

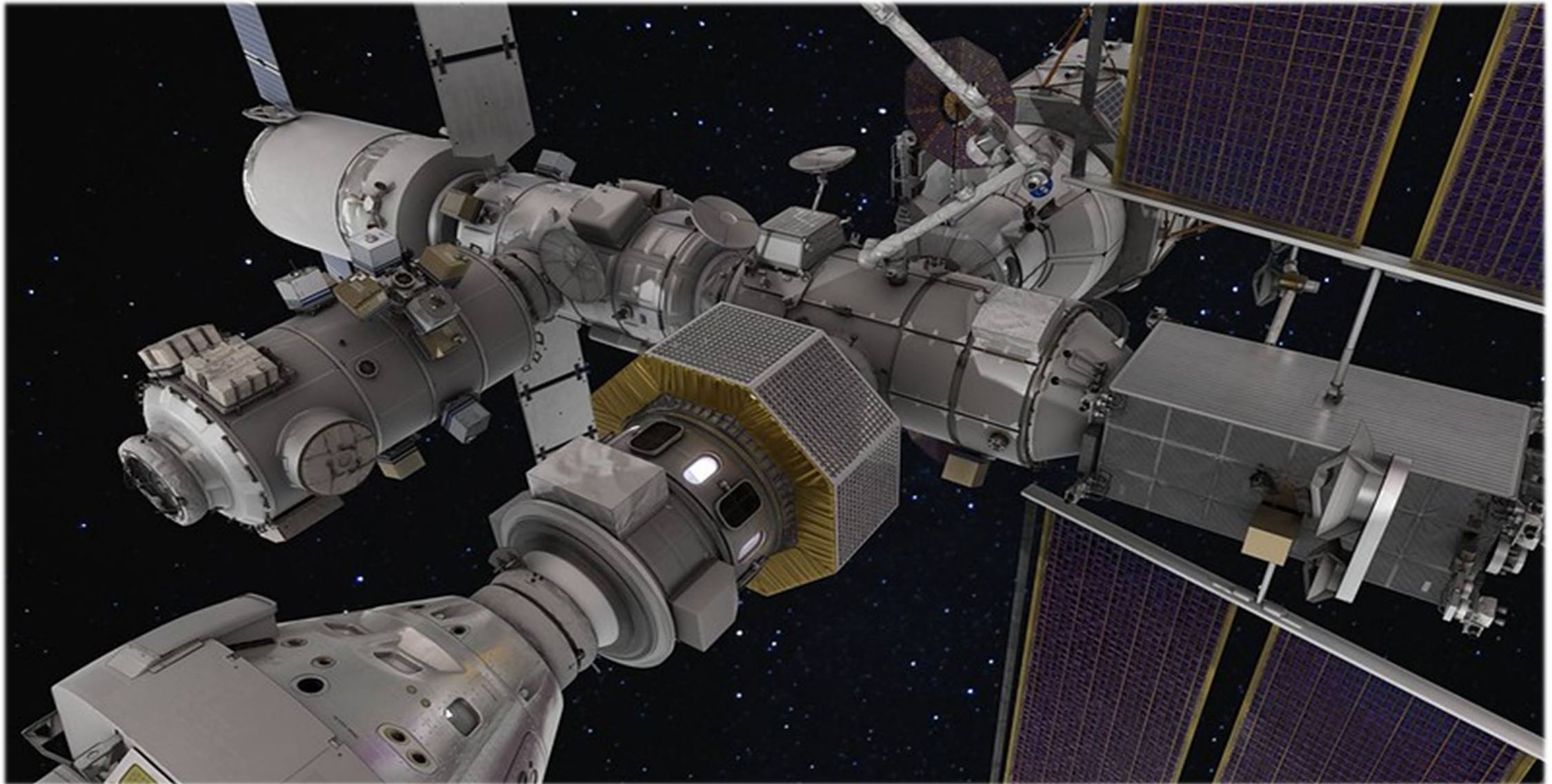
# **ASCEND 2023**

## ***Artemis Medical System Overview***

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# Orion Docked to Gateway (Artemis IV+)





# Medical System Scope: Mission Design & NASA Standard

Medical system definition for exploration is based upon several key factors:

1. Mission duration - launch to landing/recovery
2. Crew Size
3. Mission Design (e.g., docking? lunar landing/EVA?)
4. Mission Architecture (e.g., vehicle volume/config, exercise equipment, ConOps for contingencies)

The scope is derived from NASA standards of medical care but based on factors above and output from probabilistic event modeling.

TABLE 3.5.5.3-1 MEDICAL CARE CAPABILITIES

Level of Care	Mission	Capability
I	Leo < 8 Days	Space Motion Sickness, Basic Life Support, First Aid, Private Audio, Anaphylaxis Response, Acoustic Monitor
II	LEO < 30 days	Level I + Clinical Diagnostics, Ambulatory Care, Private Video, Private Telemedicine
III	Beyond LEO < 30 day	Level II + Limited Advanced Life Support, Trauma Care, Limited Dental Care
IV	Lunar > 30 days	Level III + Medical Imaging, Sustainable Advanced Life Support, Limited Surgical, Dental Care
V	Mars Expedition	Level IV Autonomous Advanced Life Support and Ambulatory Care, Basic Surgical Care

Artemis missions fall into either Level III or IV depending upon the mission.

## Integrated Medical Model (IMM)

### *Identify:*

- Probability of condition occurrence
- Estimated resource mass & volume
- Optimized Kit \*



## Ranked Conditions

- Calculated Exclusion Scores
- “Plan to Treat” Determination



$$\text{Exclusion Score} = \frac{\text{Complexity} * \text{Futility}}{\text{Probability}}$$



## Identified Specific Resources

- What do we use terrestrially?
- What do we need for this Mission?
- What fits in the medical kit?

### \* Subject to IMM limitations

Condition incidence rates rely on terrestrial data  
Built originally for Space Station  
Results are a starting point, not a solution



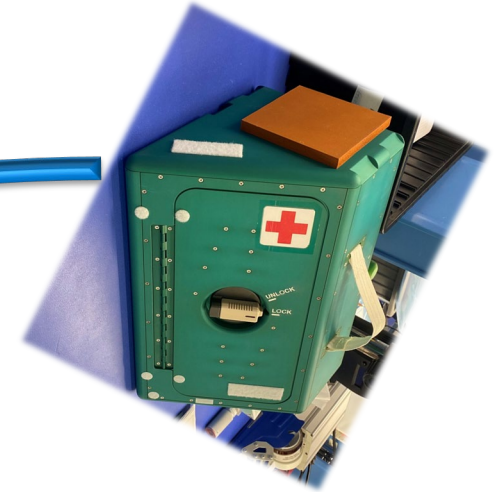
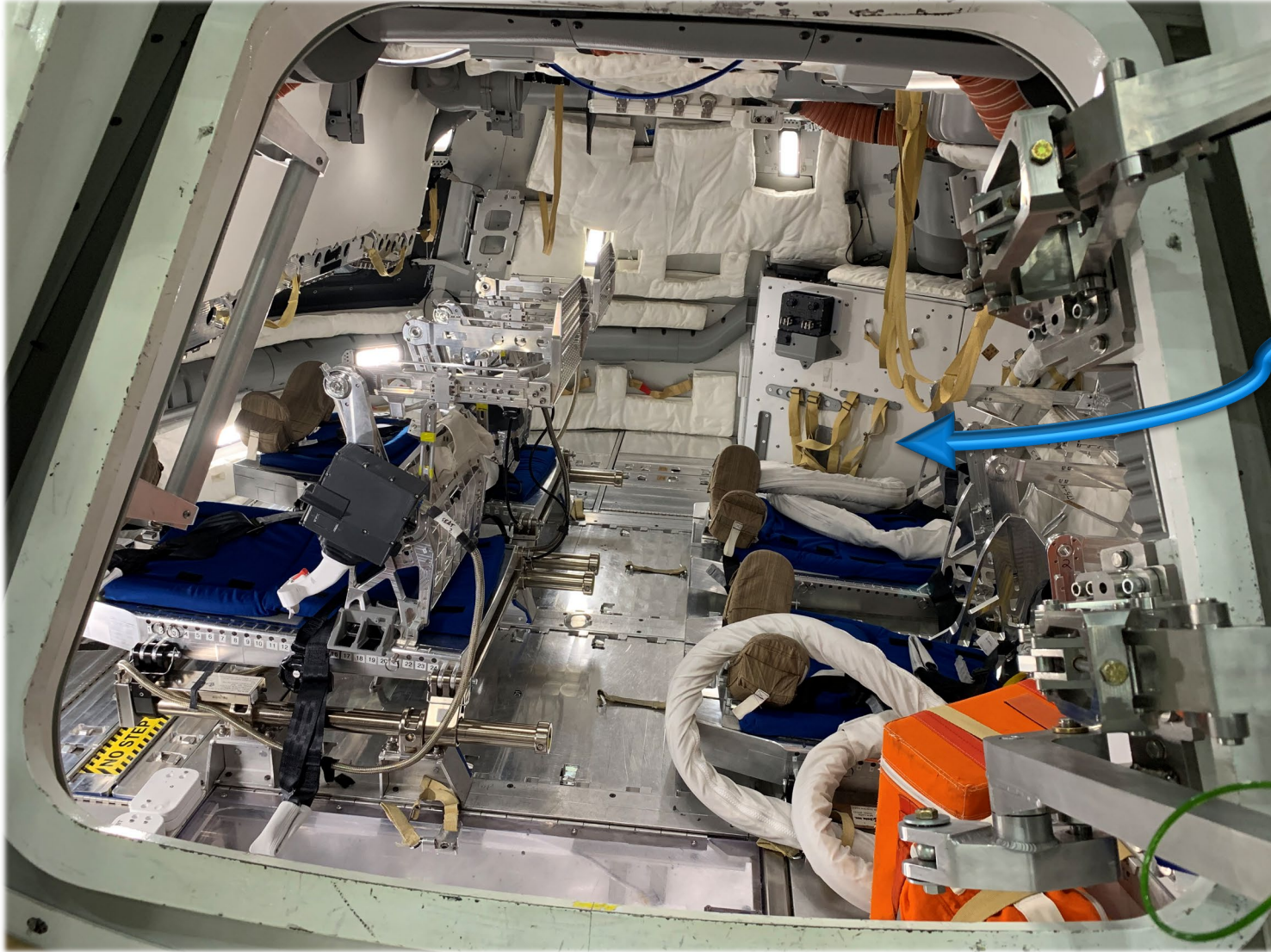
# Medical System Development

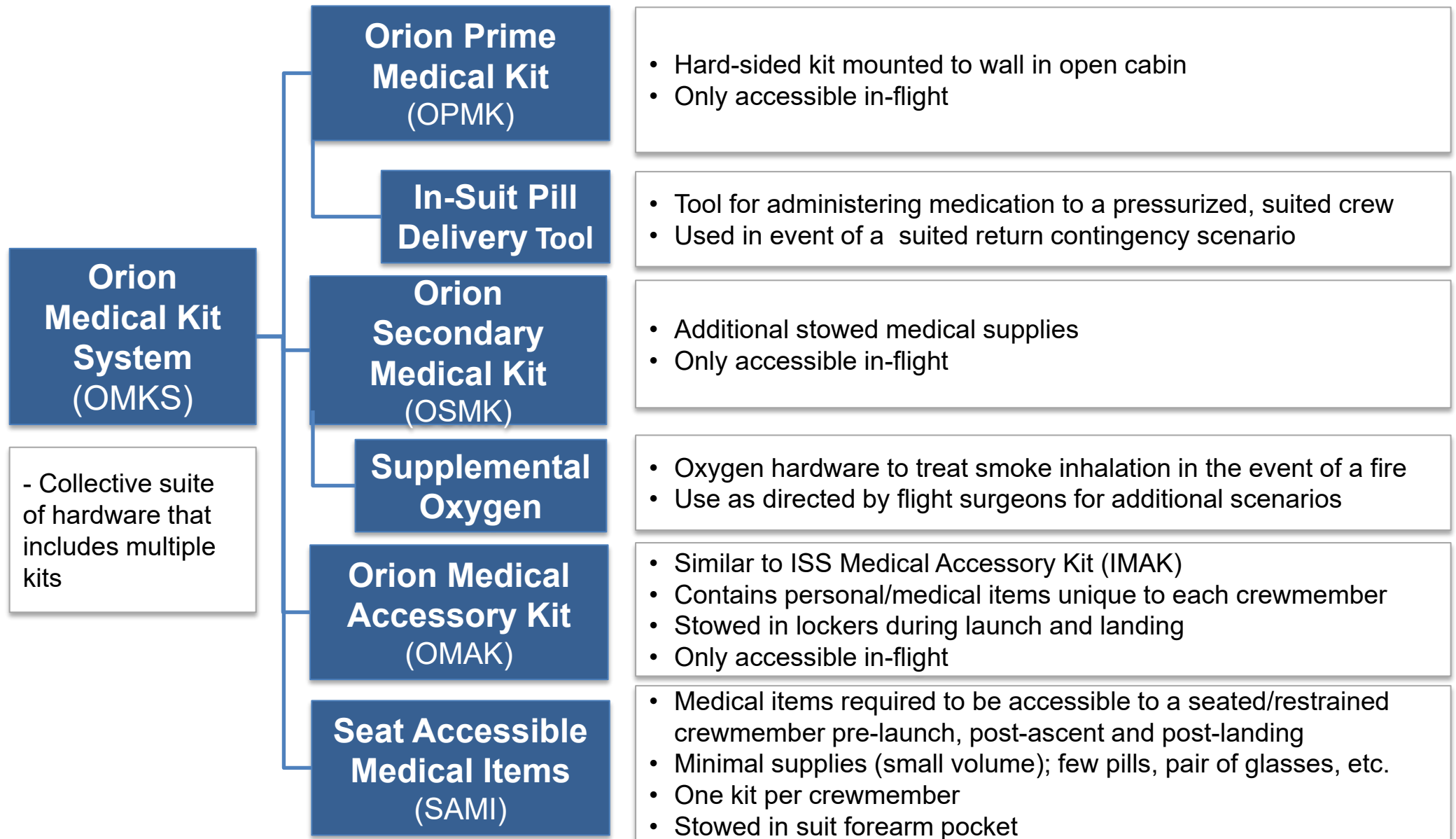
- Artemis Medical System development effort ongoing
  - Orion 21-day mission medical system design baselined and prototype built
  - Deltas under consideration for addition of Gateway and landing system
  - Goal is to balance crew health needs with mission constraints, while eliminating redundancy across vehicles
- Lunar surface mission will add to medical risk and is being evaluated
  - Current probabilistic modeling methods are being updated by NASA
  - Expert interviews also used to appropriately scope added capabilities
  - Medical ConOps to include entire mission and all vehicles
- Priority at this stage remains defining capabilities → hardware → then vehicle impacts



- No EVAs planned for Orion-only mission (Artemis II)
- Integrated capabilities across programs are being pursued
  - » Gateway will only be occupied when Orion is present
  - » Gateway to leverage as much as possible from Orion medical capabilities
  - » Lander medical capabilities are for lunar sortie only
- Medical capability design for early Artemis with lunar lander missions:
  - » ~30-day duration
  - » Multi-day Lunar sortie by 2 crewmembers, 2 remain in Lunar orbit
  - » Orion Medical System mass/volume allocation is relatively fixed

# Orion Mockup Interior & Medical Kit





## Flown on Orion

### Medications

Anti-inflammatory	Antibiotic/Antiviral/Antifungal Medication
Pain Medication	Anti-arrhythmia Medication
Sleep Medication	Anticoagulant Medications
Stimulant Medication	Bronchodilator Medication
Decongestant Medication	Pre-landing fluid support
Anti-Histamine Medication	Allergic/ Anaphylactic Reaction Medications
Anti-Emetic Medication	Ophthalmic Medications
Laxative/Motility Medication	

### Diagnostics

Lighted Imaging Capability	Point-of-care Urinalysis
Electrocardiography	Personal Protection (Equipment)
Vitals Measurement	Antiseptic Surface Cleansing
Auscultation Method	Corneal Evaluation

### Therapeutics

Splinting
Wound Closure
Wound Dressing
Dental Repair
Nasal Packing
Saliva/Blood Absorbance
Urinary Catheterization
Manual Ventilation Method
Collapsed Lung Decompression
Enriched Oxygen Breathing Gas Delivery
Airway Tailored to Mission and Care Levels

## Flown on Gateway

Extended limb injury care: Finger and Joint
Ultrasonography
Semi-invasive Wound Care
Wound Care consumables (20-day supply)
Co-oximetry
Positive Pressure Breathing Support Device

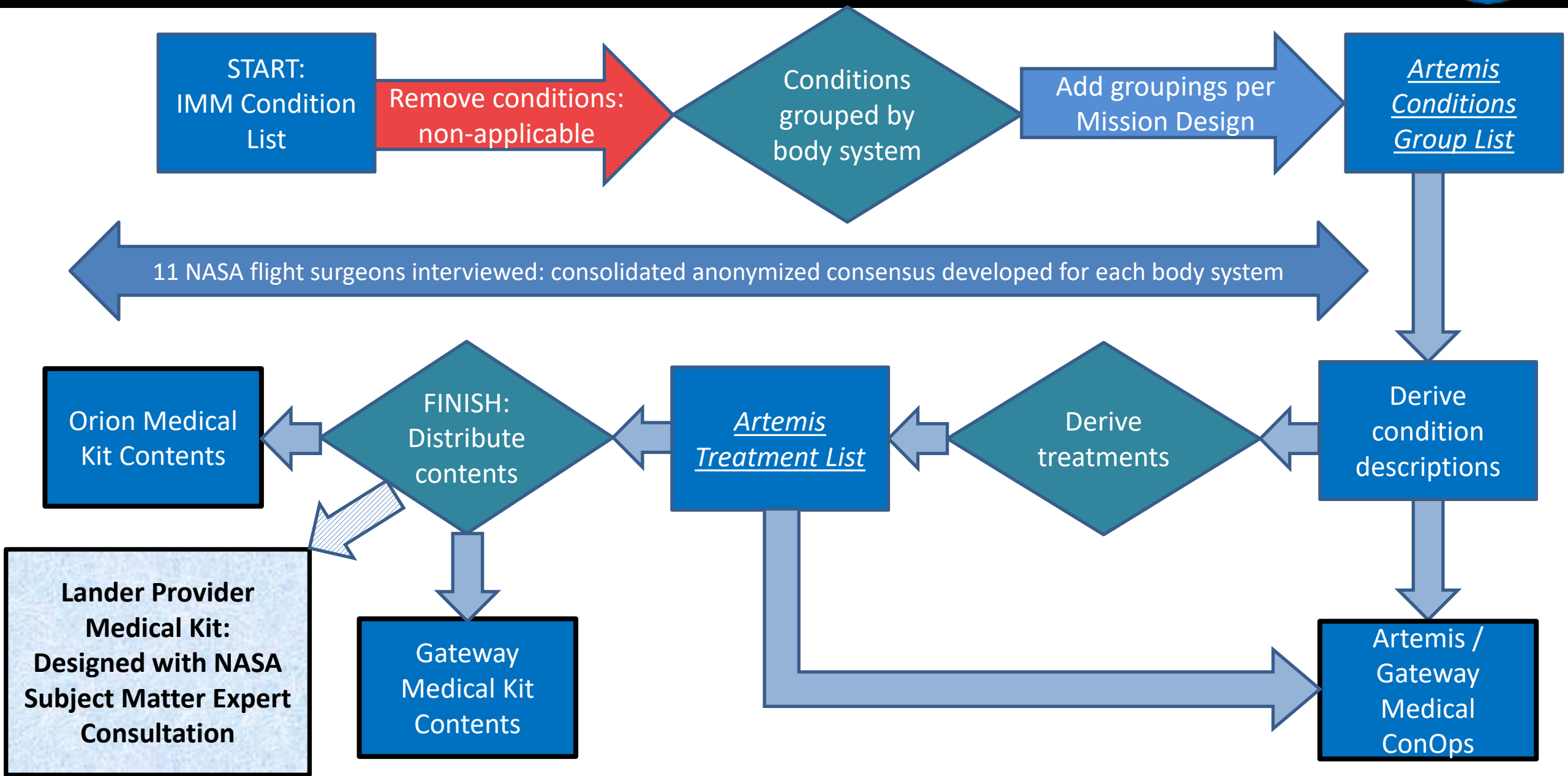
Device	Standalone Capability?	<u>Data Display</u> Requires Laptop or Other Device	<u>Data Storage</u> Laptop or Other Device	<u>Data Transmission</u> Mission Control
Augmented Stethoscope	No	No	Requirement	Requirement
Otoscope	No	Requirement	Requirement	Requirement
ECG	No	Requirement	Requirement	Requirement
Blood Pressure Cuff	Yes	No	Should- Manually Entered Ok	Should
Pulse Ox	Yes	No	Should-Manually Entered Ok	Should

- **For Orion and Artemis II:**
  - Capability of audio +/- video connection with Mission Control
  - Private audio with flight surgeon for medical discussions
  - Videoconferencing during medical events expected
    - Private video bring patient and physician “together”
  - Medical procedures will be stored on crew personal computing devices (and on main flight computer)
    - Small number of paper cue cards for critical devices/procedures
  - Advanced remote guidance or automated guidance a future goal





# Artemis (Lunar Sortie) Initial Phase Medical Conops Development





**Questions?**