



COMPARISON OF THE INTEGRATED MEDICAL MODEL PREDICTIONS TO REAL WORLD ISS AND STS OBSERVATIONS

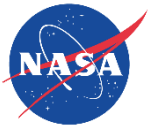
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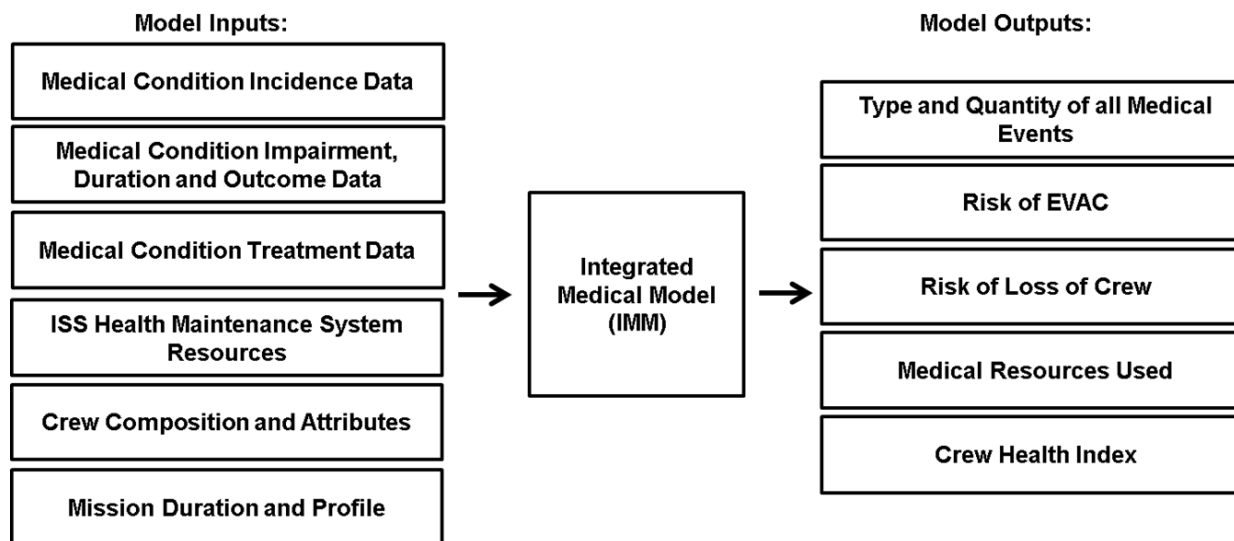
Goals

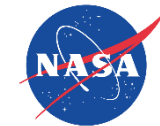
- Brief Review of IMM
- Outline the validation process
- Illustrate and compare results
- Discuss implications to decision making



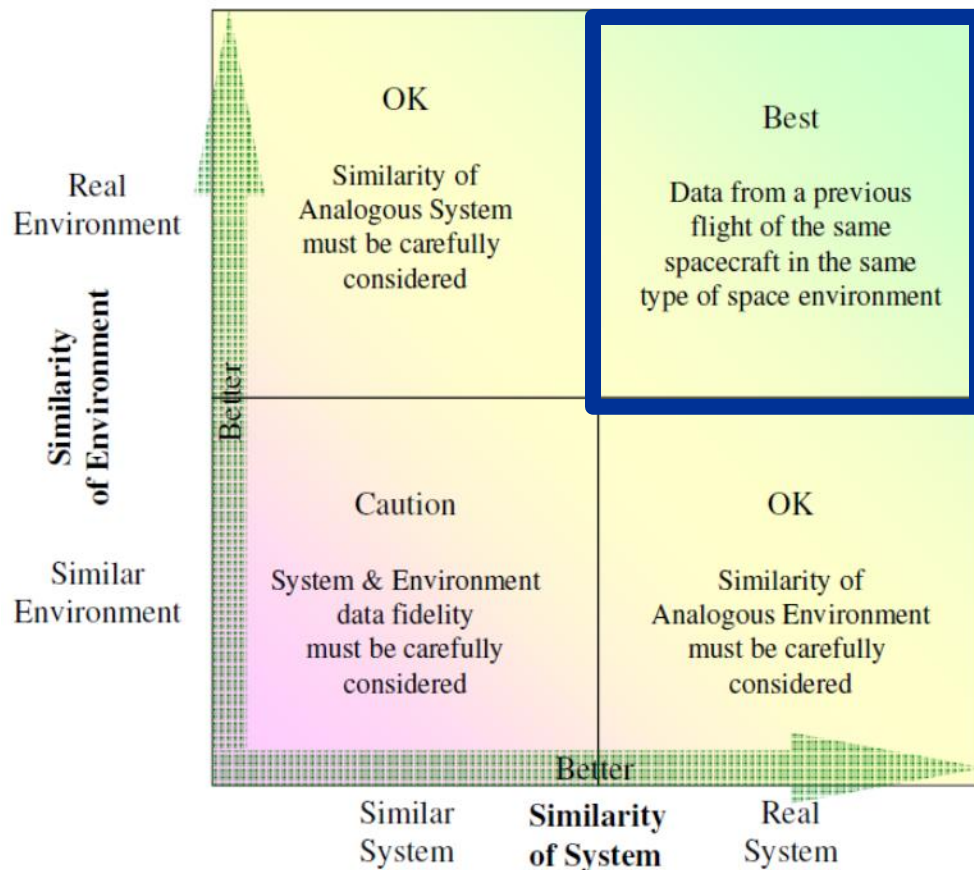
Integrated Medical Model (IMM)

- Stochastic simulation model used to predict in-flight medical events, the resources required to treat, and impacts to the spaceflight mission.
- Human Research Program supported development since before FY08.
- v4.1 transitioned to use by Crew Health and Safety in 2017.





Purpose of the Comparison – Validation



Compare IMM output to observed medical events from a selection of Shuttle Transportation System (STS) and International Space Station (ISS) missions.

What Data is Used for Comparison?

- Real World System (RWS): 31 ISS and 21 STS missions not previously incorporated into the primary IMM data repository*



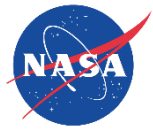
ISS015E006285

STS 115 through STS 135 and STS 107



ISS Expedition (Exp) 14 through 39/40 and ISS Exp 9

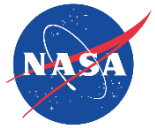
*Integrated Medical Database, iMED



IMM Simulations of the RWS Missions

Equivalent simulations performed for each RWS mission profile using IMM v 4.0

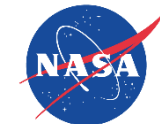
- Length of mission
- Mission schedule (EVA)
- Crew complement (sex, limited medical history)
- ISS simulation assumed resupply of medical supplies
- 100 Medical condition set



Observed and Predicted Outcomes

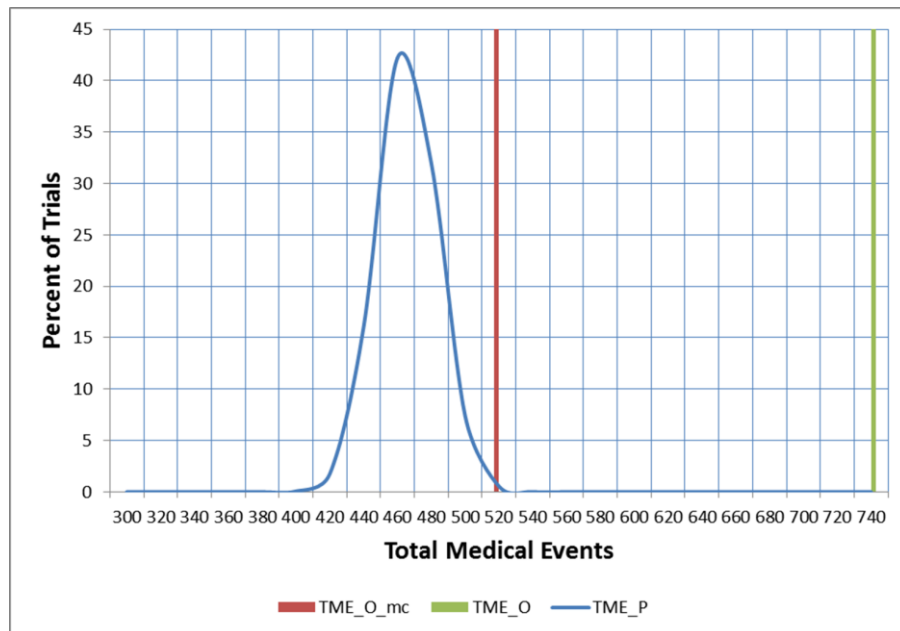
- Total medical events (TME)
- Medical consumable utilization
- LOCL and EVAC*

* RWS had zero LOCL and EVAC events

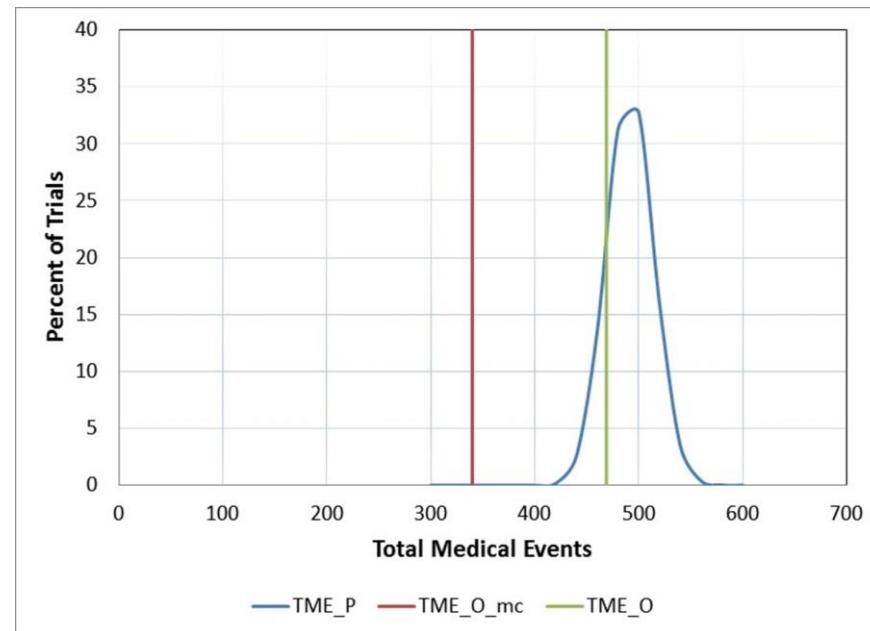


(Cumulative) Total Medical Events

STS



ISS

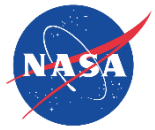


Predicted (P)
Observed (O)
IMM medical conditions list only (mc)

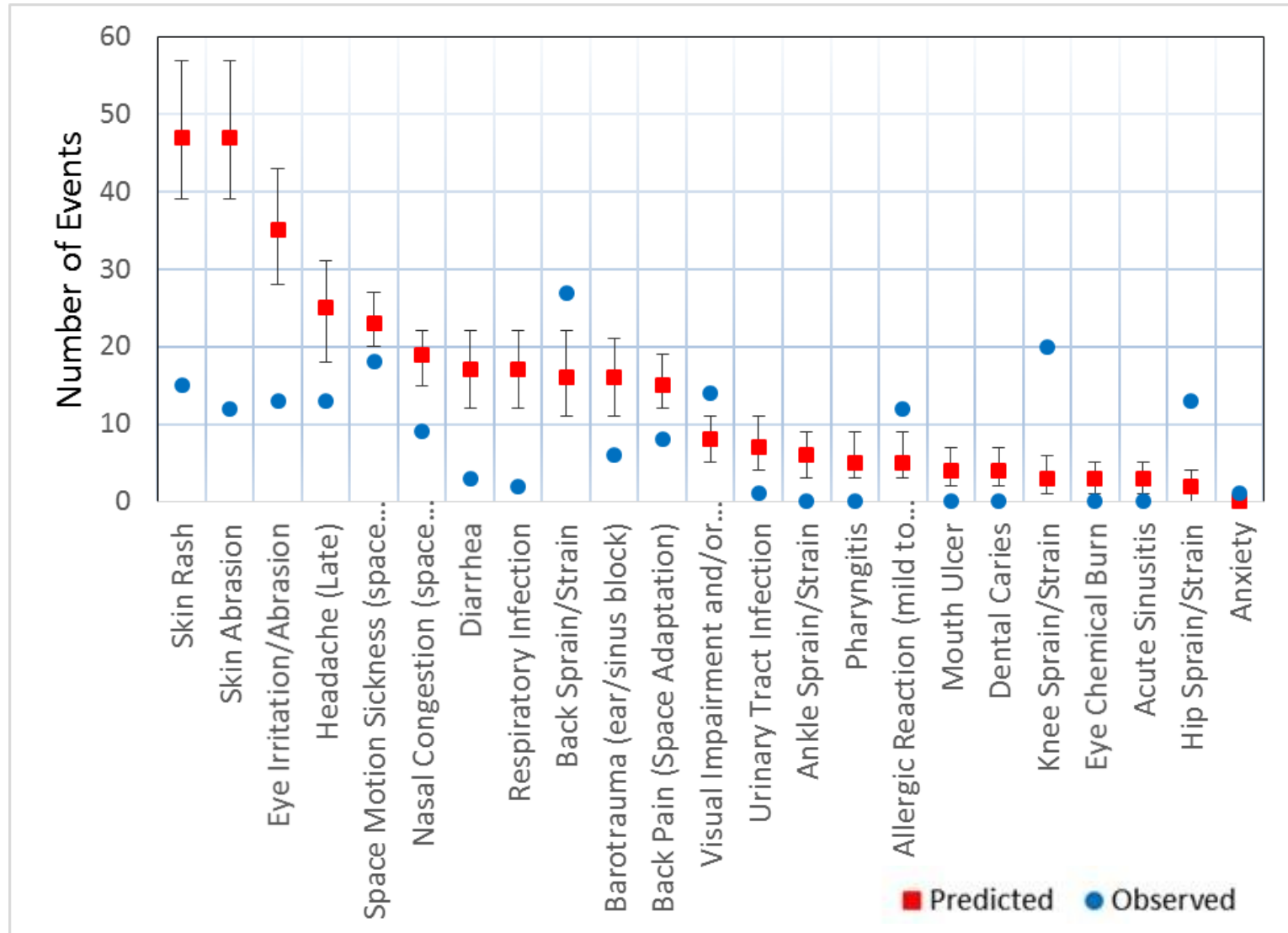


Per Condition Comparison

- 20% of the STS and 15% of the ISS medical events within expected uncertainty.
- 14% for STS and 24% for ISS medical events outside of the expected uncertainty.
- The remainder of the events had an indeterminate comparison.



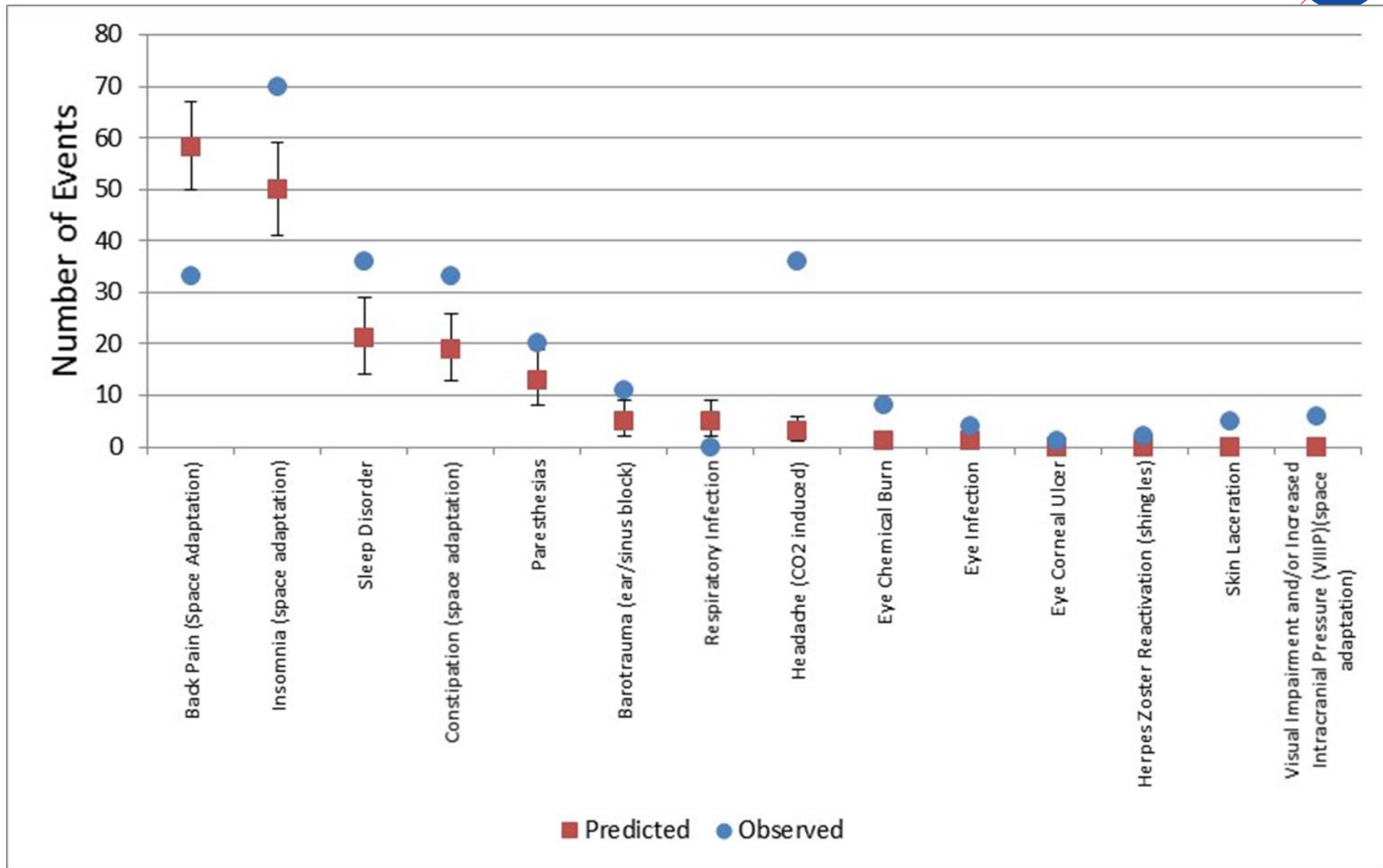
Out of Range ISS Conditions



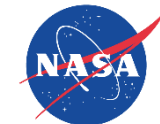
Over predicted the number of events for all but 6 conditions.



Out of Range STS Conditions



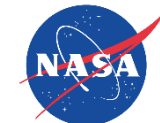
Under predicted the number of events for all but two conditions.



ISS – Medical Consumables

Observed Rank	Observed (from TME_O_mc)
1	Non-opioid Analgesics
2	Hypnotics
3	Antiemetics
4	Antihistamines
5	Steroids
6	Decongestants
7	Antibiotics
8	Ophthalmic Lubricants
9	Antifungals
10	Antacids
11	Antidiarrheals
12	Laxatives
13	Antivirals
14	Opioid Analgesics

Predicted Rank	Predicted (from TME_P)	Quality of Match
1	Non-opioid Analgesics	Excellent
2	Hypnotics	Excellent
6	Antiemetics	Fair
4	Antihistamines	Excellent
13	Steroids	Poor
7	Decongestants	Excellent
3	Antibiotics	Fair
5	Ophthalmic Lubricants	Fair
9	Antifungals	Excellent
12	Antacids	Excellent
8	Antidiarrheals	Fair
10	Laxatives	Excellent
14	Antivirals	Excellent
11	Opioid Analgesics	Fair



STS - Medical Consumables

Observed Rank	Observed (from TME_O_mc)
1	Hypnotic
2	Antiemetic
3	Non-opioid Analgesic/NSAID
4	Decongestant
5	Laxative
6	Antibiotic
7	Steroid
8	Ophthalmic Lubricants
9	Antidiarrheal
10	Antacid
11	Antihistamine
12	Antifungal
13	Opioid Analgesic
14	Antiviral

Predicted Rank	Predicted (from TME_P)	Quality of Match
4	Hypnotic	Fair
2	Antiemetic	Excellent
1	Non-opioid Analgesic/NSAID	Excellent
3	Decongestant	Excellent
6	Laxative	Excellent
5	Antibiotic	Excellent
8	Steroid	Excellent
9	Ophthalmic Lubricants	Excellent
10	Antidiarrheal	Excellent
13	Antacid	Fair
7	Antihistamine	Fair
11	Antifungal	Excellent
12	Opioid Analgesic	Excellent
14	Antiviral	Excellent



LOCL and EVAC Comparison

STS	Predicted Number	90% Confidence Interval
EVAC RWS = 0	0	0, 1
LOCL RWS = 0	0	0, 0

ISS	Predicted Number	90% Confidence Interval
EVAC RWS = 0	0	0, 1
LOCL RWS = 0	0	0, 0

- Predicted counts are estimated using the median of the simulated distribution.
- A confidence limit of (0, 0) indicates that more than 90% of the generated LOCL counts was 0 as these confidence limits are estimated by the 5th and 95th percentiles of the simulation distribution.



Potential Implications on Decision Making

- Variation exists in IMM predictive power for STS and ISS missions
- Decision should account for information limits
 - Longer mission profile - IMM tends to over predict incidences
 - Shorter mission profiles - IMM tends to under predict incidence.
- Difference in predictions
 - Different ISS and STS reporting conditions.
 - Combining all “mission type” data
 - Constant occurrence rate or fixed proportion.



Future Work (Some Already Done!)

- Incorporation RWS data into the iMED (Completed)
- Transition to CHS (Completed)
- CHS acceptance testing (On going)



Acknowledgments

GRC

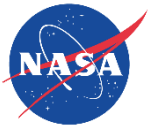
- Kelly Gilkey
- DeVon Griffin

JSC

- Millennia Young

Wyle

- Marlei Walton



Extras