

# Compartment Syndrome

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## Introduction

Acute and chronic compartment syndrome occurs when there is increased tissue pressure within a tight fascial compartment, impairing nervous tissue and/or vascular supply and tissue perfusion. This is usually a complication of acute or chronic injuries such as repetitive stress injury, fractures, blunt closed injuries and crush injuries. Symptoms include pain, paresthasias, and muscle tightness and firmness. Symptoms may include numbness and tingling and, in acute severe cases, paralysis is a late and an ominous sign. Acute compartment syndrome is considered an emergency, and requires surgical treatment via a fasciotomy.<sup>[1]</sup>

The most likely mechanisms of injury during spaceflight are 1) chronic injury involving inappropriate or required repetitive motion of wrist or ankle, and 2) major extremity fractures or crush injuries involving Extravehicular Activity (EVA) or Intravehicular Activity (IVA) translation of high mass objects.

## 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](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](https://humanresearchwiki.jsc.nasa.gov/images/6/62/EMCL_RevC_2013.pdf)).

Design Reference Mission	Clinical Priority	Clinical Priority Rationale
Lunar sortie mission  Assumptions: <ul style="list-style-type: none"> <li>▪ 4 crewmembers (3 males, 1 female)</li> <li>▪ 14 days total</li> <li>▪ 4 EVAs/crewmember</li> <li>▪ <u>Level of Care 3</u></li> </ul>	Not Addressed	The likelihood of a musculoskeletal injury severe enough to elicit acute compartment syndrome is low in the microgravity environment. Therefore, treatment capability for this medical condition will not be manifested for the lunar sortie mission.
Lunar outpost mission  Assumptions: <ul style="list-style-type: none"> <li>▪ 4 crewmembers (3 males, 1 female)</li> <li>▪ 180 days total</li> <li>▪ 90 EVAs/crewmember</li> <li>▪ <u>Level of Care 4</u></li> </ul>	Not Addressed	The likelihood of a musculoskeletal injury severe enough to elicit acute compartment syndrome is low in the microgravity environment. Therefore, treatment capability for this medical condition will not be manifested for the lunar outpost mission.
Near-Earth Asteroid (NEA) mission  Assumptions: <ul style="list-style-type: none"> <li>▪ 3 crewmembers (2 males, 1 female)</li> <li>▪ 395 days total</li> <li>▪ 30 EVAs/crewmember</li> <li>▪ <u>Level of Care 5</u></li> </ul>	Not Addressed	The likelihood of a musculoskeletal injury severe enough to elicit acute compartment syndrome is low in the microgravity environment. Therefore, treatment capability for this medical condition will not be manifested for the NEA mission.

## 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](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)
- Imaging (such as ultrasound)
- Nerve conduction and Electromyogram (EMG) testing
- Doppler
- Tissue pressure measurement device
- Clinical laboratory

## 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.*

- Crew medical restraint system
- Splints, slings, cold packs
- Surgical supplies and instruments
- Intravascular volume replacement [such as Intravenous (IV) fluids and blood products]
- Pharmacy to include drugs for acute and chronic surgical and pain conditions (antibiotics, analgesics, etc.)

## 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.
- 4.05 - 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.
- 4.08 - We do not have the capability to optimally treat musculoskeletal injuries 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.
- 4.24 - Lack of knowledge regarding the treatment of conditions on the Space Medicine Exploration Medical Condition List in remote, resource poor environments (Closed)
- 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

<b>D</b>	
DRM	Design Reference Mission
<b>E</b>	
EMCL	Exploration Medical Condition List
EMG	Electromyogram
EVA	Extravehicular Activity
<b>H</b>	
HRP	Human Research Program
<b>I</b>	

<a href="#">ISS</a>	International Space Station
<a href="#">IV</a>	Intravenous
<a href="#">IVA</a>	Intravehicular
<b>M</b>	
<a href="#">MB</a>	Megabyte
<b>N</b>	
<a href="#">NASA</a>	National Aeronautics and Space Administration
<a href="#">NEA</a>	Near Earth Asteroid

## References

1. Wall CJ, Lynch J, Harris IA, et al. Clinical practice guidelines for the management of acute limb compartment syndrome following trauma. ANZ J Surg. 2010 Mar;80(3):151-6.

## Last Update

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

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Category: Medical Conditions

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