)?
• How closely does the population included resemble the astronaut population?
• Quality of the paper (number of subjects, methods, etc.)
• How much does the editor trust the source of the evidence?
• How closely does the editor think that the data represents the exploration spaceflight environment?
• Other considerations, at the discretion of the editor, supported in the comments for LOE scoring.

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ACRONYMS

ACRONYM	PHRASE
AAOMS	American Association of Oral and Maxillofacial Surgeons
AMA	American Medical Association
ARCL	All Remaining Conditions List
ARS	Acute Radiation Sickness
BHP	Behavioral Health and Performance
CAC	Coronary Artery Calcium
CHS	Crew Health and Safety
CL	Condition List
CliFF	Clinical Finding Form
CMO	Crew Medical Officer
COMFORT	Clinical Outcome Metrics for Optimization of Robust Training
CP1	Clinical Phase 1
CP2	Clinical Phase 2
CP3	Clinical Phase 3
CRL	Clinical Resource Level
CRT	Capability Resource Table
CST	Clinical Science Team
DCS	Decompression Syndrome
DRM	Design Reference Mission
ED	Emergency Medicine Doctor
EL	Evidence Library
EMCL	Exploration Medical Condition List
EMT	Emergency Medical Technician
EVA	Extravehicular Activity
EXMC	Exploration Medical Capability
HRP	Human Research Program
ICD	International Classification of Disease
ICL 1.0	IMPACT 1.0 Medical Conditions List
ICU	Intensive Care Unit
IMCL	iMED Condition List
iMED	Integrated Medical Evidence Database
IMM	Integrated Medical Model
IMPACT-MD	Impact Medical Database
IP	Incidence Proportion
IR	Incidence Rate
ISS	International Space Station
IV	Intravenous
JSC	Johnson Space Center
LEO	Low-Earth orbit
LEVA	Lunar Extravehicular Activity
LOCL	Loss of Crew Life
LOM	Loss of Mission

LSAH	Lifetime Surveillance of Astronaut Health
LSO	Lunar Surface Operations
MCL	Master Condition List
MEVA	Medical Extravehicular Activity
NASA	National Aeronautics and Space Administration
N/A	Not Applicable
NP	Nurse Practitioner
OBGYN	Obstetrics and Gynecology
OR	Occurrence Rate
PA	Physician Assistant
PDQ	Pain Disability Questionnaire
PFCL	Proposed Future Conditions List
PPE	Personal Protective Equipment
PTRS	Project Technical Requirements Specification
PRL	Pharmaceutical Resource Level
QTL	Quality Time Lost
RCL	Removed Conditions List
REP	Rochester Epidemiology Study
RTDC	Removal to Definitive Care
SANS	Spaceflight-Associated Neuro-ocular Syndrome
SAS	Space Adaptation Syndrome
SEVA	Spaceflight Extravehicular Activity
SME	Subject Matter Expert
SoP	Standard Operating Procedure
SPE	Solar Particle Event
TBD	To Be Determined
TI	Task Impairment