Choking/Obstructed Airway Cliff

Branch Baseline

Foreign body aspiration can be a life-threatening emergency. An aspirated solid or semisolid object may lodge in the larynx or trachea. If the object is large enough to cause near or complete obstruction of the airway, asphyxia may rapidly cause death. Lesser degrees of obstruction or passage of the obstructive object beyond the carina can result in less severe signs and symptoms. Objects that descend beyond the trachea are more often found in the right endobronchial tree than in the left. (Warshawsky, 2010)

Possible mechanisms for choking and obstructed airway on orbit may include food that is partially swallowed that, due to microgravity, obstructs or irritates the upper airway. During exercise or while working near small floating objects that may be inhaled. Also talking or laughing while eating or drinking may increase the risk of choking or obstructed airway.

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:	3
Person Years:	45.49
Space Flight Incidence Rate (Events / Person Years):	3 / 45.49 = 0.065948560123104

Incidence Comments

There have been 3 events of foreign body inhalation have been reported in space flight. (Walton, 2010)

All events have been mild and self-limited. One event was described as aspiration of lint which occurred on the evening of flight day 7. The astronaut drank fluids and milk to help clear the lint. All symptoms were cleared by the next morning. A second inhaled hair while exercising, which caused the astronaut to “hack” for about one hour. The third occurred while working near an old vent that was blowing on the astronaut. The astronaut felt something go down into the upper airway. The astronaut coughed for 5 minutes, then cleared. No treatment was required. (Walton, 2010)

Increased person years by 18.17 to a total of 45.53 based on the real world system incidence data (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

Selection criteria

Disqualifying conditions in the nose, sinuses, mouth, and throat category 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; chronic enlargement of the tonsils, adenoids or redundant soft tissue of the oral pharynx that interferes with speech, swallowing, breathing, or is associated with recurrent otitis media. May be considered after surgical correction. In general, any medical condition that, in the judgment of the MSMB, may compromise mission operations, performance of duties, or crew health or safety. In the infectious diseases category: acute or chronic infectious diseases, until appropriately treated that might compromise mission operations, performance of duties, or crew health or safety. (International Space Station Program, 2009)

Other

Crew members are at increased risk of inhaling foreign bodies during space flight particularly during activities that increase minute ventilation such exercise. Sudden onset of cough accompanied by a local monotonic wheeze on auscultation would suggest foreign body inhalation. The crew medical officer (CMO) must assess all anatomical lung segments in the physical examination since the classic gravity dependent segments may not be at increased risk in microgravity. An affected crew member should be followed closely for atelectasis or pneumonia development in lung segments distal to the occlusion. Auscultaion may be challenging in the spacecraft cabin due to ambient noise. (Marshburn, 2008).

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

It is doubtful that the denominator, numerator, appropriateness, expertise, and problems of maneuvers applied to choking victims will ever be known. (Chillag, 2010) Literature on foreign body aspiration in adults is limited. The often fatal syndrome of acute asphyxiation from upper airway obstruction associated with eating, known as the "café coronary," and aspiration of gastric contents are usually not considered with other foreign body aspiration syndromes. For these reasons, the true incidence and prevalence of foreign body aspiration is unknown. (Warshawsky, 2010)

According to the National Safety Council, choking remained the fourth leading cause of unintentional injury death in the United States as of 2004. In 2006, a total of 4,100 deaths (1.4 deaths per 100,000 population) from unintentional ingestion or inhalation of food or other objects resulting in airway obstruction was reported. The incidence rate was 0.5 deaths per 100,000 population aged 0-4 years. It was lower for adolescents and young adults. The incidence rate then increased steadily with age beginning in the sixth decade, 2.6 deaths per 100,000 population aged 65-75 years. (Warshawsky, 2010)

Suffocation and choking injury is the fifth leading cause of injury death for Manitobans and the seventh leading cause of unintentional injury death for Canadians. For the age cohorts 35-44, 45-54, and 55-64 death rates by suffocation and choking were overall 1.3, 1.1, 1.9; all higher for males than females. Hospitalization rates for the same cohorts were 1.7, 3.3 and 4.7. All rates per 100,000. The publication does not include confidence intervals or standard error rates.

In 1990 a retrospective study of 60 consecutive adult patients, over 16 years of age, evaluated for tracheobronchial foreign body aspiration. All 60 patients had bronchoscopic evaluation; 59 of them had foreign bodies identified and removal was attempted using either rigid or flexible fiberoptic bronchoscopy. Twenty five had underlying impairment of protective airway mechanisms (primary neurologic disorders, trauma with loss of consciousness, or sedative or alcohol use). Fifty seven were successfully managed with bronchoscopy. Fiberoptic bronchoscopy was successful in 14 of 23 patients, and rigid bronchoscopy was successful in 43 of 44 patients, including 6 of 7 patients in whom previous fiberoptic bronchoscopy had failed. Thoracotomy was required in 3 patients. Complications of bronchoscopy were rare and not serious. Chronic complications of prolonged foreign body impaction included bronchiectasis in 3 patients. (Limper, 1990)

In Croatia, a retrospective study reviewed patients submitted to bronchoscopy from 1995 to 2006. Tracheobronchial foreign bodies (TFB) were found in 86 (0.33%) out of 26,124 patients who were submitted to flexible bronchoscopy. The majority of the patients (90%) had some risk factor for aspiration, among which stroke (30%) was the most frequent. Patients with different neurologic and neuromuscular diseases together accounted for 58% of all patients with TFB aspiration. Medical history was suggestive of foreign body aspiration in 38.4% of the patients, while chest X-ray was indicative in 7% of the patients. TFBs were most often found in the right bronchial tree (75.6%). The most common TFBs were animal and fish bones (39.5%). In 90.7% of the patients they were successfully removed under direct flexible bronchoscopy, whereas in 8.1% of the patients a TFB was extracted with flexible bronchoscope through endotracheal tube. Surgery was needed in only one case. (Mise, 2009)

A retrospective study in San Diego to describe treatments of foreign body airway obstruction in adults in the pre-hospital setting, over 17 months, determined that there were 513 cases of foreign body airway obstruction in adults. Of these, 17 (3.3%) died. The mean age was 65 years, with increasing age correlating with worse outcome. The item causing obstruction varied widely, with medications and meat being the most common items. The Heimlich maneuver was the most commonly used intervention, with an 86.5% rate of patient improvement. Magill forceps proved useful for three cases refractory to the Heimlich maneuver. Presenting vital sign aberrations, particularly with respiratory rate, correlated with poorly patient outcome. (Soroudi, 2007).

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 %: 99 - 100)	100	0.08	2 - 49	0 - 1 - 2	0	0	0
ISS-based Treatment (worst case scenario %: 0 - 1)	100	0.3	62 - 100	2 - 13 - 24	0 - 100	0 - 17	0 - 3
Untreated Best Case	0	0	0 - 100	0 - 1 - 2	0	0	0
Untreated Worst Case	0	0	100	2 - 13 - 24	100	100	0 - 100

[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 scenario is defined as choking and cough that resolves spontaneously, or obstructed airway that responds to the Heimlich maneuver.

Worst case scenario is defined as choking and obstructed airway that requires instrument extraction or advanced life support.

Based on a study my Mise published in 2009, 86 out of 26,124 adult patients (0.33%) with choking/obstructed airway had documented tracheobronchael foreign bodies. This statistic is considered conservative since this population had higher risk factors than our population for aspiration including, stroke, alcohol, head injury, neuromuscular and psychiatric conditions. To allow for uncertainty we estimated worst cases at 0-1% thus best cases are 99-100%. (Mise, 2009)

Best Case Comments

Choking - Obstructed Airway functional impairments (FI) calculation follows the IMM severe non-space adaptation template, with adjustments made to adapt to the severity of a choking event. Exceptions were made in worst case scenario, untreated best case, and untreated worst case. In the worst case scenario, during Clinical Phases II and III, classes 3 to 4 and 0-4 were used respectively. In the untreated best case, during Clinical Phases II and III, classes 0-4 and 0 were used respectively. For the untreated worst case, in both Clinical Phases II and III, FI is assigned class 4. Air passage deficits gradings are based on Table 11-6, p.267 (American Medical Association, 2008). Consciousness and Awareness gradings are based on Table 13-4, p 327 (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 choking treatment as described in ISS medical checklist for the best case scenario is estimated in 5 minutes. During Clinical Phase II, FI is estimated in 2 to 49%. Duration is estimated in 0 to 2 hours based on in-flight data (Walton, 2010). Clinical Phase III, by definition, full recovery is expected and FI is 0%; EVAC and LOCL are not expected for the best case scenario.

Worst Case Comments

Choking - Obstructed Airway functional impairments (FI) calculation follows the IMM severe non-space adaptation template, with adjustments made to adapt to the severity of a choking event. Exceptions were made in worst case scenario, untreated best case, and untreated worst case. In the worst case scenario, during Clinical Phases II and III, classes 3 to 4 and 0-4 were used respectively. In the untreated best case, during Clinical Phases II and III, classes 0-4 and 0 were used respectively. For the untreated worst case, in both Clinical Phases II and III, FI is assigned class 4. Air passage deficits gradings are based on Table 11-6, p.267 (American Medical Association, 2008). Consciousness and Awareness gradings are based on Table 13-4, p 327 (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 treatment as described in ISS medical checklist is estimated in 20 minutes During Clinical Phase II, FI is estimated at 62-100%. Duration is estimated in 2 to 24 hours. The upper limit is the minimum time to evacuation. (Beck, 2004) In the Soroudi study it was found that 17% of patients with choking or airway obstruction required hospitaliztion, with a 3.3% mortality rate. (Soroudi, 2007) Based on that statistic in Clinical Phase III, full recovery is expected in 83%.

To allow for uncertainty FI is estimated at 0-100% EVAC is estimated at 0-17% and LOCL 0-3%.

Untreated Best Case Comments

Choking - Obstructed Airway functional impairments (FI) calculation follows the IMM severe non-space adaptation template, with adjustments made to adapt to the severity of a choking event. Exceptions were made in worst case scenario, untreated best case, and untreated worst case. In the worst case scenario, during Clinical Phases II and III, classes 3 to 4 and 0-4 were used respectively. In the untreated best case, during Clinical Phases II and III, classes 0-4 and 0 were used respectively. For the untreated worst case, in both Clinical Phases II and III, FI is assigned class 4. Air passage deficits gradings are based on Table 11-6, p.267 (American Medical Association, 2008). Consciousness and Awareness gradings are based on Table 13-4, p 327 (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 0 to 100%. Duration is 0 to 2 hours, similar to the treated best case scenario. In Clinical Phase III, by definition, full recovery is expected. FI is 0% and EVAC and LOCL are not expected for the best case scenario.

Untreated Worst Case Comments

Choking - Obstructed Airway functional impairments (FI) calculation follows the IMM severe non-space adaptation template, with adjustments made to adapt to the severity of a choking event. Exceptions were made in worst case scenario, untreated best case, and untreated worst case. In the worst case scenario, during Clinical Phases II and III, classes 3 to 4 and 0-4 were used respectively. In the untreated best case, during Clinical Phases II and III, classes 0-4 and 0 were used respectively. For the untreated worst case, in both Clinical Phases II and III, FI is assigned class 4. Air passage deficits gradings are based on Table 11-6, p.267 (American Medical Association, 2008). Consciousness and Awareness gradings are based on Table 13-4, p 327 (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 100%. Duration is estimated in 2 to 24 hours, similar to the treated worst case scenario. During Clinical Phase III, by definition recovery is not possible without timely advanced treatment on the ground. FI is estimated at 100%. EVAC is 100% and, to allow for uncertainty, LOCL is estimated at 0-100%.

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
Mise, 2009	4	EVAC
American Medical Association, 2008	3	FI
American Medical Association, 2008	3	FI
American Medical Association, 2008	3	FI
Soroudi, 2007	4	BCWC

The Resource Table (RT)

Resource	Units Required Best Case	Units Required Worst Case	Units Available At Start Of Mission	Consumable	Essential	Rationale
Ambu bag and mask	0	1	1	No	Yes	Hand-held device used to provide positive pressure ventilation to a patient who is not breathing or is breathing inadequately
Blood Oximeter	0	1	1	No	Yes	Monitors the oxygen saturation of a patient's blood
Blood Pressure Cuff (regular, large)	1	1	2	No	Yes	Measure blood pressure
Blood Pressure Monitor	1	1	1	No	Yes	Measure blood pressure
BZK wipes	0	6	60	Yes	No	Cleanse skin.
CMRS	0	1	1	No	No	Restrain crew member to ensure safety
ECG Monitor (Device, USB Charge Cable, Lead Set Cable, Cue Card)	0	1	1	No	Yes	Measure and monitor ECG
Endotracheal Stylet	0	1	1	No	Yes	Assist with advanced airway insertion
Endotracheal Tube 7.0/8.0	0	1	4	Yes	Yes	Establish and maintain patent airway and ventilation
EtCO2 Monitor with EMMA adapter	0	1	1	No	Yes	Measure end tidal CO2
Gauze pads (4x4)	0	25	50	Yes	No	To absorb blood or fluids from skin
Heimlich maneuver	1	1	1	No	Yes	To expell or dislodge foreign body
Hemostats	0	1	1	No	Yes	To open incision for tracheostomy tube placement
Ketamine 50 mg/mL, 10 mL multi dose vial	0	0.3	6	Yes	Yes	For sedation in case of intubation/ventilation.
King Supraglottic Airway (SGA) Tube (size 3/size 4)	0	1	2	Yes	Yes	Establish and maintain patent airway and ventilation
Laryngoscope (blade)	0	1	1	No	Yes	For intubation
Laryngoscope handle	0	1	1	No	Yes	For intubation
Medical tape	0	0.06	5	Yes	No	Part of IKA (intubation kit airway) to secure tracheostomy tube in place
Nasal Airway (6mm, 7mm)	0	1	2	No	Yes	Airway management
Needle (23G)	0	3	20	Yes	Yes	For medication administration.
Nitrile gloves (large, medium, and small) (pair)	0	1	30	Yes	No	Personal Protective equipment for CMO
Oral Airway	0	1	2	No	Yes	Airway management
Otoscope (Head, Handle, and USB cable)	1	1	1	No	Yes	As a light source for viewing foreign bodies in oropharynx.

Resource	Units Required Best Case	Units Required Worst Case	Units Available At Start Of Mission	Consumable	Essential	Rationale
Pack of 12 ECG electrodes	0	1	5	Yes	Yes	Measure and monitor ECG
PEEP Valve	0	1	1	No	Yes	Provide positive airway pressure during ventilation
Scalpel #11 (scalpel blade & handle)	0	1	2	No	Yes	Holds a scalpel blade to facilitate use during surgery
SGA Cue Card	0	1	1	No	Yes	Guidance for use of supraglottic airway
Stethoscope	1	1	2	No	Yes	To listen for breath sounds including to confirm ET tube is correctly placed in the trachea
Suction Cartridge	0	1	1	No	Yes	Provide medical suction
Suction device	0	1	1	No	Yes	To suction fluids from airway
Suction device collection bag	0	1	2	Yes	No	To collect fluids suctioned from mouth/airway
Suction device syringe	0	1	1	No	Yes	To remove fluids/vomit from mouth
Suction tip - mouth (curette)	0	1	1	No	Yes	To remove fluids/secretions/vomit from mouth - Suction ET catheter is included in tracheal section
Suction Tubing - Endotracheal Tube	0	1	1	Yes	Yes	Provide airway suctioning
Surgical Lubricant	0	2	6	Yes	No	Provide lubrication during the ILMA insertion.
Syringe (10cc)	0	1	6	Yes	Yes	To inflate balloon in ET tube (10 cc)
Syringe (35cc)	0	1	1	Yes	Yes	Inflation of SGA tube
Syringe (3cc)	0	3	20	Yes	Yes	For medication administration.
T-adapter	0	1	1	No	Yes	Connection for ventilation tubing
Thermometer	0	1	1	No	No	To measure temperature
Tongue depressor	1	1	20	Yes	No	To depress tongue and facilitate airway exam
Valium (Diazepam) 5 mg/mL, 2 mL syringe	0	1	2	Yes	Yes	for sedation with intubation
Variable Oxygen System	0	1	1	No	Yes	Ventilation
VOS Intubated Patient Hardware (Ventilator/Respirator)	0	1	1	No	Yes	Mechanical Ventilation

Resource Comments

The table was revised on 8/23/2011. We added rationales and required resources for blood pressure, vital signs and electrocardiogram monitoring.

The ISS medical checklist includes procedures for choking, conscious and unconscious victim. All resources included in the resource table are available on board (Mission Operations Directorate (MOD), 2011).

Comparison of ISS Med Checklist procedures versus clinical guidelines

ISS medical checklist recommends procedures similar to current terrestrial guidelines (Parks, 2011)such as Heimlich maneuver, cardiopulmonary resuscitation, intubation and ventilatory support. (Beck, 2004) Procedures in the ISS medical checklist are adapted to microgravity.

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	4
EVAC / LOCL	4
Resources	2
QUALITY OF EVIDENCE	**2.8**

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

Reference List

Reference
American Medical Association. Guides to the Evaluation of Permanent Impairment. 6th ed. Chicago: American Medical Association Press; 2008.
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.
American Medical Association. Central and Peripheral Nervous System. Guides to the Evaluation of Permanent Impairment. 6th ed. Chicago: American Medical Association Press; 2008. p. 321-45.
Beck G. Emergency airway management in orbit: an evidence-based review of possibilities. Respir Care Clin N Am 2004 Sep;10(3):401-21, vii.
Chillag S, Krieg J, Bhargava R. The Heimlich maneuver: breaking down the complications. South Med J 2010 Feb;103(2):147-50.
International Space Station Program. Medical Standards for ISS Crewmembers - MED Vol A. 3.2 ed. NASA; 2011.
Limper AH, Prakash UB. Tracheobronchial foreign bodies in adults. Ann Intern Med 1990 Apr 15;112(8):604-9.
Marshburn TH. Acute Care. In: Barratt M, Pool S, editors. Principles of Clinical Medicine for Space Flight.New York: Springer; 2008. p. 101-22.
Mise K, Jurcev SA, Pavlov N, Jankovic S. Removal of tracheobronchial foreign bodies in adults using flexible bronchoscopy: experience 1995-2006. Surg Endosc 2009 Jun;23(6):1360-4.
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).
Parks SN, Kaufmann CR, Hoyt DB, Meredith JW, Acker J, Ali J, et al. Airway and Ventilatory Management. Advanced Trauma Life Support for Doctors. 7th ed. Chicago: American College of Surgeons; 2011. p. 41-68.
Saile L., Boley L, Kerstman E. Integration RWS ISS STS Observed Incidence V2. 2017.
Saile L, Boley L, Kerstman E. Integration RWS ISS STS Observed Incidence. 2017.
Soroudi A, Shipp HE, Stepanski BM, Ray LU, Murrin PA, Chan TC, et al. Adult foreign body airway obstruction in the prehospital setting. Prehosp Emerg Care 2007 Jan;11(1):25-9.
Walton M, Kerstman E, IMM. In-flight Compilation v20100414_Incidence_calculation. 2010.
Warshawsky M. Foreign Body Aspiration. Mosenifar Z, editor. WebMD - Medscape Reference . 6-11-2010. New York, WebMD. 8-23-2011.