

Chest Injury/Pneumothorax

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Introduction

Trauma to the chest may be categorized as either blunt or penetrating, each with a characteristic injury pattern. Common forms of blunt trauma are motor vehicular crashes or falls, while penetrating is typically missile (gun) or stabbing (knife). In considering chest trauma, blunt mechanisms generally leave the chest wall intact, with bruising, contusions, or crepitus the only outward physical sign. Penetrating trauma, on the other hand, breaches the integrity of the chest wall. In either form, resulting injuries may include but are not limited to rib or other boney fractures, intra-thoracic organ injury such as lung puncture, soft tissue injuries, or combination type injury. In addition to the natural outcomes of such injuries, the resulting pain may impair normal breathing.

A pneumothorax is the presence of air in the pleural space which can occur spontaneously or due to chest trauma. The plural space is the potential space between the parietal pleura (attached to the interior chest wall) and the visceral pleura (attached to the outer surface of the lungs). As this collection of air within the pleural cavity enlarges, the lung becomes smaller. A hemothorax is similar in principle but instead of air there is a collection of blood in the pleural space. Pneumothoraces and hemothoraces are both space-occupying lesions that decrease normal oxygen and CO₂ gas exchange primarily by compressing otherwise healthy lung parenchyma.

Clinical Priority and Clinical Priority Rationale by Design Reference Mission

One of the inherent properties of space flight is a limitation in available mass, power, and volume within the space craft. These limitations mandate prioritization of what medical equipment and consumables are manifested for the flight, and which medical conditions would be addressed. Therefore, clinical priorities have been assigned to describe which medical conditions will be allocated resources for diagnosis and treatment. “Shall” conditions are those for which diagnostic and treatment capability must be provided, due to a high likelihood of their occurrence and severe consequence if the condition were to occur and no treatment was available. “Should” conditions are those for which diagnostic and treatment capability should be provided if mass/power/volume limitations allow. Conditions were designated as “Not Addressed” if no specific diagnostic and/or treatment capability are expected to be manifested, either due to a very low likelihood of occurrence or other limitations (for example, in medical

training, hardware, or consumables) that would preclude treatment. Design Reference Missions (DRMs) are proposed future missions designated by a set of assumptions that encompass parameters such as destination, length of mission, number of crewmembers, number of Extravehicular Activities (EVAs), and anticipated level of care. The clinical priorities for all medical conditions on the Exploration Medical Condition List (EMCL) can be found here (https://humanresearchwiki.jsc.nasa.gov/index.php?title=Category:All_DRM). The EMCL document may be accessed here (https://humanresearchwiki.jsc.nasa.gov/images/6/62/EMCL_RevC_2013.pdf).

Design Reference Mission	Clinical Priority	Clinical Priority Rationale
<p>Lunar sortie mission</p> <p>Assumptions:</p> <ul style="list-style-type: none"> ■ 4 crewmembers (3 males, 1 female) ■ 14 days total ■ 4 EVAs/crewmember ■ <u>Level of Care 3</u> 	Not Addressed	<p>Crewmembers in the low gravity environment of the space vehicle/habitat or during EVA will be unlikely to sustain anything more than minor chest wall trauma or strain. The reduced gravity is thought to be protective in that impact forces will be minimized and the pressurized EVA suit is expected to offer some additional protection against chest injury. In addition, a spontaneous pneumothorax is unlikely in the highly screened astronaut population.</p> <p>The types of minor chest injuries likely to occur could be managed with symptomatic treatment alone (analgesics) that would be available onboard the space vehicle and in the habitat, and accounted for under the condition Extremity Sprains/Strains. Pneumothorax secondary to pulmonary barotrauma is possible but unlikely. Hemothorax is unlikely to occur as well.</p>
<p>Lunar outpost mission</p> <p>Assumptions:</p> <ul style="list-style-type: none"> ■ 4 crewmembers (3 males, 1 female) ■ 180 days total ■ 90 EVAs/crewmember ■ <u>Level of Care 4</u> 	Should	<p>The likelihood of significant chest injury is low while in microgravity and while on EVA and protected within the EVA suit. In addition, a spontaneous pneumothorax is unlikely in the highly screened astronaut population. Pneumothorax secondary to pulmonary barotrauma is possible but unlikely. On the other hand, the consequences of an untreated pneumothorax or hemothorax are severe, and the equipment and consumables required are relatively small and lightweight.</p> <p>Given the above and taking into account the length of the NEA mission and its remoteness from Earth, treatment capability should be manifested if mass-power-volume constraints allow.</p>
<p>Near-Earth Asteroid (NEA) mission</p> <p>Assumptions:</p> <ul style="list-style-type: none"> ■ 3 crewmembers (2 males, 1 female) ■ 395 days total ■ 30 EVAs/crewmember ■ <u>Level of Care 5</u> 	Should	<p>The likelihood of significant chest injury is low while in microgravity and while on EVA and protected within the EVA suit. In addition, a spontaneous pneumothorax is unlikely in the highly screened astronaut population. Pneumothorax secondary to pulmonary barotrauma is possible but unlikely. On the other hand, the consequences of an untreated pneumothorax or hemothorax are severe, and the equipment and consumables required are relatively small and lightweight.</p> <p>Given the above and taking into account the length of the NEA mission and its remoteness from Earth, treatment capability should be manifested if mass-power-volume</p>

		constraints allow.
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Initial Treatment Steps During Space Flight

A link is provided to a prior version of the International Space Station (ISS) Medical Checklist, which outlines the initial diagnostic and treatment steps recommended during space flight for various conditions which may be encountered onboard the ISS. Further diagnostic and treatment procedures beyond the initial steps outlined in the Medical Checklist are then recommended by the ground-based Flight Surgeon, depending on the clinical scenario. Please note that this version does not represent current diagnostic or treatment capabilities available on the ISS. While more recent versions of this document are not accessible to the general public, the provided version of the checklist can still provide a general sense of how medical conditions are handled in the space flight environment. Medical Checklists will be developed for exploration missions at a later point in time.

Please note this file is over 20 megabytes (MB) in size, and may take a few minutes to fully download.

ISS Medical Checklist (http://www.nasa.gov/centers/johnson/pdf/163533main_ISS_Med_CL.pdf)

Capabilities Needed for Diagnosis

The following is a hypothetical list of capabilities that would be helpful in diagnosis. It does not necessarily represent the current capabilities available onboard current spacecraft or on the ISS, and may include capabilities that are not yet feasible in the space flight environment.

- Vital signs measurement capability (blood pressure, pulse, respiratory rate, temperature, pulse oximetry, as required per the patient's clinical state)
- Electrocardiogram (12-lead ECG)
- Cardiac (ECG) monitor
- Auscultation device (such as a stethoscope)
- Peak flow pulmonary meter
- Imaging (such as chest X-ray/ultrasound)
- Blood Analysis [complete blood count (CBC) if blood loss]

Capabilities Needed for Treatment

The following is a hypothetical list of capabilities that would be helpful in treatment. It does not necessarily represent the current capabilities available onboard current spacecraft or on the ISS, and may include capabilities that are not yet feasible in the space flight environment.

- Intravenous (IV) start and administration kit
- IV pump or pressure infuser

- Intravascular volume replacement (such as IV fluids)
- Ambu bag and mask
- Intubation kit
- Ventilator
- Supplemental oxygen
- Cardiac needle
- Chest tube
- Chest tube collection device/Heimlich valve
- Suction
- Suturing kit
- Personal protective equipment
- Fenestrated drape
- Analgesics (narcotic, oral, and injectable)
- Local anesthesia (Lidocaine)

Associated Gap Reports

The NASA Human Research Program (HRP) identifies gaps in knowledge about the health risks associated with human space travel and the ability to mitigate such risks. The overall objective is to identify gaps critical to human space missions and close them through research and development. The gap reports that are applicable to this medical condition are listed below. A link to all of the HRP gaps can be found here (<http://humanresearchroadmap.nasa.gov/Gaps/>).

- 2.01 - We do not know the quantified health and mission outcomes due to medical events during exploration missions.
- 2.02 - We do not know how the inclusion of a physician crew medical officer quantitatively impacts clinical outcomes during exploration missions.
- 3.01 - We do not know the optimal training methods for in-flight medical conditions identified on the Exploration Medical Condition List taking into account the crew medical officer's clinical background. (Closed)
- 3.03 - We do not know which emerging technologies are suitable for in-flight screening, diagnosis, and treatment during exploration missions.
- 4.01 - We do not have the capability to provide a guided medical procedure system that integrates with the medical system during exploration missions.
- 4.02 - We do not have the capability to provide non-invasive medical imaging during exploration missions.
- 4.04 - We do not have the capability to deliver supplemental oxygen to crew members while minimizing local and cabin oxygen build-up during exploration missions.
- 4.05 - We do not have the capability to measure laboratory analytes in a minimally invasive manner during exploration missions.
- 4.06 - We do not have the capability to stabilize bone fractures and accelerate fracture healing during exploration missions.
- 4.07 - Limited wound care capability to improve healing following wound closure (Closed)
- 4.08 - We do not have the capability to optimally treat musculoskeletal injuries during exploration missions.
- 4.09 - We do not have the capability to provide medical suction and fluid containment during exploration missions.
- 4.12 - We do not have the capability to generate and utilize sterile intravenous fluid from potable water during exploration missions.
- 4.14 - We do not have the capability to track medical inventory in a manner that integrates securely with the medical system during exploration missions.
- 4.15 - Lack of medication usage tracking system that includes automatic time stamping and crew identification
- 4.17 - We do not have the capability to package medications to preserve stability and shelf-life during exploration

missions.

4.19 - We do not have the capability to monitor physiological parameters in a minimally invasive manner during exploration missions.

4.23 - We do not have the capability to auscultate, transmit, and record body sounds during exploration missions.

4.24 - Lack of knowledge regarding the treatment of conditions on the Space Medicine Exploration Medical Condition List in remote, resource poor environments (Closed)

4.26 - We do not have the capability to screen for, diagnose, and treat disease due to dust exposure during exploration missions.

4.27 - We do not have the capability to sterilize medical equipment during exploration missions.

5.01 - We do not have the capability to comprehensively manage medical data during exploration missions.

Other Pertinent Documents

List of Acronyms

C	
CBC	Complete Blood Count
D	
DRM	Design Reference Mission
E	
ECG	Electrocardiograph
EMCL	Exploration Medical Condition List
EVA	Extravehicular Activity
H	
HRP	Human Research Program
I	
ISS	International Space Station
IV	Intravenous
M	
MB	Megabyte
N	
NASA	National Aeronautics and Space Administration
NEA	Near Earth Asteroid
X	
X-ray	Radiograph

References

Last Update

This topic was last updated on 8/14/2014 (Version 2).

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Category: Medical Conditions

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