

Eye Penetration (Foreign Body)

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Introduction

A penetrating eye injury by a foreign body is considered an ocular emergency. After any penetrating eye injury, a serious intraocular infection may develop that can rapidly lead to permanent loss of vision in that eye. There have not been any reported cases of penetrating eye injuries in space, and while the likelihood of such an injury is estimated to be very low, if it should occur the consequences to the crewmember and to the mission will likely be significant.

A portable ultrasound device is available for use on board the International Space Station (ISS). It can be used by trained crew with ground guidance to detect the presence, location, and composition of intraocular foreign bodies with high sensitivity, specificity, and accuracy^[1] and may help establish a diagnosis in cases where the diagnosis is in question.

Treatment of a penetrating eye injury is complex and involves bed rest, protection of the eye with a shield and a plan for primary surgical repair. Microsurgical repair and systemic antibiotics may be necessary to improve the chances of saving a severely injured eye.^[2]

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> 	<p>Shall</p>	<p>Untreated foreign body penetration of the eye has the potential to result in permanent loss of vision. Although the likelihood of this condition occurring during a lunar sortie mission is low, an evacuation back to Earth will not be possible and the untreated consequence can be severe. Therefore, treatment capability shall be manifested.</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> 	<p>Shall</p>	<p>Untreated foreign body penetration of the eye has the potential to result in permanent loss of vision. Although the likelihood of this condition occurring during a lunar outpost mission is low, an evacuation back to Earth will not be possible and the untreated consequence can be severe. Therefore, treatment capability shall be manifested.</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> 	<p>Shall</p>	<p>Untreated foreign body penetration of the eye has the potential to result in permanent loss of vision. Although the likelihood of this condition occurring during a NEA mission is low, an evacuation back to Earth will not be possible and the untreated consequence can be severe. Therefore, treatment capability shall be manifested.</p>

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.

- Ophthalmoscope
- Fluorescein strips
- Cotton swabs
- Bandaging
- Magnifying glass
- Imaging capability (such as a camera)
- Slit lamp with cobalt blue light source (for Seidel Test)
- Imaging [such as ultrasound, Computed Tomography (CT) Scan, Magnetic Resonance Imaging (MRI)]
- Cardiac [Electrocardiograph (ECG)] Monitor (with penetrating eye injury bradycardia may develop secondary to vagal stimulation)

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.

- Ridge shield or Styrofoam cup (eye pad/patches are contraindicated)
- Artificial tears
- Cotton swabs
- Ophthalmic topical anesthesia
- Antiemetics
- Analgesics (non narcotic, narcotic, oral, injectable)

- Prophylactic antibiotics
- Tele-ophthalmology

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.
- 4.14 - 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)
- 5.01 - We do not have the capability to comprehensively manage medical data during exploration missions.

Other Pertinent Documents

List of Acronyms

C	
CT	Computed Tomography
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
M	
MB	Megabyte
MRI	Magnetic Resonance Imaging
N	
NASA	National Aeronautics and Space Administration
NEA	Near Earth Asteroid
U	
U.S.	United States

References

1. Sargsyan AE, Dulchavsky AG, Adams J, Melton S, Hamilton DR, Dulchavsky SA. Ultrasound detection of simulated intra-ocular foreign bodies by minimally trained personnel. Aviat Space Environ Med 2008 Jan;79(1):58-61.
2. Blanch RJ, Scott RA. Military ocular injury: presentation, assessment and management. J R Army Med Corps 2009 Dec;155(4):279-84.

Last Update

This topic was last updated on 8/12/2014 (Version 2).

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Category: Medical Conditions

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