

Executive Summary

The objective of this IMM support request is to provide a medical risk assessment for an Orion 21-day Design Reference Missions (DRM). The simulation results are as follows:

- **Average number of Total of Medical Events (TME):**
 - For the 21-day DRM with 46.63 lb. (21.15 kg) - 29755 cm³ Capabilities was 17.61 events.
- **Average Crew Health Index (CHI):**
 - For the 21-day DRM with 46.63 lb. (21.15 kg) - 29755 cm³ Capabilities was 96.38.
- **Probability of consideration for Evacuation (EVAC):**
 - For the 21-day DRM with 46.63 lb. (21.15 kg) - 29755 cm³ Capabilities was 0.0426.
- **Probability of Loss of Crew Life (LOCL):**
 - For the 21-day DRM with 46.63 lb. (21.15 kg) - 29755 cm³ Capabilities was 0.0006.

Background

The IMM is a stochastic model that uses Monte Carlo methodology to simulate medical outcomes during spaceflight missions. The IMM consists of a three-step process. First, mission and crew member characteristics are specified to define a mission profile, or design reference mission (DRM). Next, medical events and outcomes during the space flight mission are randomly generated based on pre-defined incidence values and probability distributions. Finally, total crew health and mission impact outcomes are summarized. For this report, the primary outcomes of interest are crew health index (CHI), need for evacuation (EVAC) and loss of crew life (LOCL).

The IMM is most useful for comparing risks across multiple mission profiles based on probable events and resource availability. Biased results may be incurred due to limitations of the model, but the bias will be consistent across mission profiles within the same service request.

Methods

Crew and Mission Parameters

The DRM was configured using the crew profile shown in Table 1. The 21-day crew profile is consistent with that of the previous Orion DRM from the IMM Service Request (SR) # S-201808-406. The outcomes of certain IMM medical conditions are influenced by pre-existing medical history including: coronary artery calcium score (CAC), dental crowns, contact lenses, and history of prior abdominal surgery. Pre-existing conditions, as defined here, are consistent with historical U.S. crew data.

Table 1: 21-day DRM crew profile

	Sex	Crowns	EVA	CAC	Contacts	Prior Abdominal Surgery
Crew 1	Male	Yes	No	Yes	Yes	No
Crew 2	Male	No	No	No	Yes	No
Crew 3	Male	No	No	No	No	No
Crew 4	Female	No	No	Yes	No	Yes

Medical Conditions and Resources

The one hundred medical conditions currently included in the IMM are shown in Appendix B. However, to better approximate Orion real world system, the set of conditions was modified for this request as described in Appendix C. The incidence of IMM medical events occurring during simulated missions are based on historical mission and cohort data contained within the Integrated Medical Evidence Database (iMED). For each condition the percentage of “best case” and “worst case” scenarios are specified, as well as a defined set of medical resources that are used to treat the condition. The iMED entry for each condition details the specific medical resources and quantity necessary for treatment in both the best and worst-case scenarios. In-flight medical treatment is assumed to follow a specified protocol [5] or clinical practice guidelines for each medical condition and is constrained by resource availability on the ISS.

Model outcomes can be given for the all-treated (continuous resupply, e.g. ISS in low earth orbit), all-untreated (no Medkit) and baseline MedCap (Medkit without resupply). For exploration missions, the MedCap state should most closely resemble a real-world deep space mission where resupply is not possible but where utilization of partial and alternative treatment can occur.

For this service request, the 46.63 lb. set of resources used for the 21-day DRM was provided by the requestor. This set of resources is based on the preliminary Orion medical kit design but then translated into equivalent iMED resource content by clinicians because the Orion design resources were not an exact match to the iMED resources needed to run the IMM. Examples of this process are:

- 1) The Orion design specified 1"x3" bandaids. There are no 1"x3" bandaids in iMED, therefore the closest iMED resource equivalent that IS called out for conditions - the bandaid strip – was substituted.
- 2) The Orion design specified Bismuth subsalicylate 524 mg oral tablets. The iMED resource list contains only 262mg tablets, therefore the number of 262mg tablets in IMED had to be increased by a factor of two.
- 3) The Orion design specified three ophthalmic medications - 0.5% Timolol Maleate, 1% Apraclonidine, and 2% Pilocarpine – typically used to treat glaucoma. The IMM condition, *Acute Angle-closure Glaucoma*, does not call for any of those medications nor were any equivalent medications, therefore those three resources were omitted from the resource list used to run the IMM for this request.
- 4) Additionally, surgical lubricant was substituted for lidocaine jelly in resources required to treat the condition Urinary Retention to more closely match the Orion Medkit contents.

Of the 167 resources provided by the requestor, 44 (or ~26%), were not able to be translated into iMED resources, but none of those were called out by the IMM simulation as resources required to treat any conditions. This lack of translation, therefore, had no effect on the model outputs.

The “MedCap” results for the 21-day DRM correspond to the above-mentioned sets of resources. A comparison of the sets of resources (between the requestor-provided resources and the resources included in the previously provided optimized resource set from the IMM Service Request (SR) # S-201808-406 is provided in Table 2.

Main Outcomes

The IMM primary medical outcomes include the number of total medical events (TME), crew health index (CHI), probability of Evacuation (EVAC), probability of Loss of Crew Life (LOCL), and required resources.

CHI is a calculated percentage using the quality-adjusted mission time lost (QAMTL) due to in-flight medical events and resources available to treat those conditions [2].

$$\text{CHI} = (1 - (\text{QAMTL} \div \text{Mission Length})) \times 100$$

For a given condition, QAMTL is determined by summing the product of functional impairment and duration for all three clinical phases of that condition: i) diagnosis and initial treatment, ii) ongoing treatment, and iii) end-state. CHI percent values range from 0-100, where zero represents complete crew impairment and one hundred represents a completely functional crew.

EVAC in the context of IMM means that medical evacuation from the ISS would be considered for definitive treatment of the afflicted crew member(s). EVAC is considered an end state result if any of the following criteria are met: 1) potential LOCL; 2) potential significant permanent impairment; or 3) potential intractable pain. When EVAC is calculated by the IMM, no consideration has been given to the availability of a return vehicle or the likelihood of a successful clinical outcome should a return vehicle be available.

LOCL in the context of IMM should be interpreted to mean that the clinical scenario resulted in death of the affected crew member(s). In version 4.1 of the IMM, the simulation usually assigns each crew member only one end state of EVAC or LOCL. In rare instances a crewmember can get a condition that will go to EVAC or LOCL, and then develop another condition that will also go to EVAC or LOCL in the time between the onset of first condition and the EVAC or LOCL time. Both events are recorded as EVAC or LOCL outcomes. These assumptions should result in more accurate IMM forecasts for the occurrence of EVAC and LOCL as compared to the prior versions of the model. Catastrophic vehicle failures such as the Challenger and Columbia accidents, and MMOD (micrometeorite and orbital debris) are not considered as possible causes of EVAC and LOCL.

Required resources for treatment are tracked for each simulated mission trial. The number of each resource that is used to treat a given condition is decremented from available resources. If more of any particular resource is used than is available, then that resource is considered “depleted” in the MedCap (no resupply) scenario. Events that require a “depleted” resource are considered “partially treated” if only a portion of the required resources are available. If there are sufficient available alternate resources in the MedCap, the event is considered “fully treated.” If none of the resources are available to treat the event, the event is considered “untreated.” The initial quantities for medical resources are baselined to a fully stocked ISS medical kit (MedCap) for the simulation. Note that when an event is partially treated, its outcomes are based on a weighted average of the treated and untreated values. For example, if a condition has a 0% chance of going to EVAC in the best case treated scenario and a 0-100% chance of going to EVAC in the best case untreated scenario, then under best case partial treatment, it is possible the condition will go to EVAC.

Modeling Approach

One hundred thousand (100,000) trials were run for the DRM where each trial can be considered an individual “mission”. This ensures that the distribution of outcomes meet convergence criteria. Convergence criteria are met when there is less than or equal to a 5% change in the average standard deviation of the CHI, EVAC, and LOCL primary model outcomes in the last 2 - 1,000 mission increments. This last step is performed manually by the modelers using the IMM4ConvergenceReport.

IMM outcomes were determined for the DRM using the ISS MedCap scenario where all conditions are treated, partially treated or untreated based on the available resources of the ISS MedCap without resupply. CHI is calculated as a percentage, with 95% confidence intervals (CIs) for the associated distributions. EVAC and LOCL are probabilities, with 95% CI for EVAC and LOCL obtained using bootstrap resampling of the simulation output [3]. In this report, TME, CHI, EVAC and LOCL results are presented. Features, assumptions and limitations pertinent to this report are described in a separate section below.

Features, Assumptions and Limitations of IMM Version 4.1 [3]

1. All non-space adaption (SA) and non-extravehicular activity (EVA) related conditions have a uniform likelihood of occurring throughout the mission duration. With the exception of VIIP, Space Adaptation Syndrome conditions occur in the first 5 days of the mission, with a peak occurrence at 48 hours.
2. Individuals cannot get the same condition for which they are currently being treated (i.e. during Clinical Phase (CP) I and II).
3. EVAC and LOCL are generated for each medical event, and then the timing of the EVAC or LOCL is generated according to a specified distribution.

4. Individuals are no longer at risk for further conditions once their status changes to either EVAC or LOCL. From the start time of the EVAC or LOCL, the functional impairment of the crew member is assumed to be 100%.
5. When the status of a crew member changes to EVAC, only one crew member is evacuated.
6. The IMM assumes that, per crew member, the first condition requiring a specific therapy utilizes all resources required for treating that condition before a second condition has access to those resources.
7. Most medical conditions, with exceptions including acute radiation syndrome (triggered by Solar Particle Events) and EVA-linked conditions (triggered by EVA events), occur independently of the occurrence of mission events and other medical conditions. Currently there is no correlation or association within or between crew members for most medical conditions.
8. The model assumes another crew member is available to act as caregiver but does not track the time impact of providing this care.
9. Medical procedures are accurately followed and successful; no mistakes occur in executing medical procedures.
10. Crew medical skill level and preflight/inflight training is not modeled.
11. All diagnoses are 100% accurate.
12. All pharmaceuticals maintain maximum efficacy.
13. All medical events receive the appropriate treatment.
14. All medical events respond to the treatment as expected terrestrially.
15. All medical equipment is 100% reliable.
16. For each of the medical conditions specified in iMED, all crew members with the same characteristics (sex, presence of CAC, crowns, contacts, history of abdominal surgery) have the same likelihood distribution of experiencing the condition.
17. All crew members are assumed to have all intrinsic body parts intact (i.e. appendix, gall bladder, and uterus or prostate, etc.).
18. IMM assumes ISS power, potable water and oxygen resources are always available in unlimited supply.
19. No Russian medical capabilities aboard the ISS are available to US crew members in this model.
20. Medical capabilities do not include the use of personal crew carry-on items contained in the Individual Medical Accessories Kit, (IMAK).
21. If a crew member is undergoing treatment for concurrent medical conditions requiring the same consumable resource, the crew member will only utilize resources at the level required by the condition that requires the most resources.
22. If the primary resource required for treating a medical condition is unavailable, one or more alternative resources are considered, if appropriate. One example might be using acetaminophen in place of ibuprofen.
23. Total quantities of a consumable medical resource requiring a daily dose will be adjusted if a

dosage schedule runs past the end of the mission.

24. If a solar particle event causes acute radiation sickness in one or more crew members, IMM assumes the condition begins identically in all affected crew members at the beginning of the solar particle event.
25. The IMM does not decrement non-consumable items and allows all non-consumable items to be used simultaneously by multiple astronauts (e.g. blood pressure cuff).

Results

The clinician-translated, requestor-provided medical kit is presented below in Table 2. The IMM simulation MedCap results for TME, CHI, EVAC, LOCL and the top ten influential conditions for EVAC/LOCL for the simulated DRM are shown in Tables 3-9 and Figures 1-4 below.

Table 2: The clinician-translated, requestor-provided medical kit (as modeled in IMM) with 46.63 lbs. (21.15 kg.) – 29755 cm³. (The 21-day, 20 lb., unconstrained volume optimized medical kit from the previous IMM Request (S-20180815-406, “Orion Medkit Contents”) is shown for comparison purposes.) The **yellow highlighted** individual resources have quantities with decimal values. Those values were rounded up to the nearest integer for the proceeding simulation, shown in parentheses. The **green highlighted** resource quantities are those that differed between this request’s results and the previous, S-20180815-406, results.

<u>Resource</u>	<u>Requestor-Provided Quantity</u> (after clinician translation to iMED equivalence)	<u>Previously Provided Quantity</u> (from S-406)
ABSORBABLE SUTURE 3.0	2	2
ACE BANDAGE 2 INCHES	1	1
ACE BANDAGE 3 INCHES	1	1
ACE BANDAGE 4 INCHES	1	1
AFRIN (OXYMETAXOLINE) 0.05% 15ML BOTTLE	2	1
ALBUTEROL INHALER (PROVENTIL) 90 MCG, 6.7 GM	2	2
AMBIEN 10MG TABLET	20	11
AMBU BAG AND MASK	1	0
ANTIVERT (MECLIZINE) 25 MG	20	0
ASPIRIN 325MG TAB.	6	1
ATIVAN (LORAZEPAM) 1 MG TABLET	15	31
BACITRACIN 500 UNITS/GM. 28 GM TUBE	1	0.85 (1)
BACTRIM (SULFAMETHOXAZOLE/TRIMETHOPRIM) DS 800 MG/160 MG TABLET	52	40
BANDAID STRIP	15	0
BENADRYL 25 MG CAPSULE	26	26

BENADRYL 50 MG/ML, 1ML INJECTABLE	1	1
BLOOD OXIMETER	1	1
BLOOD PRESSURE /ECG MONITOR	1	0
BLOOD PRESSURE CUFF - LARGE	1	0
BOUGIE ET TUBE INTRODUCER	1	0
BZK WIPES	20	0
CIPROFLOXACIN AND DEXAMETHASONE (CIPRODEX) 3%,7%, 7.5 ML BOTTLE	1	0.52 (1)
CLEOCIN (CLINDAMYCIN) 300MG	21	21
COTTON SWABS	6	0
DENTAL ADHESIVE (76 GRAMS)	1	0.1 (1)
DENTAL ADHESIVE TIP	1	1
DENTAL AMALGAM FILE	1	0
DENTAL ELEVATOR - 301 (I)	1	1
DENTAL ELEVATOR - 34S (J)	1	1
DENTAL EXPLORER/PROBE (E)	1	1
DENTAL FORCEPS-10S (A)	1	0
DENTAL FORCEPS-151A (B)	1	0
DENTAL FORCEPS-17 (C)	1	0
DENTAL MIRROR (H)	1	1
DERMABOND APPLICATOR 0.5ML	2	1
DEXAMETHASONE (DECADRON) 10MG INJECTABLE	5	1
DIAMOX (ACETAZOLAMIDE) 250 MG TABLETS	15	6
DIFLUCAN (FLUCONAZOLE) 150 MG	3	1
DILAUDID (HYDROMORPHONE) 2MG/ML, 1ML SYRINGE	4	6
DISPOSABLE OTOSCOPE SPECULA	2	0
DULCOLAX (BISACODYL) TABLET 5MG	16	14
EAR CURETTE	1	0
ENDOTRACHEAL STYLET	1	0
EPIPEN 1:1000	2	1
ERTAPENEM 1GM	4	6
ERYTHROMYCIN OINTMENT 0.5%, 3.5 GM TUBE	1	1
ETHINYL ESTRADIOL / NORGESTREL 0.05 MG/ 0.5 MG	21	0
FLUOCINONIDE 0.05%, 30GM TUBE	1	0.5 (1)
FLUORESCEIN 1MG STRIPS	2	6
GAUZE PADS (4X4)	10	0
ILMA ENDOTRACHEAL TUBE 7.0/7.5 & ENDOTRACHEAL TUBE 7.0/8.0	3	1
IMODIUM (LOPERAMIDE HCL) 2 MG TABLET	24	24
IODINE SWAB STICK	3	0
IV CATHETER (14G)	1	0
IV CATHETER (20G)	4	2

IV CATHETER (22G)	2	1
KETAMINE 50 MG/ML, 10 ML MULTI DOSE VIAL	3	0.3 (1)
LARYNGOSCOPE (BLADE)	1	0
LARYNGOSCOPE HANDLE	1	0
LEVAQUIN (LEVOFLOXACIN) 500MG	25	0
LIDOCAINE (XYLOCAINE) PLAIN 1%, 10ML MULTI DOSE VIAL	6	1
LOPRESSOR (METOPROLOL) 50 MG	30	60
LOTTRIMIN AF CREAM (CLOTRIMAZOLE) 1%, 30GM TUBE	1	1.1 (2)
MEDICAL TAPE	2	0
MIRROR	1	0
MOTRIN (IBUPROFEN) 400MG	80	52
MOXIFLOXACIN (AVELOX) 0.5%, 3ML BOTTLE	1	0.3 (1)
NASAL AIRWAY 6MM	1	0
NASAL AIRWAY 7MM	1	0
NASAL PACKING (POSTERIOR NASAL PACKING)	1	1
NEEDLE (23G)	10	0
NEEDLE [25G]	5	1
NEEDLE DRIVER (AA)	1	1
NITRILE GLOVES (LARGE, MEDIUM, AND SMALL) (PAIR)	3	0
NITROGLYCERIN TABLET 0.4MG	10	10
NONSTICK BANDAGE (TEFLA PADS)	8	0
NYLON SUTURE 2.0	1	2
NYLON SUTURE 5.0	1	0
ORAL AIRWAY	1	0
OTOSCOPE HANDLE	1	1
OTOSCOPE HEAD	1	1
OXYGEN TUBING	1	0
PANOPTIC OPHTHALMOSCOPE	1	1
PENLIGHT	1	1
PEPTO-BISMOL 262MG CHEWABLE TABS	12	6
PREDNISONE 20 MG	24	4
PRILOSEC 20MG	14	0
PROPACARCAINE EYE DROPS 0.5%, 15ML BOTTLE	1	0
PROVIGIL (MODAFINIL) 200 MG TABLETS	10	0
REFRESH ARTIFICIAL TEARS (CARBOXYMETHYLCELLULOSE) 0.5%, 0.4ML BOTTLE	6	6
ROCEPHIN (CEFTRIAXONE) 1 GM	4	0
STERILE GLOVES (LARGE, MEDIUM, AND SMALL) (PAIR)	2	0
STETHOSCOPE	1	1
SUCTION TUBING - GASTRIC TUBE	1	0

SUDAFED 12 HOUR (PSEUDOEPHEDRINE) 120 MG	2	6
SURGICAL LUBRICANT	4	0
SYRINGE (10CC)	3	3
SYRINGE (3CC)	2	2
SYRINGE (60ML)	1	1
TAMSULOSIN 0.4 MG TABLET	10	10
TEMPORARY TOOTH FILLING	1	0
THERMOMETER	1	0
TONOMETER	1	0
TONOMETER TIP COVER	1	0
TORADOL (KETOROLAC) 30MG/ML, 2ML SINGLE DOSE VIAL	4	4
TOURNIQUET	1	1
TYLENOL (ACETAMINOPHEN) 325 MG	77	91
URINARY COLLECTION BAG (LEG BAG)	1	2
URINE CATHETER FOLEY	1	0
URINE CATHETER SHORT	2	3
URINE CATHETER STRAIGHT	2	3
VALACYCLOVIR 1 GM TABLET	21	21
VALIUM (DIAZEPAM) 5 MG/ML, 2 ML SYRINGE	2	1
VICODIN HP (HYDROCODONE/ ACETAMINOPHEN HP) 10 MG/660 MG	18	36
ZITHROMAX (AZITHROMYCIN) 250 MG	20	12
ZOFRAN (ONDANSETRON) 8 MG TABLET	12	12
ABILIFY (ARIPIRAZOLE) 5 MG	0	0
ABILIFY (ARIPIRAZOLE) 7.5 MG/ML, 1.3 ML	0	0
ADRENALINE (EPINEPHRINE 1:10000) 10ML	0	0
AED	0	0
AMOXICILLIN 500 MG CAPSULE	0	22
ATROPINE 1 MG, 10ML SYRINGE.	0	0
BANDAID (2X3)	0	0
BANDAID (KNUCKLE)	0	0
BANDAID DOT	0	0
BENZOCAINE SWAB STICK ORAL 20%, 0.15 ML SWAB	0	0
BIOHAZARD TRASH BAG	0	0
BLOOD PRESSURE CUFF – SMALL	0	0
BURN BANDAGE	0	0
CAMERA	0	0
CLARITIN (LORATADINE)10MG TABLET	0	0
CLEAR BANDAGE	0	0
CMRS	0	0
COTTON PELLET	0	0

CYCLOPENTOLATE 2% 15ML BOTTLE.	0	0.2 (1)
DCS EXAMINATION SCORECARD	0	0
DEBROX FOR EARWAX (CARBAMIDE PEROXIDE) 6.5% 15ML BOTTLE	0	0
DENTAL CARVER FILE (G)	0	1
DENTAL CROWN REMOVER	0	0
DENTAL EUGENOL ANESTHETIC 1ML ORAL SYRINGE	0	2
DENTAL SYRINGE (TUBEX)	0	0
DILANTIN (PHENYTOIN) 300MG CAPSULES	0	6
EAR WICK	0	2
EFFEXOR XR (VENLAFAXINE XR) 75 MG CAPSULES	0	0
EPT	0	1
ESTROGEN 1.25 MG TABLETS	0	7
EYE SHIELD	0	0
EYE SIMULATOR CORNEA	0	0
EYE WASH GOGGLES & TUBING	0	1
EYEWASH WASTE WATER BAG	0	3
FINGER SPLINT	0	1
FLAGYL (METRONIDAZOLE) 500MG	0	30
FLUTICASONE 220MCG, 12GM INHALER	0	0
FOAM ELECTRODES	0	10
G1 CAMCORDER	0	0
HEIMLICH MANEUVER	0	1
HEMOSTATS	0	0
HOT AND COLD PAD	0	0
ILMA CUE CARD	0	1
ILMA HARDWARE	0	0
ILMA STABILIZING ROD	0	1
ILMA SYRINGE	0	0
INTRAOSSEOUS DEVICE STARTER KIT	0	1
INTRAOSSEOUS INJECTION DEVICE	0	1
IV ADMINISTRATION SET	0	2
IV CAP	0	2
IV CATHETER (18G)	0	2
IV FLUID 1L (1000ML)	0	2
IV PRESSURE INFUSER	0	1
LIDOCAINE (XYLOCAINE) CARDIAC 2% (20MG/ML) 5ML SYRINGE	0	0
LIDOCAINE JELLY 2% 30ML TUBE	0	1.2 (2)
LIDOCAINE W/ EPINEPHRINE (XYLOCAINE) 2 %, 2-ML UNITS 1:100,000 EPI, 20 ML. MULTI DOSE VIALS.	0	0.1 (1)
MAXIMUM ABSORBENCY GARMENT (MAG)	0	0
MELATONIN 3 MG	0	0

MUPIROCIN (BACTROBAN) 2%, 22 GM TUBE	0	1.1 (2)
NEEDLE PLASTIC	0	0
OTOSCOPE USB CABLE	0	1
OXYGEN MASK - RESUSCITATION MASK	0	0
PHENERGAN (PROMETHAZINE TABLET) 25 MG	0	4
PROMETHAZINE INJECTABLE (PHENERGAN) 50MG/ML SINGLE DOSE VIAL	0	1.5 (2)
PSYCHOTHERAPY	0	1
REFRESH EYE OINTMENT (PETROLATUM WHITE AND MINERAL OIL) 42.5%; 57.3%, 3.5GM	0	0
ROBINUL (GLYCOPYRROLATE) 0.2MG/ML	0	0
ROLLED GAUZE	0	0
SALINE NOSE SPRAY 22ML BOTTLE	0	0
SAM SPLINT - LEG/ARM SPLINT	0	1
SCALPEL #11 (SCALPEL BLADE & HANDLE)	0	1
SCISSORS – TRAUMA	0	0
SHARPS CONTAINER	0	0
SILVER NITRATE STICK 75%/25%	0	0
SKIN STAPLE REMOVER	0	1
SKIN STAPLER	0	1
SMOOTH FORCEPS	0	1
SPACE ANTICIPATION GLASSES	0	0
SPACE STATION EYE WASH	0	1
STERILE WATER 10 ML VIAL	0	0
STETHOSCOPE EAR PIECES	0	0
SUCTION CARTRIDGE	0	0
SUCTION DEVICE	0	1
SUCTION DEVICE COLLECTION BAG	0	0
SUCTION DEVICE SYRINGE	0	1
SUCTION TIP - MOUTH (CURETTE)	0	0
SUCTION TUBING - ENDOTRACHEAL TUBE	0	0
SUDAFED (PSEUDOEPHEDRINE) 30MG	0	0
SURGICAL TOOLS KIT	0	0
SUTURE SCISSORS (BB)	0	0
SYRINGE (35CC)	0	0
SYRINGE (5CC)	0	0
TOBRAMYCIN AND DEXAMETHASONE 0.3%; 0.1%, 10ML BOTTLE	0	0
TONGUE DEPRESSOR	0	0
TOOTHED FORCEPS (EE)	0	0
TROPICAMIDE 1%	0	0
ULTRASOUND GEL	0	3
ULTRASOUND MACHINE	0	0

URINE CATHETER COUDE	0	0
URINE CHEMSTRIPS	0	9
URINE COLOR CHART	0	0
VARIABLE OXYGEN SYSTEM	0	1
VOS INTUBATED PATIENT HARDWARE (VENTILATOR/RESPIRATOR)	0	0
WATER	0	0
WOUND PACKING	0	0
ZANTAC (RANITIDINE) 150 MG	0	4
ZIPRASIDONE (GEODON 20MG/ML)	0	0
ZOLOFT (SERTRALINE) 50 MG	0	20
ZYRTEC (CETIRIZINE) 10 MG TABLET	0	0

The IMM MedCap results for TME, CHI, EVAC, and LOCL for the simulated DRM are presented in the tables below. (The 21-day, 20 lb., unconstrained volume MedCap results from the previous IMM Request (S-20180815-406, “Orion Medkit Contents”) are shown in the tables for comparison purposes.) Table 3 and Figure 1 show the average number of total medical events (TME) during the mission across the DRM. Table 4 and figure 2 show the average CHI across the DRM. Table 5 along with Figure 3 and Figure 4 show the probability of EVAC and LOCL across the DRM. Note that in the figures cc corresponds to cm³.

Table 3: Average Number of TME for the DRMs

		TME	95% CI	
21-day DRM with 46.63 lb. (21.15 kg) - 29755 cc	MedCap	17.61	11	25
21-day DRM with 20 lb., Unconstrained Volume from previous S-406 Request	MedCap	17.69	11	25

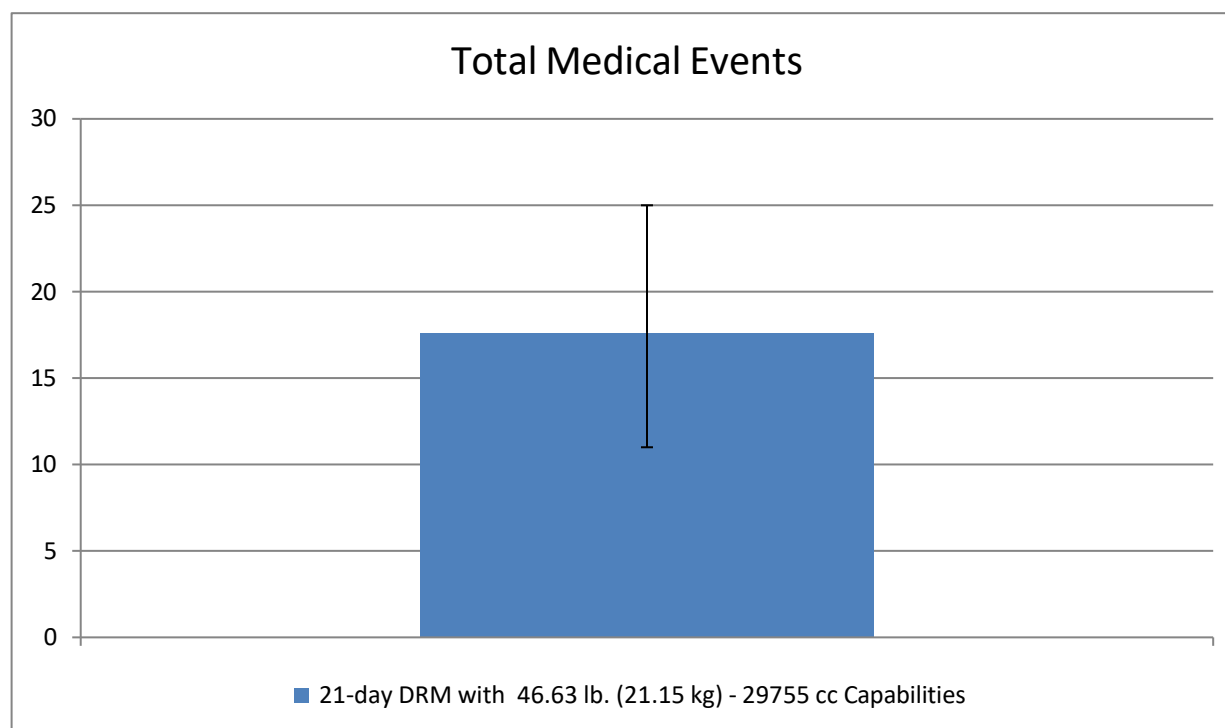


Figure 1: Average Number of TME for the DRMs

Table 4: Average CHI for the DRMs

		CHI	95% CI	
21-day DRM with 46.63 lb. (21.15 kg) - 29755 cc	MedCap	96.38	85.59	98.75
21-day DRM with 20 lb., Unconstrained Volume from previous S-406 Request	MedCap	97.20	93.66	98.88

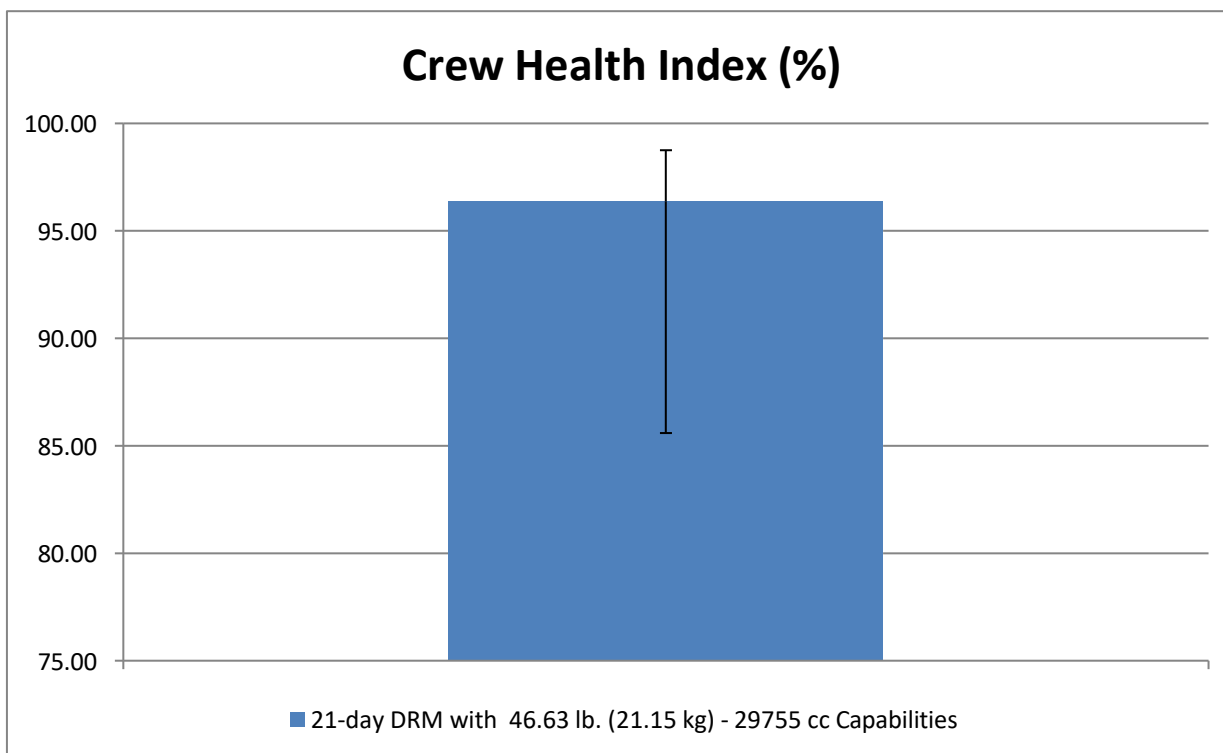


Figure 2: Average CHI for the DRMs

Table 5: Probability of EVAC and LOCL for the DRMs

		EVAC			LOCL		
		Probability	95% CI		Probability	95% CI	
21-day DRM with 46.63 lb. (21.15 kg) - 29755 cc	MedCap	0.0426	0.0415	0.0439	0.0006	0.0005	0.0008
21-day DRM with 20 lb., Unconstrained Volume from previous S-406 Request	MedCap	0.0065	0.0059	0.0070	0.0005	0.0003	0.0006

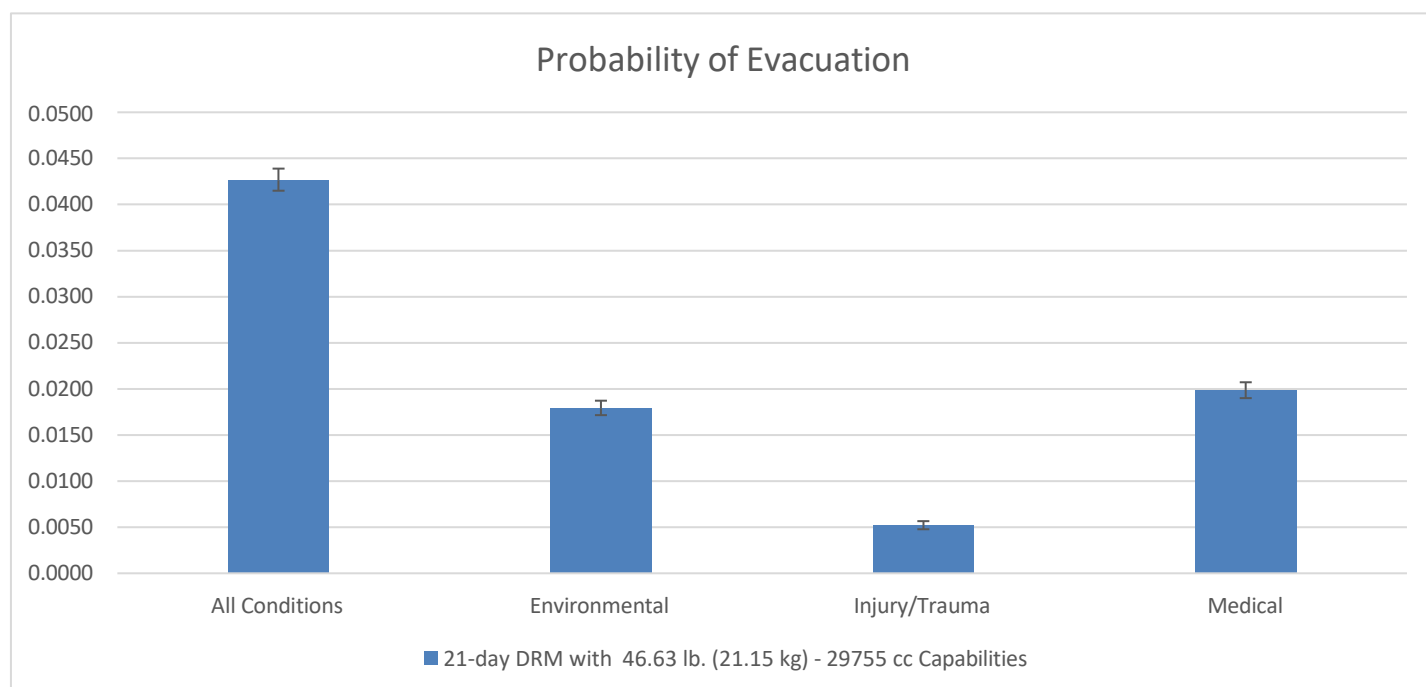


Figure 3: Probability of EVAC for the DRMs

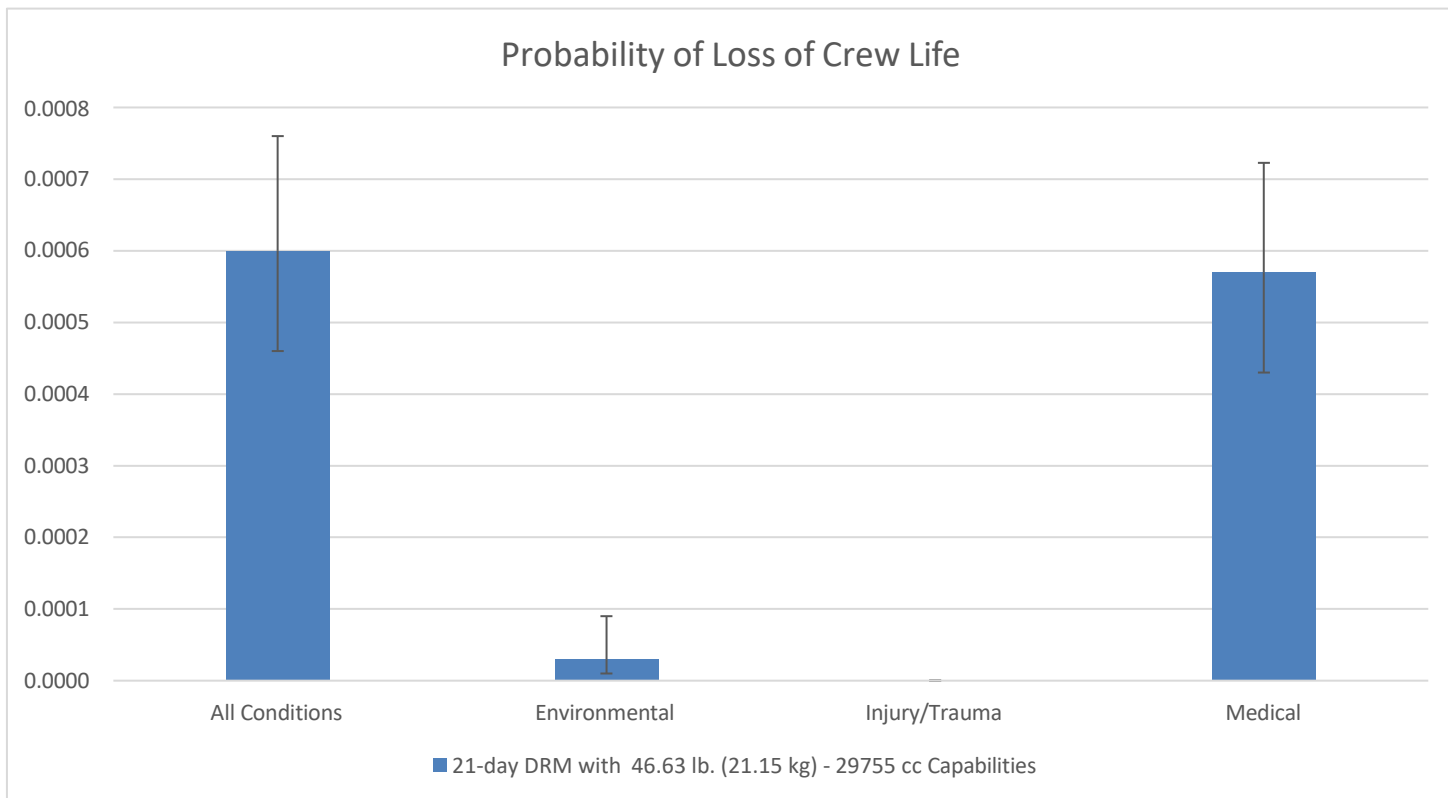


Figure 4: Probability of LOCL for the DRMs

Table 6 below shows the top ten influential conditions for EVAC for the 21-day DRM with 46.63 lb. (21.15 kg) - 29755 cm³ Medical Kit capabilities. Table 7 shows the top ten influential conditions for EVAC for the 21-day DRM with 20-lb, unconstrained volume, CHI Optimized Medical Kit (from the S-406 request) for comparison purposes. Table 8 presents the top ten influential conditions for LOCL for the same mission run for this

request. Table 9 shows the top ten influential conditions for LOCL for the comparison set from the S-406 request.

Table 6: 21-day DRM with 46.63 lb. (21.15 kg), **29755 cm³** Medical Capabilities; Top Ten Influential Conditions for **EVAC**

Scenario	Treated	Medical Condition	Total EVAC
BEST CASE	PARTIAL	EYE CHEMICAL BURN	1558
BEST CASE	PARTIAL	URINARY RETENTION (SPACE ADAPTATION)	976
WORST CASE	PARTIAL	EYE CHEMICAL BURN	235
BEST CASE	PARTIAL	FINGER DISLOCATION	232
WORST CASE	PARTIAL	URINARY RETENTION (SPACE ADAPTATION)	145
WORST CASE	PARTIAL	DIARRHEA	136
WORST CASE	PARTIAL	URINARY TRACT INFECTION	108
WORST CASE	PARTIAL	SKIN LACERATION	94
WORST CASE	PARTIAL	GASTROENTERITIS	84
WORST CASE	PARTIAL	OTITIS MEDIA	48

Table 7: 21-day DRM with 20-lb, unconstrained volume, CHI Optimized Medical Kit (from the S-406 request) Top Ten Influential Conditions for **EVAC** (For Comparison)

Scenario	Treated	Medical Condition	Total EVAC
BEST CASE	PARTIAL	FINGER DISLOCATION	80
WORST CASE	PARTIAL	SKIN INFECTION	56
WORST CASE	PARTIAL	URINARY TRACT INFECTION	50
WORST CASE	PARTIAL	NEPHROLITHIASIS	40
WORST CASE	PARTIAL	SKIN LACERATION	37
WORST CASE	PARTIAL	ACUTE SINUSITIS	28
WORST CASE	PARTIAL	HEADACHE (SPACE ADAPTATION)	27
WORST CASE	PARTIAL	DENTAL ABSCESS	27
WORST CASE	PARTIAL	DIARRHEA	26
WORST CASE	PARTIAL	DENTAL EXPOSED PULP	26

Table 8: 21-day DRM with 46.63 lb. (21.15 kg), **29755 cm³** Medical Capabilities; Top Ten Influential Conditions for **LOCL**

Scenario	Treated	Medical Condition	Total LOCL
BEST CASE	PARTIAL	SEPSIS	15
WORST CASE	PARTIAL	SEPSIS	14
WORST CASE	PARTIAL	MEDICATION OVERDOSE/ADVERSE REACTION	13
BEST CASE	PARTIAL	ANAPHYLAXIS	4
WORST CASE	PARTIAL	STROKE (CEREBROVASCULAR ACCIDENT)	4
WORST CASE	PARTIAL	TOXIC EXPOSURE (AMMONIA)	2
WORST CASE	PARTIAL	ACUTE DIVERTICULITIS	2
WORST CASE	PARTIAL	CHOKING/OBSTRUCTED AIRWAY	1
WORST CASE	PARTIAL	BURNS SECONDARY TO FIRE	1
BEST CASE	PARTIAL	APPENDICITIS	1

Table 9: 21-day DRM with 20-lb, unconstrained volume, CHI Optimized Medical Kit (from the S-406 request) Top Ten Influential Conditions for **LOCL** (For Comparison)

Scenario	Treated	Medical Condition	Total LOCL
WORST CASE	PARTIAL	SEPSIS	17
WORST CASE	PARTIAL	MEDICATION OVERDOSE/ADVERSE REACTION	5
WORST CASE	PARTIAL	TOXIC EXPOSURE (AMMONIA)	4
BEST CASE	PARTIAL	APPENDICITIS	4
WORST CASE	PARTIAL	BURNS SECONDARY TO FIRE	3
WORST CASE	PARTIAL	STROKE (CEREBROVASCULAR ACCIDENT)	3
WORST CASE	PARTIAL	CHOKING/OBSTRUCTED AIRWAY	2
WORST CASE	PARTIAL	ACUTE RADIATION SYNDROME	1
BEST CASE	PARTIAL	SEPSIS	1
WORST CASE	PARTIAL	ACUTE DIVERTICULITIS	1

Discussion

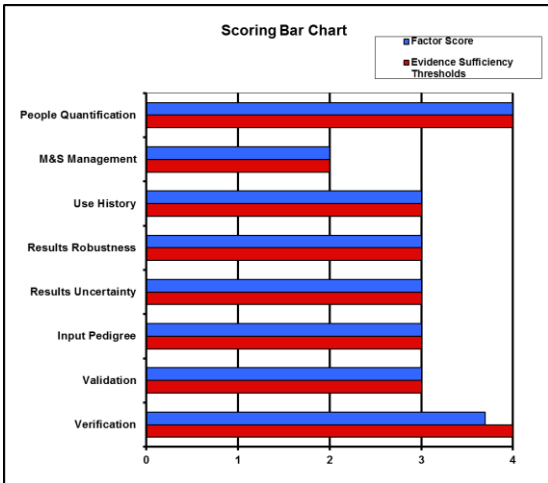
The purpose of this support request was to validate that the preliminary Orion medical kit results in acceptable CHI and probabilities of EVAC and LOCL based on IMM outputs. The resultant CHI of 96.38 is comparable to the resultant CHI of 97.20 for the prior IMM Orion Medkit support request (S-20180815-406). The resultant LOCL probability of 0.0006 is comparable to the resultant LOCL probability of 0.0005 for the prior IMM support request (S-20180815-406). The resultant EVAC probability of 0.0426 is significantly higher than the resultant EVAC probability of 0.0065 for the prior IMM support request (S-20180815-406). This increase in EVAC probability appears to be due primarily to the insufficiency of resources that are considered by the iMED to be essential to treatment of certain conditions (thereby forcing the conditions to go either partially or untreated). The requestor-provided resource set lacked approximately 40.5% of required essential resources for the top ten influential conditions for EVAC, where the previously provided S-20180815-406 optimized resource set only lacked approximately 6.7% of those resources. (See Appendix D.) The increased probability of EVAC forecasted by IMM based on the requestor-provided Orion medical kit may not, however, be of significant concern for the following reasons: 1. Evacuation due to eye chemical burn was primarily due to eye chemical burns that have historically occurred primarily during EVAs and no EVAs are planned for this DRM; 2. Best case finger dislocation is not expected to contribute to EVAC. This EVAC output is due to iMED input data for untreated best case finger dislocation of 0-100% instead of 0%; and 3. Evacuation due to the insufficiency of resources that are considered by the iMED to be essential to treatment of certain conditions may not be nearly as high as predicted because, in an actual spaceflight scenario, other resources would almost certainly be utilized for treatment. (For example: taping fingers together in the absence of a finger splint, substituting oral hydration for IV fluids, utilizing only sutures or butterfly bandaging for skin lacerations, forgoing testing that might require urine chem strips.)

References

1. Integrated Medical Model Project. Integrated Medical Model Operations Plan. JSC-66114. 2011. Houston, TX, NASA, Johnson Space Center. *Ref Type: Report*
2. Integrated Medical Model Project. Integrated Medical Model Software Requirements Specification. IMM-SFTWR-008. 2017. Houston, Texas, KBRwyle Integrated Science, Technology and Engineering. *Ref Type: Report*
3. Integrated Medical Model Project. Integrated Medical Model version 4 Assumptions and Limitations. IMM-GEN-300. 2017. Houston, Texas, KBRwyle Integrated Science and Engineering Space Medicine Information Technology. *Ref Type: Report*

4. NASA-STD-7009: Standard for Models and Simulations (2008). NASA: Washington, DC.
5. ISS Medical Checklist (Med CL), 04 June 2014, NASA Johnson Space Center, Medical Operations Group
6. ISS PRA Model v.3.2.0. ISS PRA Fire and Ammonia Model Contributions to the Integrated Medical Model. 2015. Houston, Texas, NASA Johnson Space Center. *Ref Type: Report*

Appendix A: IMM Status at Time of Service Request Report

Validation status for IMM	IMM V&V Matrix: The following bar chart shows the IMM v4.1 MATLAB status of IMM validation for each IMM element listed. Scoring Bar Chart <table><thead><tr><th>IMM Element</th><th>Evidence Sufficiency Thresholds</th><th>Factor Score</th></tr></thead><tbody><tr><td>People Quantification</td><td>4</td><td>4</td></tr><tr><td>M&S Management</td><td>2</td><td>2</td></tr><tr><td>Use History</td><td>3</td><td>3</td></tr><tr><td>Results Robustness</td><td>3</td><td>3</td></tr><tr><td>Results Uncertainty</td><td>3</td><td>3</td></tr><tr><td>Input Pedigree</td><td>3</td><td>3</td></tr><tr><td>Validation</td><td>3</td><td>3</td></tr><tr><td>Verification</td><td>4</td><td>3.7</td></tr></tbody></table>	IMM Element	Evidence Sufficiency Thresholds	Factor Score	People Quantification	4	4	M&S Management	2	2	Use History	3	3	Results Robustness	3	3	Results Uncertainty	3	3	Input Pedigree	3	3	Validation	3	3	Verification	4	3.7																															
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Compliance with NASA-Standard-7009 requirements	IMM Compliance Matrix: The IMM has no waivers to any of the requirements in the NASA-Standard-7009 for Models and Simulations (6); however, there are certain requirements that are not applicable to the IMM and other requirements where IMM compliance has not yet been fully attained. <table><thead><tr><th>Compliant</th><th>Compliance Incomplete</th><th>Not applicable</th></tr></thead><tbody><tr><td>36</td><td>5</td><td>5</td></tr></tbody></table>	Compliant	Compliance Incomplete	Not applicable	36	5	5																																																				
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Current NASA-Standard-7009 credibility assessment score	IMM Credibility Matrix: The following table shows the overall IMM v4.1 MATLAB credibility assessment score (CAS), individual factor CAS, customer-specified sufficiency thresholds, and weighted scores. Legend depicts CAS score designated range and color assignments from NASA-Standard-7009. <table><thead><tr><th>Factor</th><th>Sufficiency Thresholds</th><th>Factor Score</th><th>Weighted Scores</th><th>Overall Score</th></tr></thead><tbody><tr><td>Verification</td><td>4</td><td>3.7</td><td>0.28</td><td></td></tr><tr><td>Validation</td><td>3</td><td>3</td><td>0.45</td><td></td></tr><tr><td>Input Pedigree</td><td>3</td><td>3</td><td>0.53</td><td></td></tr><tr><td>Results Uncertainty</td><td>3</td><td>3</td><td>0.60</td><td>3.06</td></tr><tr><td>Results Robustness</td><td>3</td><td>3</td><td>0.45</td><td></td></tr><tr><td>Use History</td><td>3</td><td>3</td><td>0.45</td><td></td></tr><tr><td>M&S Management</td><td>2</td><td>2</td><td>0.10</td><td></td></tr><tr><td>People Qualification</td><td>4</td><td>4</td><td>0.20</td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td></tr></tbody></table> Legend from NASA-STD-7009 <table><tbody><tr><td>Blue</td><td>CAS Score > Threshold Exceeds credibility requirements</td></tr><tr><td>Green</td><td>Threshold ≥ CAS Score ≥ (Threshold-0.5) Ready for use</td></tr><tr><td>Yellow</td><td>Threshold-0.5 > CAS Score ≥ Threshold-1.0 Use with caution</td></tr><tr><td>Red</td><td>CAS Score < Threshold - 1.0 Use not recommended or to be used with EXTREME CAUTION by subject matter experts only</td></tr></tbody></table>	Factor	Sufficiency Thresholds	Factor Score	Weighted Scores	Overall Score	Verification	4	3.7	0.28		Validation	3	3	0.45		Input Pedigree	3	3	0.53		Results Uncertainty	3	3	0.60	3.06	Results Robustness	3	3	0.45		Use History	3	3	0.45		M&S Management	2	2	0.10		People Qualification	4	4	0.20							Blue	CAS Score > Threshold Exceeds credibility requirements	Green	Threshold ≥ CAS Score ≥ (Threshold-0.5) Ready for use	Yellow	Threshold-0.5 > CAS Score ≥ Threshold-1.0 Use with caution	Red	CAS Score < Threshold - 1.0 Use not recommended or to be used with EXTREME CAUTION by subject matter experts only
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Additional verification and validation information applicable to this analysis	None																																																										
Integrated Medical Evidence Database (iMED) code version and date accessed	iMED Lockdown ID: (60), created on (11/19/2019)																																																										
IMM version and code version	Data analysis for this report was generated using IMM v4.1 with release 2016a of MATLAB software. MATLAB and all other MathWorks product or service names are registered trademarks or trademarks of MathWorks, Natick, MA, USA.																																																										
Modifications made to the code for analysis	None																																																										

Appendix B: Medical Conditions in iMED by Category (iMED_20170221)

ENVIRONMENTAL Acute Radiation Syndrome Altitude Sickness Barotrauma (ear/sinus block) Burns secondary to Fire Decompression Sickness Secondary to EVA Eye Chemical Burn Headache (CO ₂ induced) Smoke Inhalation Toxic Exposure: Ammonia	MEDICAL ILLNESS (continued) Anxiety Appendicitis Atrial Fibrillation/Atrial Flutter Back Pain (space adaptation) Behavioral Emergency Cardiogenic Shock Secondary to Myocardial infarction Choking/Obstructed Airway Constipation (space adaptation) Dental: Exposed Pulp Dental Caries Dental: Abscess Dental: Crown Loss Dental: Filling Loss Depression Diarrhea Eye Corneal Ulcer Eye Infection Gastroenteritis Headache (Late) Headache (space adaptation) Hearing Loss Hemorrhoids Herpes Zoster Reactivation (shingles) Hypertension Indigestion Influenza Insomnia (space adaptation) Medication Overdose/Adverse Reaction Mouth Ulcer Nasal Congestion (space adaptation) Nephrolithiasis Nose bleed (space adaptation) Otitis Externa Otitis Media Pharyngitis Respiratory Infection Retinal Detachment Seizures Sepsis Skin Infection Skin Rash Sleep Disorder Small Bowel Obstruction Space Motion Sickness (space adaptation) Stroke (Cerebrovascular Accident) Sudden Cardiac Arrest Urinary Incontinence (space adaption) Urinary Retention (space adaptation) Urinary Tract Infection Vaginal Yeast Infection Visual Impairment and Increased Intracranial Pressure (VIIP) (space adaptation)
INJURY/TRAUMA Abdominal Injury Acute Compartment Syndrome Ankle Sprain/Strain Back Sprain/Strain Chest Injury Dental: Avulsion (tooth loss) Elbow Dislocation Elbow Sprain/Strain Eye Irritation/Abrasion Eye Penetration (foreign body) Finger Dislocation Fingernail Delamination Secondary to EVA Head Injury Hip Sprain/Strain Hip/Proximal Femur Fracture Knee Sprain/Strain Lower Extremity Stress Fracture Lumbar Spine Fracture Neck Sprain/Strain Neurogenic Shock Paresthesias Secondary to EVA Shoulder Dislocation Shoulder Sprain/Strain Skin Abrasion Skin Laceration Traumatic Hypovolemic Shock Wrist Fracture Wrist Sprain/Strain	
MEDICAL ILLNESS Abdominal Wall Hernia Abnormal Uterine Bleeding Acute Angle-Closure Glaucoma Acute Arthritis Acute Cholecystitis/Biliary Colic Acute Diverticulitis Acute Pancreatitis Acute Prostatitis Acute Sinusitis Allergic Reaction (mild to moderate) Anaphylaxis Angina/Myocardial Infarction	

Appendix C: Medical Conditions Excluded or Modified for the 21 Day DRM

Due to limited vehicle size consisting of a single module and limited movement of crew the following major traumatic injury conditions are judged highly unlikely to occur during a 21-day DRM (and were removed prior to running the simulation):

- Abdominal Injury
- Acute Compartment Syndrome
- Chest Injury
- Elbow Dislocation
- Head Injury
- Hip/Proximal Femur Fracture
- Lower Extremity (LE) Stress Fracture
- Lumbar Spine Fracture
- Shoulder Dislocation
- Neurogenic Shock
- Traumatic Hypovolemic Shock

Due to short duration of mission (21 days) plus the above limitations, the following conditions are judged highly unlikely to develop (and was removed prior to running the simulation):

- Visual Impairment and/or Increased Intracranial Pressure (VIIP) (Space Adaptation)

Due to absence of any EVAs and a constant cabin pressure of 14.7psi, the following condition is judged highly unlikely to occur (and was removed prior to running the simulation):

- Barotrauma (ear/sinus block)

Since the IMM worst case definition of depression specifies symptoms lasting more than 4 weeks and the DRM of these missions lasting 21 days, the following condition will follow the best case scenario for 100% of events that occur for this request:

- Depression

Rather than considering the entire ISS volume for application of Fire Model result input to the IMM, ISS Node 3 was used to approximate the size of the Orion vehicle. The corresponding Node 3 Fire Model results (directly from the ISS PRA Fire Model v3.2) were used to update Burns Secondary to Fire and Smoke Inhalation for this request as follows:

- Burns Secondary to Fire:
 - **incidence 0.00613 (events/person year)** - probability one or more crew exposed to response level event (value same as for likelihood for Fire Sustains (response level event) since modeling for single compartment, i.e. Node 3) (v3.2);
 - **worst case scenario = 0-5%** - EVAC (uncontrollable fire- not vehicle) (value = 0.0486; derived from uncontrolled fire event/probability one or more crew exposed to response level event)
- Smoke Inhalation:
 - **incidence 0.00613 (events/person year)** - Fire Sustains (response level event) (v3.2);
 - **worst case scenario = 0-5%** - EVAC (uncontrollable fire- not vehicle) (value = 0.0486; derived from uncontrolled fire event/Fire Sustains (response level event))

Appendix D: Resource Comparison for Top 10 Influential Conditions for EVAC

Appendix D Table 1: Legend

Column C = Quantity required (of Column B) of only the <u>essential resources</u> , according to whether for BC or WC.
Blue highlighted cells in column D = not enough required resources available in requestor's Orion kit to treat the condition (thereby forcing the condition to go either partially or untreated). ($30/74 = \sim 40.5\%$).
Yellow highlighted numbers in Column E = not enough resources in the <u>S-406 kit</u> to treat the condition (thereby forcing the condition to go either partially or untreated). ($5/74 = \sim 6.7\%$)
Green highlighted cells in column F = IMM Request S-406 Optimized Kit (Column E) had more resources than the requestor-provided Orion Kit for this IMM Request S-417 (Column D).

Appendix D Table 1:

<u>Condition</u>	<u>Essential</u> Resources (not auto-eliminated by optimizer)	Qty <u>Required</u>	Qty in Orion Kit <u>Requestor- Provided</u> (after clinical translation)	Qty in <u>Opt Kit S- 406</u>	406 > 417 Resources
Eye Chemical Burn (<u>BC</u>)					
EVAC - 0 - 100%	Cyclopentolate 2% 15mL bottle.	0	0	1	
	Eyewash waste water bag	1	0	3	
	Moxifloxacin (Avelox) 0.5%, 3ml bottle	0	1	1	
	Panoptic Ophthalmoscope	1	1	1	
	Refresh artificial tears (Carboxymethylcellulose) 0.5%, 0.4mL bottle	1	6	6	
	Space station eye wash	1	0	1	
	Urine chemstrips	3	0	9	

Urinary Retention (BC)					
EVAC - 0 - 100%	Lidocaine Jelly 2% 30mL Tube	0.33	1 (Surgi-lube)	2	
	Syringe (10cc)	1	3	3	
	Urinary Collection Bag (leg bag)	0	1	2	
	Urine Catheter Short	1	2	3	
	Urine Catheter Straight	1	2	3	
	Urine chemstrips	1	0	9	
Eye Chemical Burn (WC)					
EVAC - 0 - 100%	Cyclopentolate 2% 15mL bottle.	0.0133	0	1	
	Eyewash waste water bag	2	0	3	
	Moxifloxacin (Avelox) 0.5%, 3ml bottle	0.28	1	1	
	Panoptic Ophthalmoscope	1	1	1	
	Refresh artificial tears (Carboxymethylcellulose) 0.5%, 0.4mL bottle	1	6	6	
	Space station eye wash	1	0	1	
	Urine chemstrips	4	0	9	
Finger Dislocation (BC)					
EVAC - 0 - 100%	Blood Pressure Cuff - Large	0	1	0	
	Finger splint	1	0	1	
	Lidocaine (Xylocaine) plain 1%, 10mL multi dose vial	0	6	1	
	Needle [25g]	0	5	1	
	Syringe (3cc)	0	2	2	
	Tylenol (Acetaminophen) 325 mg	12	77	91	

	Ultrasound gel	1	0	3	
	Ultrasound machine	1	0	0	
	Vicodin HP (Hydrocodone/ Acetaminophen HP) 10 mg/660 mg	0	18	36	
Condition	Essential Resources (not auto- eliminated by optimizer)	Qty Required	Qty in Orion Kit Requestor- Provided (after clinical translation)	Qty in Opt Kit S- 406	406 > 417 Resources
Urinary Retention (WC)					
EVAC - 0 - 100%	Lidocaine Jelly 2% 30mL Tube	0.33	1 (Surgi- lube)	2	
	Syringe (10cc)	1	3	3	
	Urinary Collection Bag (leg bag)	1	1	2	
	Urine Catheter Short	1	2	3	
	Urine Catheter Straight	1	2	3	
	Urine chemstrips	1	0	9	
Diarrhea (WC)					
EVAC - 0 - 100%	Blood Pressure /ECG Monitor	1	1	0	
	Foam electrodes	5	0	10	
	Imodium (loperamide HCL) 2 mg tablet	16	24	24	
	IV administration set	1	0	2	
	IV Cap	1	0	2	
	IV Catheter (18G)	1	0	2	
	IV Fluid 1L (1000mL)	2	0	2	
	IV pressure infuser	1	0	1	
	Tourniquet	1	1	1	

<u>Condition</u>	<u>Essential</u> Resources (not auto-eliminated by optimizer)	Qty <u>Required</u>	Qty in Orion Kit <u>Requestor-Provided</u> (after clinical translation)	Qty in <u>Opt Kit S-406</u>	406 > 417 Resources
UTI (<u>WC</u>)					
EVAC - 0 - 100%	Bactrim DS (Sulfamethoxazole/Trimethoprim) 800 mg/160 mg tablet	0	52	40	
	Levaquin (levofloxacin) 500mg	7	25	0	
	Motrin (Ibuprofen) 400mg	9	80	52	
	Urine chemstrips	2	0	9	
Skin Laceration (<u>WC</u>)					
EVAC - 0 - 100%	Absorbable Suture 3.0	1	2	2	
	Bacitracin 500 units/gm. 28 gm tube	0.1	1	1	
	Dermabond applicator 0.5mL	0	2	1	
	Lidocaine (Xylocaine) plain 1%, 10mL multi dose vial	0.5	6	1	
	Needle Driver (AA)	1	1	1	
	Nylon Suture 2.0	1	1	2	
	Scissors - Trauma	1	0	0	
	Skin Staple Remover	1	0	1	
	Skin stapler	1	0	1	
	Tylenol (Acetaminophen) 325 mg	8	77	91	
	Vicodin HP (Hydrocodone/ Acetaminophen HP) 10 mg/660 mg	6	18	36	
Gastroenteritis (<u>WC</u>)					
EVAC - 0 - 100%	Blood Pressure Cuff - Large	1	1	0	

	Imodium (loperamide HCL) 2 mg tablet	9	24	24	
	IV administration set	1	0	2	
	IV Cap	1	0	2	
	IV Catheter (18G)	1	0	2	
	IV Fluid 1L (1000mL)	2	0	2	
	IV pressure infuser	1	0	1	
	Promethazine injectable (Phenergan) 50mg/mL	2	0	2	
	Stethoscope	1	1	1	
	Tourniquet	1	1	1	
	Zofran (Ondansetron) 8 mg tablet	6	12	12	
<u>Condition</u>	<u>Essential</u> Resources (not auto-eliminated by optimizer)	<u>Qty Required</u>	Qty in Orion Kit <u>Requestor-Provided</u> (after clinical translation)	Qty in <u>Opt Kit S-406</u>	406 > 417 Resources
Otitis Media (<u>WC</u>)					
EVAC - 0 - 100%	Amoxicillin 500 mg capsule	20	0	22	
	Motrin (Ibuprofen) 400mg	24	80	52	
	Otoscope handle	1	1	1	
	Otoscope head	1	1	1	
	Otoscope USB Cable	1	0	1	

Appendix E: Clinician Translation of Requestor-Provided Resources to iMED Resources

The table below shows all resources provided by the requestor (in the first column), along with the quantity of those resources (in the second column). The third and fourth columns show the disposition of the resource (resource translation to iMED resources by the clinicians) and notes for the rationale behind those decisions. The yellow-highlighted cells are resources that could not be translated over to iMED. There were **44/167, or ~26%**, that could not be translated and thus were not used for the simulation. **Red font** indicates where an equivalent substitution was made.

Resource Provided by Requestor	Orion Med Kit Quantity	IMM Disposition	IMM Disposition Notes
0.5% Timolol Maleate [Ophthalmic]	1*	Do not include	No equivalent resource in iMED. Not called out for Glaucoma.
1% Apraclonidine [Ophthalmic]	1*	Do not include	No equivalent resource in iMED. Not called out for Glaucoma.
2% Pilocarpine [Ophthalmic]	1*	Do not include	No equivalent resource in iMED. Not called out for Glaucoma.
2-Octyl cyanoacrylate (Dermabond)	2*	Include Dermabond 0.5 ml (#2)	Same resource/dosage
Acetaminophen 500mg [PO]	50	Use #77 Acetaminophen 325mg tabs (instead of this #50 Acetaminophen 500mg tabs).	IMM uses 325mg tabs, so must increase the # of tabs in IMM by a factor of 1.54
Acetazolamide 250mg [PO]	15	Include Acetazolamide 250mg (#15)	Same resource/dosage
Acoustic Dosimeter	1	Do not include	No equivalent resource in iMED. Not called out for Hearing Loss.

Adhesive Bandages	15*	Include Bandaid Strip (#15)	No 1"x3" bandaids in iMED. Closest equivalent that IS called out for conditions in the bandaid strip.
Advanced Airway - Bougie	1*	Include Advanced Airway - Bougie (#1)	Same resource/dosage
Advanced Airway - BVM (Bag-Valve-Mask)	1*	Include Advanced Airway - BVM (Bag-Valve-Mask)	Same resource/dosage
Advanced Airway - Calorimeter	1*	Do not include	No equivalent resource in iMED. Not called out for any conditions.
Advanced Airway - Cric Kit - Scalpel/Hook/Tracheal Tube/Forceps	1*	Do not include	No equivalent resource in iMED. Not called out for any conditions.
Advanced Airway - Endotracheal Intubation - ET Tube 7.0	1*	Include Advanced Airway - Endotracheal Intubation - ET Tube 7.0 (#2)	Substitute for ILMA Endotracheal Tube 7.0/7.5 & 8.0
Advanced Airway - Endotracheal Intubation - ET Tube 8.0	1*	Include Advanced Airway - Endotracheal Intubation - ET Tube 8.0 (#1)	Substitute for ILMA Endotracheal Tube 7.0/7.5 & 8.0
Advanced Airway - Endotracheal Intubation - Stylet	1*	Include Advanced Airway - Endotracheal Intubation - Stylet (#1)	Same as iMED's Endotracheal Stylet
Advanced Airway - King Tube	1*	Do not include	No equivalent resource in iMED
Advanced Airway - Laryngoscope (Video) - Blade	1*	Include (#1)	Same resource/dosage
Advanced Airway - Laryngoscope (Video) - Handle	1*	Include (#1)	Same resource/dosage
Advanced Airway - PEEP Valve	1*	Do not include	Not called out for any conditions in iMED
Advanced Airway - Tube Collar	1*	Do not include	Not called out for any conditions in iMED
Albuterol 90mcg/actuation [Inhaler]	2*	Include (#2)	Same resource/dosage
Apixaban 5mg [PO]	24	Do not include	Not called out for any conditions in iMED
Aspirin [PO]	6	Include (#6)	Same resource/dosage

Atorvastatin [PO]	6	Do not include	Not called out for any conditions in iMED
Bactrim DS 800/160mg [PO]	40*	Include (#40)	Same resource/dosage
Bisacodyl 5mg [PO]	16	Include (#16)	Same resource/dosage
Bismuth subsalicylate 524 mg [PO]	6	Use #12 Pepto-Bismol 262mg tabs (instead of this #6 Pepto-Bismol 524mg tabs).	IMM uses 262mg tabs, so must increase the # of tabs in IMM by a factor of 2
Blood Pressure Cuff (Large)	1*	Include (#1)	Same resource/dosage
Blood Pressure Cuff (Regular)	1*	Include #1 Blood Pressure Cuff - Large	IMM uses one large and one small cuff (no "regular" cuff)
Blood Pressure Monitor	1*	Include	Same resource/dosage
Caffeine 200mg [PO]	24	Do not include	Dosing: Provigil 200 mg QD Vivarin 200 mg Q3-4 hr
Calcium Hydroxide Base (Dycal)	1	Include (#1)	Use as equiv to Dental Adhesive 76 gm #1 in iMED
Carboxymethylcellulose 0.5%, 0.4mL [ophthalmic]	6 (Refresh) OR 1 (Nature's Tears)	Include Refresh (#6)	Same resource/dosage
Catheter (Urinary) - Foley	1	Include (#1)	Same resource/dosage
Catheter (Urinary) - Straight	4	Include (#2) Straight and (#2) Short	iMED calls for both short and straight catheters for Urinary Retention, so gave Orion 2 of each (where they list #4 Straight)
Catheter (Vascular Access) (14G)	1*	Include for IV Catheter (14G) (#1)	Same resource/dosage
Catheter (Vascular Access) (20G)	4	Include for IV Catheter (20G) (#4)	Same resource/dosage
Catheter (Vascular Access) (22G)	2	Include for IV Catheter (22G) (#2)	Same resource/dosage
Cefdinir [PO]	20	Include (#10) Levaquin 500mg	Similar resource/dosage adjustment
Ceftriaxone [injectable-IM]	4	Include (#4)	Same resource/dosage
Cephalexin [PO]	12	Include (#12) Bactrim DS	Similar resource/dosage
Ciprofloxacin/Dexamethasone (drops) [otic]	1	Include (#1)	Same resource/dosage
Clindamycin [PO]	21	Include (#21)	Same resource/dosage

Clopidogrel [PO]	6	Do not include	Not called out for any conditions in iMED
Clotrimazole 1% [topical]	1	Include (#1)	Same resource/dosage
Compression Wrap - Coban	1	Do not include	Not called out for any conditions in iMED
Compression Wrap (ACE) - 2"	1*	Include (#1)	Same resource/dosage
Compression Wrap (ACE) - 3"	1	Include (#1)	Same resource/dosage
Compression Wrap (ACE) - 4"	1*	Include (#1)	Same resource/dosage
Cotton Swabs	6	Include (#6)	Same resource/dosage
Cyclobenzaprine [PO]	10	Do not include	Not called out for any conditions in iMED
Dental Amalgam File	1	Include (#1)	Same resource/dosage
Dental Elevator - 301	1	Include (#1)	Same resource/dosage
Dental Elevator - 34S	1	Include (#1)	Same resource/dosage
Dental Explorer Probe	1*	Include (#1)	Same resource/dosage
Dental Mirror	1	Include (#1)	Same resource/dosage
Dexamethasone 10mg/mL [injectable]	5*	Include (#5)	Same resource/dosage
Diazepam [injectable]	2	Include (#2)	Same resource/dosage
Diazepam [PO]	7*	Do not include	Not called out for any conditions in iMED
Diphenhydramine 25mg [injectable]	1	Change to 50mg (#1)	To match iMED resource dose
Diphenhydramine 25mg [PO]	26	Include (#26)	Same resource/dosage
Doxycycline 100mg [PO]	20	Include (#20)	Same resource/dosage
Ear Plugs	4	Do not include	Not called out for any conditions in iMED
ECG/Waveform Analysis	1	Blood Pressure/ECG Monitor already included earlier (Row 60)	Not called out for any conditions in iMED
Enoxaparin [injectable]	6	Do not include	Not called out for any conditions in iMED
Epinephrine (EpiPen) [injectable-IM]	2	Include (#2)	Same resource/dosage
Ertapenem 1g [injectable-IM]	4	Include (#4)	Same resource/dosage
Famotidine 20mg [PO]	10*	Do not include	Orion calls for Prilosec, Row 302

Fexofenadine 180mg [PO]	20	Do not include	iMED has Claritin, but it is not associated with any conditions
Fluconazole 150mg [PO]	3*	Include (#3)	Same resource/dosage
Fluorescein Strips	2	Include (#2)	Same resource/dosage
Forceps - Dental	1*	Include dental forceps - 10S (A) (#1), 151A (B) (#1), 17 (C) (#1) Do not include Magill Forceps	Dental forceps are included in iMED. Magill Forceps do not have an equivalent resource in iMED
Forceps - Magill	1*	Do Not Include	Magill Forceps do not have an equivalent resource in iMED
Gauze - Pads (4"x4")	10	Include (#10)	Same resource/dosage
Gauze - Telfa Pads	8*	Include (#8)	Same resource/dosage
Gloves - Non-Sterile (Large)	1	Use iMED's nitrile gloves (#3)	iMED groups all three sizes together and calls for total of 30 pair)
Gloves - Non-Sterile (Medium)	1	Do not include	See above
Gloves - Non-Sterile (Small)	1	Do not include	See above
Gloves - Sterile	2	Use iMED's sterile gloves (#2)	iMED groups all three sizes together and calls for total of 6 pair)
Hydrocodone 5mg + Acetaminophen 325mg [PO]	36	Use iMED's Vicodin (#18)	iMED uses double the strength, so would need to halve the quantity
Ibuprofen [PO]	80	Include (#80)	Same resource/dosage (dosage for Orion not specified)
In-Suit Pill Delivery Tool	1	Do not include	Not called out for any conditions in iMED
IV Tourniquets (Vascular Access)	1	Include iMED's Tourniquet (#1)	Same resource/dosage
Ketamine [injectable]	3*	Include (#3)	Same resource/dosage
Ketorolac [injectable]	4	Include (#4)	Same resource/dosage
Ketorolac [ophthalmic]	1	Do not include	Not called out for any conditions in iMED
Levofloxacin [PO]	15	Include (#15)	Same resource/dosage

Levonorgestrel (0.1) + Ethinyl estradiol (20) [PO]	1	Use iMED's ETHINYL ESTRADIOL / NORGESTREL 0.05 MG/ 0.5 MG, but decrease quantity to 21	Same usage, but different med/dose
Lidocaine 1% [injectable]	6	Include (#6)	Same resource/dosage
Loperamide 2mg [PO]	24	Include (#24)	Same resource/dosage
Lorazepam 1mg [PO]	15*	Include (#15)	Same resource/dosage
Magnifying Surgical/Dental Loupes	1 set	Do not include	Not called out for any conditions in iMED
Meclizine [PO]	20	Include (#20)	Same resource/dosage
Methylprednisolone Sodium Succinate [125 mg] [injectable]	1	Include Prednisone 20 mg (#8)	Similar resource/dosage adjustment Prednisone 20mg = 16mg Methylprednisolone
Metoprolol [PO]	30	Include (#30)	Same resource/dosage
Mirror	1*	Include (#1)	Same resource/dosage
Modafinil 200mg [PO]	10	Include (#10)	Same resource/dosage
Morphine [injectable]	4	Include (#4)	Same resource/dosage
Naloxone [injectable]	2	Do not include	Not called out for any conditions in iMED
Nasal Tampon	1	Use iMED's posterior nasal packing (#1)	Virtually same resource
Nasogastric tube	1*	Use iMED's Suction Tubing - Gastric Tube (#1)	Same resource/dosage
Needle	10 5	Include Needle (23G) (#10) Include Needle (25G) (#5)	Virtually same resource
Needle driver	1	Include (#1)	Same resource/dosage
Nitroglycerin 0.4mg [PO]	10	Include (#10)	Same resource/dosage
Norethindrone 5 mg [PO]	10*	Do not include	Not called out for any conditions in iMED
NPA (Nasopharyngeal Airway) (6MM)	1	Include (#1)	Same resource/dosage
NPA (Nasopharyngeal Airway) (7MM)	1	Include (#1)	Same resource/dosage
Omeprazole 20mg [PO]	14	Include (#14)	Same resource/dosage
Ondansetron [PO]	12	Include (#12)	Same resource/dosage
OPA (Oropharyngeal Airway)	1	Include (#1)	Same resource/dosage
Ophthalmoscope	1*	Include panoptic ophthalmoscope (#1)	

Oral Rehydration Solution	4*	Do not include	Not called out for any conditions in iMED
Otoscope - Handle	1	Include (#1)	Same resource/dosage
Otoscope - Head	1	Include (#1)	Same resource/dosage
Otoscope - Speculum - Regular	1	Include (#1)	Same resource/dosage
Otoscope - Speculum - Small	1	Include (#1)	Same resource/dosage
Oxymetazoline [intranasal]	2	Include (#2)	Same resource/dosage
Pen Light - UV	1	Include iMED's Pen Light (#1)	iMED does not use UV penlight
Phenazopyridine 80mg [PO]	12*	Do not include	Not called out for any conditions in iMED
Prednisolone Acetate 1.0%, 5mL	1	Do not include	Not called out for any conditions in iMED
Prednisone [PO]	16	Include (#16)	Same resource/dosage
Providone Iodine Sepp Applicator	3*	Use iMED's Iodine Swabstick Include (#3*)	Virtually same resource
Pseudoephedrine (120mg) [PO]	2	Include (#2)	Same resource/dosage
Pseudoephedrine [30mg] [PO]	24	Do not include	Not called out for any conditions in iMED
Rehydration Salts	12	Do not include	Not called out for any conditions in iMED
Saline [Injectable-IV]	1	Do not include	Not called out for any conditions in iMED
Scalpel	1	Include Scalpel #11 (#1)	Same resource/dosage
Scissors - Surgical	1	Include Suture Scissors (BB) (#1)	Same resource/dosage
Scissors - Trauma	1	Include (#1)	Same resource/dosage
Simethicone [PO]	8	Do not include	Not called out for any conditions in iMED
Skin Sanitizer	20	Include (#20) BZK Wipes	Same resource/dosage
SpO2 Monitor	1	Use iMED's blood oximeter (#1)	Same resource/dosage
Stethoscope	1	Include (#1) Stethoscope	Same resource/dosage
Supplemental Oxygen Equipment - Mask	1	Do not include	(Ambu bag and mask (#1) already included)
Supplemental Oxygen Equipment - Regulator	1	Do not include	Same resource/dosage
Supplemental Oxygen Equipment - Tubing	1	Include (#1)	Same resource/dosage

Surgical Lubricant	4	Include (#4)	Same resource/dosage
Sutures - Absorbable (Variety of Sizes) (Vicryl)	2	Include Absorbable Suture 3.0 (#2)	Same resource/dosage
Sutures - Non-Absorbable (Nylon/Prolene) - 2.0	1	Include (#1)	Same resource/dosage
Sutures - Non-Absorbable (Nylon/Prolene) - 5.0	1	Include (#1)	Not called out for any conditions in iMED
Syringe	2	Include Syringe (3cc) (#2)	Same resource/dosage
Syringe - 10cc	3	Include (#3)	Similar resource/dosage in iMED
Syringe - 60cc	1	Include (#1)	Similar resource/dosage in iMED
Tampons	2	Do not include	Not called out for any conditions in iMED
Tamsulosin [PO]	10	Include (#10)	Same resource/dosage
Tape - Micropore	1	Include Medical Tape (#1)	Same resource/dosage
Tape - Silk	1	Include Medical (#1)	Same resource/dosage
Tegaderm	2	Do not include	Same resource/dosage
Temporary Tooth Filling (Cavit-G)	1	Include (#1)	Similar resource/dosage in iMED
Tenecteplase [injectable-IV]	1	Do not include	Not called out for any conditions in iMED
Tetracaine 0.5% [ophthalmic]	1	Include (#1)	Same resource/dosage
THERMOMETER	1	Include (#1)	Same resource/dosage
Tonometer	1	Include (#1) Tonometer and (#1) Tonometer Tip Cover	Same resource/dosage
Tonometer - Tip Covers	1	N/A	
Topical Bacitracin [topical]	1	Include (#1)	Same resource/dosage
Topical Erythromycin 0.5% [ophthalmic]	1	Include (#1)	Same resource/dosage
Topical Fluocinonide 0.05% [topical]	1	Include (#1)	Same resource/dosage
Topical Ketotifen 0.25% [ophthalmic]	1	Do not include	Not called out for any conditions in iMED
Topical Moxifloxacin 0.5%, 3mL [ophthalmic]	1	Include (#1)	Same resource/dosage
Tubing (Vascular Access)	2	Do not include	Not called out for any conditions in iMED
Tweezers	1	Do not include	Not called out for any conditions in iMED

Urinary Collection Bag (Leg Bag)	1	Include (#1)	Same resource/dosage
Valacyclovir 1000mg [PO]	21	Include (#21)	Same resource/dosage
Wire loop (curette)	1	Include (#1*)	Same resource/dosage
Zaleplon 10mg [PO]	10	Include (#10)	Same resource/dosage
Zolpidem 10mg [PO]	10	Include (#10)	Same resource/dosage