Clinical Finding Form (CliFF)

Branch Baseline

ICL90_Small Bowel Obstruction

Small bowel obstructions are common, accounting for 12 to 16 percent of surgical hospital admissions and more than 300,000 operations annually in the United States. Patients diagnosed with acute small bowel obstruction should be admitted to the hospital and evaluated by a surgeon. Postoperative adhesions and strangulated hernias are the most common causes of small bowel obstruction, while a variety of conditions, such as cancer, diverticulitis, volvulus, constipation and inflammatory bowel disease, can cause large bowel obstruction. The common symptoms of small bowel obstruction are pain (colicky at first), abdominal distension, vomiting, and after some time absence of flatus and stool, vomiting and dehydration. The goals of initial management are to relieve discomfort and to restore normal fluid volume and electrolytes. Bowel compromise (ischemia, necrosis, or perforation) and a surgically correctable cause (e.g., incarcerated hernia) require immediate surgical exploration; other patients may be a candidate for nonoperative management. It is essential to identify the patient with threatening or actual strangulation of the bowel. This is suggested by a sharper, more constant and more localized pain, and the patient often has fever and signs of peritonitis (diffuse tenderness, guarding). A small bowel obstruction requires urgent care and may require medical evacuation.

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

There are no documented events of small bowel obstruction during spaceflight.

ANALOG LITERATURE

Glover reported 1 bowel obstruction aboard UK Polaris submarines, during the period 1968-1978. The incidence was estimated to be 1 surgical patient per 7,944 man-days (0.000125 x 365) = 0.0459 events/person-years. No EVAC was reported (Glover, 1981). Tansey reported medical events in US submarines. There were 2 small bowel obstruction events during the period 1968-73, causing 7 sick days (Tansey, 1979). We estimated the incidence rate as 0.000165 events/person-year (2/4,410,000 man-days * 365 days/1 year). There were EVACs for surgical conditions but they were not segregated by condition (Tansey, 1979). The Tansey study is used to estimate the incidence rate for this condition since this is a large healthy medically screened population somewhat similar to the astronaut population.

TERRESTRIAL LITERATURE

(Scott, 2012) found the incidence of SBO to be 28.9 to 41.6 events per 100,000 person-years in persons aged 15-44 years. This study involves a large terrestrial general population. However, this population is not a healthy screened population like the astronauts and therefore is only given an LOC = 2 (neutral).

OVERALL INCIDENCE SUMMARY

INCIDENCE

mean 1.667E-4 and SD 1.175E-4

INCIDENCE SUMMARY

The Bayesian posterior distribution for the incidence rate given the Polaris submariner analog data, under an uninformative prior, is

Gamma(shape=2.0128, rate=12074.24) with mean 1.667E-4 and SD 1.175E-4. Evidence: Analog – Submariners – Tansey 1979. Analysis of health data from 10 years of Polaris submarine patrols. Total man-days for submarines: 4,410,000 which is 12073.92 person-years (365.25 days per year). 2 cases of small bowel obstruction reported. IR: 1.656E-4 (95%CI: 0.2777E-4, 5.473E-4)

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
0.000166702

SD
0.000117501

Gamma
(Shape): 2.0128
(Rate): 12074.2

TABLE 2. INCIDENCE LEVEL OF CONFIDENCE (LOC)

Citation	Source	LOC Value
Tansey, 1979	Analog	3

(Tansey, 1979) is based on a large analog military population study. This study is used to estimate the incidence rate for small bowel obstruction in astronauts during spaceflight since it involves a large healthy medically screened population somewhat similar to the astronaut population. This study is given an LOC = 3 (somewhat confident).

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

There are no specific preflight preventive measures for small bowel obstruction.

BEST CASE SCENARIO DEFINITION

A small bowel obstruction which responds to conservative medical treatment such as bowel rest, fluid resuscitation, analgesics and NG tube.

WORSE CASE SCENARIO DEFINITION

A small bowel obstruction that is not responsive to conservative management and requires surgical intervention.

CONDITIONS INCLUDED, BUT NOT EXPLICITLY STATED (CNES)

None

BEST CASE/WORST CASE PROBABILITY COMMENTS

Terrestrial general population studies were used to estimate the best case scenario and worst case scenario percentages. In Shih 2003, there was 155 patients that had a total of 293 admissions (from January 1999 to December 2001). Of the 293 admissions, medical management alone was used during 220 (75.1 %) admissions, repeat laparotomy was performed in 73 admissions. The duration of observation until resolution of bowel obstruction ranged from 2 to 12 days with an average of 6.9 days (Shih, 2003). From Catena 2015, Level I data have shown that non-operative management can be successful in up to 90% of patients without peritonitis (Catena, 2015). Using these studies, it estimate that the best case scenario percentage is 75% to 90% and a worst case scenario percentage is 10% to 25%. It should be noted that the best case percentage will likely be higher in a younger and healthier astronaut population.

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

Citation	Source	LOC Value
Shih, 2003	Terrestrial	3
Catena, 2015	Terrestrial	3

Terrestrial population studies are used to estimate the best case scenario and worst case scenario percentages. In Shih 2003, there was 155 patients that had a total of 293 admissions (from January 1999 to December 2001). Of the 293 admissions, medical management alone was used during 220 (75.1 %) admissions, repeat laparotomy was performed in 73 admissions. The duration of observation until resolution of bowel obstruction ranged from 2 to 12 days (average 6.9 days (Shih, 2003). From Catena 2015, Level I data have shown that non-operative management can be successful in up to 90% of patients without peritonitis (Catena, 2015). Using these two studies results in a best case probability percentage of 75% - 90% and a worst case probability percentage of 10% -25%. It should be noted that the best case percentage may be somewhat higher in a younger and healthier astronaut population. These studies are given a LOC = 3 (somewhat confident).

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)	mean 1.667E-4 and SD 1.175E-4	75 - 90	100	1.583	34.9588	48	288	0	0	0	0	0
Treated Worst Case (TWC)		10 - 25	100	1.583	96.8775	48	336	99.8406	100	100	3	30
Untreated Best Case (UTBC)	N/A	N/A	N/A	1.583	86.4204	48	288	100	20	60	0	0
Untreated Worst Case (UTWC)	N/A	N/A	N/A	1.583	100	48	336	100	100	100	30	100

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

Small bowel obstruction incidence is based on a terrestrial general population study that captured all hospitalizations for small bowel obstructions. The worst case scenario percentage represents the percentage of cases of small bowel obstruction that do not respond to nonoperative management. The RTDC surrogate is the need for surgery.

TREATED BEST CASE (TBC) SCENARIO COMMENTS

The duration in treated best case scenarios was characterized in (Shih, 2003). Conservative treatment ranged from 2-12 days, with an average of 6.9 days. In (Cox, 1993) complete resolution for non-operative treatment occurred within 48 hours in 75 (88%) cases, the remaining 10 had resolved by 72 hours. RTDC in the treated best case scenario is 0% based on the best case scenario definition. The probability of LOCL for the treated best case scenario is 0% based on the best case scenario definition.

TREATED WORST CASE SCENARIO (TWC) COMMENTS

The clinical phase 2 durations encompass relapses or recurrences of the same medical condition necessitating additional treatment or recovery time due to unsuccessful primary treatment response. The literature (Foster, 2016) found recurrence rates of SBO in patients managed nonoperatively 12% within 1 year and 20% within 5 years. This could have implications for long interplanetary missions. The average duration for worst case SBO was 48 to 336 hours (Shih, 2003). The probability of RTDC for the treated worst case scenario SBO 100% based on the worst case definition (SBO that is not responsive to conservative management and requires surgical intervention). A complicated case of small bowel obstruction is considered to be a medical emergency in which the obstruction has progressed to intestinal ischemia, gangrene, and/or perforation. These are life threatening emergencies that require urgent resuscitation and surgical intervention. These complicated cases of small bowel obstruction may result in loss of crew life. Published studies (Long, 2019) (Rami 2017) indicate that complicated cases of small bowel obstruction have an overall mortality between 3% and 10%, but this increases to 30% with bowel necrosis/perforation. Therefore, LOCL is estimated at 3% to 30%.

UNTREATED BEST CASE (UTBC) SCENARIO COMMENTS

There is little data on untreated SBO. Even in austere environments such as submarines and Antarctic stations, IV fluids are available and used in conservative treatment. The duration for an SBO with no conservative treatment ranges from 2-12 days, with an average of 6.9 days (Shih, 2003). The probability of RTDC for the untreated best case scenario of a SBO was estimated based on data related to the progression to surgical management in terrestrial patients. This was found to be between 20% and 50-60% by (Cox, 1993) and (Muang, 2012) . Hence, even if a patient is initially responsive to nonoperative treatment, they still may require RTDC up to 60% of the time for operative management. Therefore, the probability of RTDC is estimated as 20% - 60%. SBO that was initially responsive to conservative treatment can progress to a worst case scenario. The probability of LOCL due to SBO in the best case scenario is 0% by definition.

UNTREATED WORST CASE (UTWC) SCENARIO COMMENTS

For untreated worst case scenarios, immediate evacuation is required. The average duration for worst case SBO was 48 to 336 hours (Shih, 2003). The probability of RTDC is 100% for the untreated worst case scenario based on the worst case definition. For LOCL , strangulated bowl found on imaging was used a surrogate for "worst case "as these cases are typically more advanced and/or not responsive to conservative treatment. Mortality data for this population subset was found in systematic reviews of terrestrial patients. The lowest mortality reported with SBO, strangulated bowl, and nonoperative treatment is 30% (Reddy 2017). Smith reported a mortality rate of close to 100% in patients with SBO and any strangulated bowel that is left untreated (Smith 2021). This wide variation is due to many factors including time of presentation to the hospital and the differences in etiology of SBO (tumor, adhesions, hernias). In a medically screened astronaut population with no pre-existing conditions, the mortality rate may be towards the lower end of that range. The probability of LOCL is therefore estimated as 30% - 100%.

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

Citation	Source	LOC Value
Shih, 2003	terrestrial	
Cox, 1993	terrestrial	

Citation	Source	LOC Value
Foster, 2006	terrestrial	1
Smith, 2021	terrestrial	
Johnson, 2008	analog	

The studies that were used to inform duration of illness (CP2) were mainly in terrestrial patients. LOC was 1 (somewhat unconfident) for these because all patient populations were generally older and had significantly more co-morbidities that the average astronaut population. Furthermore, these studies were conducted in hospitalized patients with full access to emergency and ICU care. (Shih, 2003) was the main source used for CP2 durations for the best and worst case scenarios.

TABLE 6. RTDC LEVEL OF CONFIDENCE (LOC)

Citation	Source	LOC Value
Shih, 2003	terrestrial	3
Cox, 1993	terrestrial	
Muang, 2012	terrestrial	
Boudiaf, 2001	terrestrial	
ten Broek, 2018	terrestrial	

In a terrestrial study (ten Broek, 2018), nonoperative management was reported to be successful in 70%-80% of patients with partial obstruction without peritonitis. Combining this data we find that the minimum RTDC in the best case treated group was 0% by definition. RTDC for the untreated worst case scenario of small bowl obstruction was set at 100% based on the worst case scenario definition. RTDC is given an LOC = 3 (somewhat confident) based on terrestrial general population studies.

TABLE 7. LOCL LEVEL OF CONFIDENCE (LOC)

Citation	Source	LOC Value
Long, 2019	terrestrial	2
Rami, 2017	terrestrial	
Paulson, 2015	terrestrial	
Reddy, 2017	terrestrial	
Smith 2021	terrestrial	

Studies for LOCL were given an LOC value of 2 (neutral) for the worst case scenarios since these studies suffered from some of the same drawbacks as the articles used for the CP2 duration (all patient populations were generally older and had significantly more co-morbidities that the average astronaut population). The strengths of these studies were that they were all meta-analysis of different studies that incorporated a large sample size of patients with different etiologies of SBO and different age ranges, and included studies from many countries and hospitals. LOCL is given an LOC of 4 (confident) for the best case scenarios based on the best case definition.

CAPABILITY RESOURCE TABLE (CRT) OVERVIEW

Capabilities and Resourcing Scope Overview In general, SBO occurs when the flow of intestinal contents through the small bowel is impeded and management depends upon the etiology and severity. As adhesions are one of the leading causes of SBO terrestrially, initial often involves surgical consultation and consideration of operative intervention. However, as surgical intervention will not be possible, the condition will be worked up and treated conservatively. CNES: None Diagnostic Scope and Resourcing Diagnosis begins with a history, primary assessment, and abdominal exam. In patients with high-grade obstruction, ultrasound evaluation of the abdomen has high sensitivity (85%). Terrestrially, CT has largely replaced ultrasonography as the first-line investigation in stable patients with suspected intestinal obstruction, however, during spaceflight, US can be considered to help with the diagnosis if it is equivocal. Lastly, part of the triage in determining severity is also determining volume depletion, electrolyte abnormalities, or metabolic acidosis/alkalosis is present and thus intravenous access, a BMP, and CBC should be obtained. Given the definitions of this case, the diagnostic resourcing remains the same for both the best and worst case. 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): 1.583 CP1 WC (Treated or Untreated): 1.583 The highest scope of practice required for diagnosis includes the interpretation of the ultrasounds which is SOP 5 (attending). Treatment Scope and Resourcing For the best case, the resourcing standard of care involves making the patient nil per os (NPO) and initiating IV hydration. IV antiemetics can be used to assist with nausea/vomiting caused by the obstruction, however, will not treat the obstruction itself. Other adjunctive medications include the use of oral gastrographin, magnesium oxide, simethicone, and probiotics. All of these modalities have shown an improvement in outcomes with SBO, however, severe SBOs will preclude the ability to utilize oral agents effectively. For the worst case, while all of these modalities can be considered, likely a nasogastric tube will be needed for decompression, low-powered suction, and drainage. Surgical management will not be possible. Communications and Support Needs While ground communications can help guide management and guide RTDC decisions especially if the diagnosis warrants surgical management, the need for picture or video messaging is unlikely. REFERENCES Abbas S, Bissett IP, Parry BR. Oral water soluble contrast for the management of adhesive small bowel obstruction. Cochrane Database Syst Rev. 2007 Jul 18;2007(3):CD004651. doi: 10.1002/14651858.CD004651.pub3. PMID: 17636770; PMCID: PMC6465054. Chen SC, Yen ZS, Lee CC, Liu YP, Chen WJ, Lai HS, Lin FY, Chen WJ. Nonsurgical management of partial adhesive small-bowel obstruction with oral therapy: a randomized controlled trial. CMAJ. 2005 Nov 8;173(10):1165-9. doi: 10.1503/cmaj.1041315. PMID: 16275967; PMCID: PMC1277043.

IMM CLIFF RECONCILATION COMMENTS

LIMITATIONS SUMMARY

There are no documented events of small bowel obstruction during spaceflight. Large terrestrial studies do not stratify healthy patients from patients with multiple comorbid medical conditions who may be more likely to develop small bowel obstruction. It is uncertain how a small bowel obstruction would manifest and respond to treatment in microgravity and partial gravity environments.

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)		664	113	89			145		13			
Untreated Best Case (UTBC)	223	664		89			145		13			
Treated Worst Case (TWC)		664	113	89	854	44	145	5	13			
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	564	414	22	196	34	34	211	2631	3763	0.699176	69.9176
Untreated Best Case (UTBC)	132	564	414	22	196	34	34	211	2741	3763	0.728408	72.8408
Treated Worst Case (TWC)	132	564	414	22	196	34	34	211	3534	3763	0.939144	93.9144
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)												
Untreated Best Case (UTBC)	223	664	113	89	854	44	145	5	13	6		
Treated Worst Case (TWC)	223	664	113	89	854	44	145	5	13			
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	3763	0	0
Untreated Best Case (UTBC)	132	564	414	22	196	34	34	211	3763	3763	1	100
Treated Worst Case (TWC)	132	564	414	22	196	34	34	211	3757	3763	0.998406	99.8406
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

CP2: The communications HSTC was affected by the placement of an NG tube in the treated best-case and both worst-case scenarios. The treated worst-case scenario largely mirrors the untreated worst-case scenario since the definition states that surgery is required and surgical capabilities are outside the scope of resources for this CLiFF, (i.e. the "treated" worst-case scenario is partial treatment since there are no surgical capabilities). However, while conservative treatment in the worst-case scenario does not resolve the bowel obstruction, it would improve symptoms, which affects TI. Thus there is less TI in the worst-case treated scenario than the worst-case untreated scenario despite lack of surgical intervention in both. CP3: The worst-case treated scenario doesn't constitute true treatment since surgical capabilities are outside the scope of this CLiFF. Thus, it is anticipated that the patient would be kept comfortable, but die after prolonged starvation in the setting of a non-resolving SBO. TI was therefore assigned nearly 99.8% for this scenario.

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.

REFERENCES

Reference
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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