Neurogenic Shock Cliff

Branch Baseline

Neurogenic shock is manifested by the triad of hypotension, bradycardia, and hypothermia. Shock tends to occur more commonly in injuries above T6, secondary to the disruption of the sympathetic outflow from T1-L2 and to unopposed vagal tone, leading to a decrease in vascular resistance, with associated vascular dilatation. Neurogenic shock needs to be differentiated from spinal and hypovolemic shock. Hypovolemic shock tends to be associated with tachycardia. (Dawodu, 2011)

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:	Fixed
Space Adaptation:	No
Incidence Type:	Rate

Distribution Data	
Incidence:	Fixed
Occurrence:	Poisson

Data Characteristics	
Fixed Rate:	5.2219E-06

Incidence Comments

It is estimated that the annual incidence of spinal cord injury (SCI), not including those who die at the scene of the accident, is approximately 40 cases per million population in the U. S. or approximately 12,000 new cases each year. Since there have not been any overall incidence studies of SCI in the U.S. since the 1970's it is not known if incidence has changed in recent years (National Spinal Cord Injury Statistical Center, 2009). Incidence per person year is 0.00004. Occurrence by location of SCI in a tertiary trauma care center showed the following: cervical 59.6%, thoracic 8.2%, and lumbar 32.6% (McKinley, 2007). The proportion of patients presenting with neurogenic shock following SCI in an emergency department was 19.3% for cervical SCI, 7% for thoracic SCI, and 3% for lumbar SCI (Guly, 2008). We estimated neurogenic shock incidence by combining data from the above three studies. Incidence for neurogenic shock after SCI by location is as follows: cervical- 0.0000046011 (0.00004 * 0.596 * 0.193); thoracic- 0.0000002296 (0.00004 * 0.082 * 0.07); and lumbar 0.0000003912 (0.00004 * 0.326 * 0.03). The sum of the three incidences is 0.0000052219. Since 2005, the average age at injury is 40.2 years. Currently, 80.9% of spinal cord injuries reported to the national database have occurred among males (National Spinal Cord Injury Statistical Center, 2009).

Information Regarding Prevention

Selection criteria

Disqualifying conditions in the neurologic disorders area include: any neurologic disorders that may interfere with the performance of duties; tumors of the nervous system; vascular disorders of the nervous system (e.g. arteriovenous malformation, intracranial aneurysms, familial cavernous angioma, and temporal arteritis). Sporadic cavernous angiomas require neurologic evaluation. History of cerebrovascular accident (stroke, TIA, or subarachnoid hemorrhage). Asymptomatic disease of the carotid or vertebral arteries requires neurologic evaluation. Seizure disorders or history of seizure disorders, including absence. History of traumatic brain injury with associated intracerebral hemorrhage with persistent neurologic deficits; or intracranial hemorrhage requiring surgery or with persistent neurologic deficits (e.g. subdural or epidural hematoma).

In the cardiovascular area disqualifying conditions include hypertension, if pharmacologically controlled requires special consideration by the MSMB; ventricular or atrial fibrillation and/or flutter; if successfully ablated requires consideration by the MSMB; history of recurrent thrombophlebitis, and deep vein thrombosis. (International Space Station Program, 2009); (NASA, 2007)

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
National Spinal Cord Injury Statistical Center, 2009	4	Incidence
McKinley, 2007	4	Incidence
Guly, 2008	4	Incidence

Incidence data not included in the model

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

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

Distribution Data	
Incidence:	Fixed
Occurrence:	Poisson

Data Characteristics	
Fixed Rate:	4.9844E-06

Incidence Comments

It is estimated that the annual incidence of spinal cord injury (SCI), not including those who die at the scene of the accident, is approximately 40 cases per million population in the U. S. or approximately 12,000 new cases each year. Since there have not been any overall incidence studies of SCI in the U.S. since the 1970's it is not known if incidence has changed in recent years. (National Spinal Cord Injury Statistical Center, 2009). Incidence per person year is 0.00004

A study on spinal cord injuries determined incidence by location of injury in a tertiary trauma care center to be cervical 59.6%, thoracic 16.4%, and lumbar 30.3% (McKinley, 2007)Cardiogenic shock occurs most commonly in injuries to T1-T6 (Popa, 2010) , or 2.3%.

Another study determined the incidence of patients presenting with neurogenic shock in the emergency department at 19.3% for cervical SCI, 7% for thoracic SCI, and 3% for lumbar SCI. (Guly, 2008)

We estimated the incidence combining data from the previously mentioned studies. Incidence for neurogenic shock cervical SCI is 0.00000456 (0.00004 * 0.60 * 0.19); for thoracic 0.0000000644 (0.00004 * 0.023 * 0.07); and for lumbar 0.00000036 (0.00004 * 0.30 * 0.03). The sum of the three incidences is **0.0000049844**

Since 2005, the average age at injury is 40.2 years. Currently, 80.9% of spinal cord injuries reported to the national database have occurred among males (National Spinal Cord Injury Statistical Center, 2009).

Information Regarding Prevention

Selection criteria

Disqualifying conditions in the neurologic disorders area include: any neurologic disorders that may interfere with the performance of duties; tumors of the nervous system; vascular disorders of the nervous system (e.g. arteriovenous malformation, intracranial aneurysms, familial cavernous angioma, and temporal arteritis). Sporadic cavernous angiomas require neurologic evaluation. History of cerebrovascular accident (stroke, TIA, or subarachnoid hemorrhage). Asymptomatic disease of the carotid or vertebral arteries requires neurologic evaluation. Seizure disorders or history of seizure disorders, including absence. History of traumatic brain injury with associated intracerebral hemorrhage with persistent neurologic deficits; or intracranial hemorrhage requiring surgery or with persistent neurologic deficits (e.g. subdural or epidural hematoma).

In the cardiovascular area disqualifying conditions include hypertension, if pharmacologically controlled requires special consideration by the MSMB; ventricular or atrial fibrillation and/or flutter; if successfully ablated requires consideration by the MSMB; history of recurrent thrombophlebitis, and deep vein thrombosis. (International Space Station Program, 2009); (NASA, 2007)

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
McKinley, 2007	4	Incidence
Guly, 2008	4	Incidence
National Spinal Cord Injury Statistical Center, 2009	4	Incidence

Alternative Incidence Data

Subjects presenting with spinal cord Injury (SCI) are frequently trauma patients and thus can exhibit multisystem injuries requiring intensive management. However, the consequences of the SCI itself are also capable of rendering patients critically ill. Key issues are the occurrence of neurogenic shock and the risk of ventilatory insufficiency in these patients. (Casha, 2011)

Casha et al. (Casha, 2011) reviewed 25 case series, control studies and diagnostic studies and reported that regarding cardiovascular insufficiency 90% of patients with cervical complete (ASIA A) SCI required pressor support, 52% in incomplete SCI, and 31% with thoracic SCI. 82% exhibited volume-resistant hypotension within the first 7 days. 40% of the acute SCI patients they studied exhibited multi-organ system injury. Studies vary in several ways but most notably in the population described and in the definition of hemodynamic compromise. Nonetheless, they all indicate that a significant number of SCI patients require cardiovascular support with fluids and vasopressor therapy and that the incidence of these events is correlated with severity of injury and is higher with cervical SCI and when hypotension is present at admission.

Pulmonary insufficiency requiring ventilatory support is also presented in several reports. 35.7% of 123 acute SCI patients experienced pulmonary complications in the first month including atelectasis, pneumonia, edema, pulmonary embolism, and aspiration and that this accounted for 11% of the mortality. Hypoxia was frequently seen even in the presence of adequate ventilation and normocarbia likely due to V/Q mismatch. Most early deaths were due to pulmonary complications and that respiratory insufficiency occurred in 70% of cervical complete injured patients and 26.8% of those with incomplete injury. Similar to the incidence of cardiovascular complications, many clinical series have documented a high rate of pulmonary complications, and specifically pulmonary insufficiency requiring ventilatory support. (Casha, 2011)

The literature supports that, in light of the significant incidence of cardio respiratory complications, SCI patients should be managed in a monitored special care unit. (Casha, 2011)

Studies included in Casha's review were published between 1973 and 1997. More recent articles have presented the same variability. 100% complete motor cervical SCI (ASIA A and B) have bradycardia and 35–71% in incomplete motor cervical SCI (ASIA C and D) develop bradycardia; 30% deaths (Grigorean, 2009). All the patients with motor complete cervical SCI (ASIA A and B) develop bradycardia, 68% develop arterial hypotension, 35% of the patients require vasopressors, and cardiac arrest occurs in 16% of them. From patients with motor incomplete cervical SCI (ASIA C and D), 35–71% develop bradycardia, but few have hypotension and require vasopressors. Very rarely they develop cardiac arrest. Thoracolumbar SCI bradycardia is encountered in 13–35% cases. (Popa, 2010) Neurogenic shock was present in 19 (31%) of the 62 patients with high Cervical SCI (CSCI) and in 5 (24%) of the 21 patients with low CSCI ($P = .56$). There was a marked difference in the use of a cardiovascular intervention between those with a high and those with a low CSCI: 15 (24%) of 62 patients versus 1 (5%) of 21 patients (Bilello, 2003)

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 %: 0 - 100)	100	1	2 - 36	48 - 108 - 168	0	0	0
ISS-based Treatment (worst case scenario %: 0 - 100)	100	1 - 2	16 - 58	0 - 12 - 24	0 - 58	100	0 - 100
Untreated Best Case	0	0	16 - 58	0 - 12 - 24	0 - 36	100	0 - 100
Untreated Worst Case	0	0	38 - 75	0 - 12 - 24	38 - 75	100	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

The **best case scenario is defined** as mild neurogenic shock that responds to treatment.

The **worst case scenario is defined** as moderate to severe neurogenic shock that does not respond to treatment, and may result in significant impairment or loss of crew life.

Percentages of how often best versus worst case scenarios occur

Based on terrestrial data, there is high variability in the outcomes of neurogenic shock. Its severity is affected by location and level of the spinal cord injury. (Casha, 2011) To allow for uncertainty, the percentage of worst case is estimated at 0-100%. Thus best case is also 0-100%

Best Case Comments

Neurogenic Shock is not listed in the AMA Guides to the Evaluation of Permanent Impairment. The functional impairments (FI) calculation follows the IMM severe non-space adaptation template. Neurogenic Shock may affect respiratory function and cause unconsciousness, which are the bases for our FI calculations. Neurogenic Respiratory Dysfunction ratings are based on Table 13-16, p.338 (American Medical Association, 2008). Episodic Loss of Consciousness and Awareness is based on Table 13-5, p.328 (American Medical Association, 2008). Total 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 during **Clinical Phase I**, FI is 100% and duration is estimated to be one hour for diagnosis evaluation for neurological impairment and initial treatment. During **Clinical Phase II**, Functional Impairment is estimated in 2-36%. Duration s estimated at 48-168 hours, 2 to 7 days. By definition, during **Clinical Phase III** complete recovery and 0% functional impairment is expected. Transfer to a definitive care facility is routine for all shock patients. By definition, the probability of EVAC is 0%. LOCL is not expected for this scenario.

Worst Case Comments

Neurogenic Shock is not listed in the AMA Guides to the Evaluation of Permanent Impairment. The functional impairments (FI) calculation follows the IMM severe non-space adaptation template. Neurogenic Shock may affect respiratory function and cause unconsciousness, which are the bases for our FI calculations. Neurogenic Respiratory Dysfunction ratings are based on Table 13-16, p.338 (American Medical Association, 2008). Episodic Loss of Consciousness and Awareness is based on Table 13-5, p.328 (American Medical Association, 2008). Final 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 during **Clinical Phase I**, FI is 100% and duration is estimated to be 1-2 hours for diagnosis evaluation for neurological impairment and initial treatment following the ISS Medical Checklist procedures and clinical experience. During **Clinical Phase II**, FI is estimated at 16 to 58%. Since this is an emergent EVAC, the duration is limited to 0-24 hours. During **Clinical Phase III**, some or incomplete recovery is expected, with functional impairment estimated at 0-58%. EVAC is expected for 100% of worst case scenario. Terrestrially, all patients with shock are hospitalized (Guly, 2008)and may require surgery based on the type of injury (Tuli, 2007). Deaths occur at a rate of 10 20% terrestrially. (Popa, 2010); (Guly, 2008)To allow for uncertainty LOCL is estimated at 0 to 100%.

Untreated Best Case Comments

Neurogenic Shock is not listed in the AMA Guides to the Evaluation of Permanent Impairment. The functional impairments (FI) calculation follows the IMM severe non-space adaptation template. Neurogenic Shock may affect respiratory function and cause unconsciousness, which are the bases for our FI calculations. Neurogenic Respiratory Dysfunction ratings are based on Table 13-16, p.338 (American Medical Association, 2008). Episodic Loss of Consciousness and Awareness is based on Table 13-5, p.328 (American Medical Association, 2008). Final 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**, Functional Impairment is estimated in 16-58%. Since this is an emergent EVAC, the duration is limited to 0-24 hours. During **Clinical Phase III** functional impairment is estimated at 0 to 36%. Without treatment, EVAC of a crew member with shock is estimated at 100% for in-hospital evaluation, similar to the treated best case scenario. LOCL may occur and it is estimated at 0-100%.

Untreated Worst Case Comments

Neurogenic Shock is not listed in the AMA Guides to the Evaluation of Permanent Impairment. The functional impairments (FI) calculation follows the IMM severe non-space adaptation template. Neurogenic Shock may affect respiratory function and cause unconsciousness, which are the bases for our FI calculations. Neurogenic Respiratory Dysfunction ratings are based on Table 13-16, p.338 (American Medical Association, 2008). Episodic Loss of Consciousness and Awareness is based on Table 13-5, p.328 (American Medical Association, 2008). Final 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 38 to 75%. Duration is estimated at 24-72 hours, similar to the treated worst case scenario. During **Clinical Phase III**, no recovery is expected, with functional impairment remaining at 38-75%. Without treatment available, EVAC and LOCL are expected for 100% of worst case scenario.

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
Casha, 2011	4	BCWC
American Medical Association, 2008	3	FI
American Medical Association, 2008	3	FI
Tuli, 2007	4	EVAC
Popa, 2010	4	EVAC
Guly, 2008	4	EVAC

The Resource Table (RT)

Resource	Units Required Best Case	Units Required Worst Case	Units Available At Start Of Mission	Consumable	Essential	Rationale
Adrenaline (Epinephrine 1:10000) 10mL	0	4	4	Yes	Yes	to restart the heart and/or stimulates it to beat more strongly; to open up the airways making it easier to breathe.
Ambu bag and mask	1	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	1	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	5	12	60	Yes	No	Cleanse skin.
CMRS	1	1	1	No	No	Restrain crew member to ensure safety
ECG Monitor (Device, USB Charge Cable, Lead Set Cable, Cue Card)	1	1	1	No	Yes	Measure and monitor ECG
Endotracheal Stylet	0	1	1	No	Yes	Assist with advanced airway placement
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)	4	6	50	Yes	No	to absorb blood or fluids from skin
IV administration set	1	1	3	Yes	Yes	For administration of IVF
IV Cap	1	1	5	Yes	No	For use with IV administration set
IV Catheter (18G, 20G, or 22G)	1	1	14	Yes	Yes	IV fluid administration
IV Fluid 1L (1000mL)	4	4	5	Yes	Yes	to replenish fluids
IV Fluid Air Filter	1	1	3	Yes	No	To filter air from IV line.
IV pressure infuser	1	1	1	No	No	IV Fluids infusion
Ketamine 50 mg/mL, 10 mL multi dose vial	0	0.3	6	Yes	Yes	For sedation in case of intubation.
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	0.03	0.03	5	Yes	No	single-coated tapepressure adhesive tape

Resource	Units Required Best Case	Units Required Worst Case	Units Available At Start Of Mission	Consumable	Essential	Rationale
Nasal Airway (6mm, 7mm)	0	1	2	No	Yes	Establish and maintain patent airway and ventilation.
Needle (23G)	1	9	20	Yes	Yes	For medication administration
Nitrile gloves (large, medium, and small) (pair)	1	2	30	Yes	No	Personal Protective equipment for CMO
Oral Airway	0	1	2	No	Yes	Establish and maintain patent airway and ventilation.
Pack of 12 ECG electrodes	1	1	5	Yes	Yes	Measure and monitor ECG
PEEP Valve	0	1	1	No	Yes	Provides positive airway pressure during ventilation
SGA Cue Card	0	1	1	No	Yes	Guidance for use of supraglottic airway
Sharps container	1	1	40	No	No	To dispose of medical waste such as used medical needles, scalpels, IV catheters, razors, vials
Stethoscope	1	1	2	No	Yes	to listen to lung,heart, and bowel sounds, to blood flow in arteries and veins
Suction Cartridge	0	1	1	No	Yes	Provide airway suctioning
Suction device	0	1	1	No	Yes	to clean out secretions or vomit
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, secretions, vomit from mouth
Suction tip - mouth (curette)	0	1	1	No	Yes	used for suction by inserting into the end of a suction tube
Suction Tubing - Endotracheal Tube	0	1	1	Yes	Yes	Provide airway suctioning
Surgical Lubricant	0	1	6	Yes	No	Provides lubrication for the ILMA insertion.
Syringe (10cc)	0	1	6	Yes	Yes	to inflate endotracheal tube cuff
Syringe (35cc)	0	1	1	Yes	Yes	Inflation of SGA
Syringe (3cc)	1	9	20	Yes	Yes	For medication administration
T-adapter	0	1	1	No	Yes	Connection for ventilation tubing
Thermometer	1	1	1	No	No	To measure temperature
Tourniquet	1	1	1	No	No	To stop blood flow and engorge vein, this facilitates IV insertion
Valium (Diazepam) 5 mg/mL, 2 mL syringe	0	1	2	Yes	Yes	For sedation with intubation
Variable Oxygen System	1	1	1	No	Yes	Respiratory support
VOS Intubated Patient Hardware (Ventilator/Respirator)	0	1	1	No	Yes	Mechanical Ventilation

Resource Comments

The table was revised on 9/23/2011 to complete supplies for IV Fluids, respiratory support, and BP-ECG.

Neurogenic shock is not listed as a medical condition in the ISS Medical Checklist. Treatment is based on the Shock - Circulatory Collapse Procedure. All resources are available on board (Mission Operations Directorate (MOD), 2011) and/or ISS Checs Catalog (ISS Medical Operations, 2009)

Comparison of terrestrial guidelines versus ISS treatment

Pre-hospital guidelines recommendations for EMTs (Prehospital Trauma Life Support Committee of the National Association of Emergency Medical Technicians (NAEMT), 2011)include: manage ABCs cardiac monitoring, intravenous access, oxygen (as required oxygen saturation equal or greater than 92%), and rapid transport to closest appropriate facility. In the prehospital setting internal causes of shock cannot be definitively treated. All EMT treatment can be provided with on board resources.

On arrival to the emergency department or trauma center, clinical guidelines (Consortium for Spinal Cord Medicine, 2008)recommend: CT of the entire spine or MRI of the known or suspected areas of spinal cord injury, analgesia, sedation, Prevention and treatment of venous thromboembolism (VTE), respiratory management, urinary catheterization, Gastrointestinal tract management, and enteral nutrition. Respiratory management is available on board.

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
NASA ISS Medical Operations, 2011	2	Resources

Level Of Evidence

Input Data	LOE Average
Incidence	4
Functional Impairment	3
Best Case / Worst Case	4
EVAC / LOCL	4
Resources	2
QUALITY OF EVIDENCE	**3.4**

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

Reference List

Reference
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