

Burns

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Introduction

Burn injuries can be caused by exposure to heat, cold, electricity, chemicals, radiation, or friction. Depending on the location and depth of the burn, complications may occur, including electrolyte imbalance, infection, shock and respiratory failure. The severity of a burn is generally classified according to its depth, and is described as first, second or third degree burn, first degree being the mildest and third degree the most severe. The extent of burns is classified by the percent of body surface area involved.^[1] Depending on the severity of the burn, the desired treatment in flight may include analgesia, wound cleaning and debridement, topical therapy, dressings, intravenous (IV) fluids, and antibiotics. In-flight burns have been reported on the Russian Mir space station, secondary to fires that occurred on board. There have not been any in-flight burns reported in the U.S. space program.^[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>The long duration of the lunar sortie mission and the lack of timely evacuation options necessitate some capability for treatment of burns. Risk is expected to be minimized by vehicle and habitat design such that only minor burns would be likely and would only require analgesia and burn dressings. However, the capability to address more extensive or more severe types of burns may be desired, including vascular volume replacement with IV fluids), performance of escharotomies, and antibiotic treatment to prevent infection, sepsis, long-term contractures, or loss of crew life. Smoke-related inhalation injury is considered under the condition entitled “Smoke Inhalation”.</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>The long duration of the lunar outpost mission and the lack of timely evacuation options necessitate some capability for treatment of burns. Risk is expected to be minimized by vehicle and habitat design such that only minor burns would be likely and would only require analgesia and burn dressings. However, the capability to address more extensive or more severe types of burns may be desired, including vascular volume replacement with IV fluids), performance of escharotomies, and antibiotic treatment to prevent infection, sepsis, long-term contractures, or loss of crew life. Smoke-related inhalation injury is considered under the condition entitled “Smoke Inhalation”.</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>The long duration of the lunar outpost mission and the lack of timely evacuation options necessitate some capability for treatment of burns. Risk is expected to be minimized by vehicle and habitat design such that only minor burns would be likely and would only require analgesia and burn dressings. However, the capability to address more extensive or more severe types of burns may be desired, including vascular volume replacement with IV fluids), performance of escharotomies, and antibiotic treatment to prevent infection, sepsis, long-term contractures, or loss of crew life. Smoke-related inhalation injury is considered under the condition entitled “Smoke Inhalation”.</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.

- Vital signs measurement capability (blood pressure, pulse, respiratory rate, temperature, pulse oximetry, as required per the patient's clinical state)
- Auscultation device (such as a stethoscope)
- Cardiac [Electrocardiograph (ECG)] monitor
- Imaging capability (such as a camera) (to document severity and Body Surface Area involved)
- Blood Analysis [Complete Blood Count (CBC), electrolytes, creatinine]

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.

- IV start and administration kit
- IV pump or pressure infuser
- Intravascular volume replacement (such as IV fluids)
- Gauze (Vaseline/Plain) Dressings (Cling/Adaptic)
- Telfa Pads
- Tape
- Silvadene Cream
- Analgesics (non-narcotic, narcotic, oral, and injectable)
- Antibiotics
- Crew Medical Restraint System

- Personal protective equipment
- Intubation kit
- Ventilator/Mask
- Supplemental oxygen
- Debridement instruments

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 have the capability to provide non-invasive medical imaging 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.
- 4.07 - Limited wound care capability to improve healing following wound closure (Closed)
- 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)
- 4.27 - We do not have the capability to sterilize medical equipment during exploration missions.
- 5.01 - {{(5.01 Title}}}

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
I	
ISS	International Space Station
IV	Intravenous
M	
MB	Megabyte
N	
NEA	Near Earth Asteroid
T	
TBD	To Be Determined
U	
U.S.	United States

References

1. Evers LH, Bhavsar D, Mailander P. The biology of burn injury. *Exp Dermatol* 2010 Sep;19(9):777-83.
2. Marshburn TH. Acute Care. In: Barratt M, Pool S, editors. *Principles of Clinical Medicine for Space Flight*. New York: Springer; 2008. p. 101-22.

Last Update

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

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