



NASA Astronaut Urinary Conditions Associated with Spaceflight

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Aerospace Medical Association 87th Annual Scientific Meeting
April 28, 2016

Disclosures

- We have no financial relationships to disclose.
- We will not discuss off-label use or investigational use in this presentation.

Introduction

- Spaceflight is associated with many factors which may promote urinary retention, urinary tract infection, kidney stone formation
 - Obstructive (anatomical) – e.g., BPH
 - Psychosocial
 - Gravitational
 - Pharmacologic
 - Neurogenic (SAS-Related)
 - Infectious (UTI)
- Urinary conditions are among the top 3 conditions predicted by NASA's Integrated Medical Model as the most likely reason for emergent medical evacuation from ISS
 - Kidney stone: #2
 - Sepsis (urosepsis as primary driver): #3

Methods

- Inflight and post-flight medical records of NASA astronauts were reviewed for urinary retention, urinary tract infection, and kidney stones during Mercury, Gemini, Apollo, Mir, Shuttle, and ISS Expeditions 1-38

Results – Kidney Stones

- No inflight occurrence of kidney stones
- 7 events(N=6) of kidney stones developed in the 12 months after flight
 - One case in the first 90 days after flight
 - Three cases occurred within 90 to 180 days after landing

Results – Urinary Retention

- 9 cases of urinary retention documented
- 16 total if symptoms suggestive of urinary retention are included (0.018 events per person-mission)

	Shuttle	ISS	Catheter Required	EVA Related	SMS Med Usage
Urinary Retention	8	1	4	1	7
Bladder fullness/pressure	2	0	0	0	1
Difficulty initiating/hesitancy	5	0	0	1	4
TOTAL	15	1	4	2	12

Urinary Retention	Incidence Rates
Shuttle	0.019 events/person mission
ISS	0.021 events/person mission

	<u>N</u>	<u>Average Age (±SD)</u>
Total	16	43.44 (6.62)
M	9	46.00 (7.50)
F	7	40.14 (3.48)

Contributing Factors

- Incidence of space motion sickness (SMS) starting with Apollo range from 35-80%. ¹⁻⁴Anticholinergics are a common treatment for SMS; i.e., Promethazine, Scopolamine, Meclizine (both prophylactic and active treatment)
- Decongestants/Antihistamines are frequently used for treatment on ISS, prophylactically for EVAs and for active treatment of upper respiratory infections/allergic rhinitis⁵
- Urinary retention is a known side effect of anticholinergics/anticholinergic-like medication

¹Nicogossian et al Space Physiology and Medicine 3rd ed, ²Reschke et al Space Biology and Medicine , ³Davis et al ASEM March 1993, ⁴Jennings J Vestib Res 1998,

⁵Wotring FASEB J. 2015

Results – Urinary Retention

Odds of developing urinary retention are **3 times** higher among astronauts who took promethazine.

P<0.0001^{1,2}	Incidence Rate	95% Confidence Limits	
Promethazine	0.032	0.0165	0.0612
None	0.0108	0.0044	0.0265

Females are **4 times** more likely to develop urinary retention than males

P=0.0161^{1,2}	Incidence Rate	95% Confidence Limits	
Males	0.0128	0.0058	0.0280
Females	0.0546	0.0226	0.01261

¹Based on Shuttle US and IP crewmembers and ISS US crewmembers

²Adjusted for repeated individuals

Results – Urinary Tract Infection

- All Shuttle crewmembers and/ ISS US crewmembers: 9 cases
 - Male: 1 event
 - Female: 8 events (5 crewmembers)
- Other publically known events of UTI in males in space flight
 - Apollo
 - Early Russian Mir

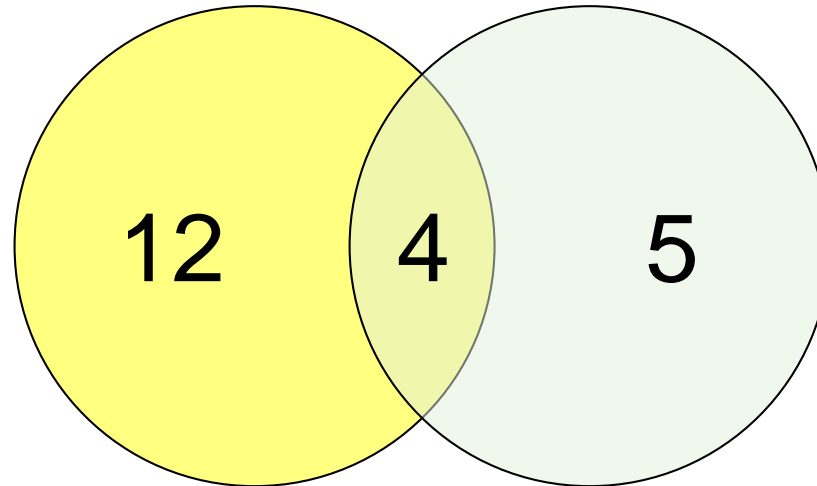
Urinary Tract Infection

- Report of two Shuttle flights of a crewmember with positive urine culture for *Escherichia coli* at landing
 - Both cases had bladder catheterizations in flight
 - First case prophylaxed with antibiotics at time of bladder cath
 - Switched to TMP/SMX DS after exhausted supply of nitrofurantoin
 - Ground culture later found to be resistant to TMP/SMX DS
 - Second case received antibiotic prophylaxis and still had bacteriuria at landing

Stepaniak PC, Ramchandani, SR, Jones, JA. Acute Urinary Retention Among Astronauts. *Aviation, Space, and Environmental Medicine*. April 2007;78,4: A5-8

Urinary Retention and Urinary Tract Infection

Urinary Retention **Urinary Tract Infection**



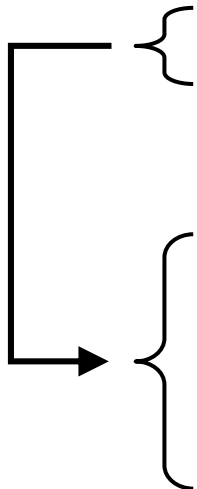
	Events	N=
Only Urinary Retention	12	10
Only Urinary Tract Infection	5	5
Urinary Retention + Urinary Tract Infection	4	3
Total Events	21	15

Urinary Retention and UTI

- An astronaut with urinary retention is **25x** more likely to have a UTI
 - **17% infection rate**
 - Urinary retention vs. UTI - which is the chicken and which is the egg?

P<0.0001	Infection Rate	95% Confidence Limits	
Retention	0.1679	0.0619	0.3818
No retention	0.0067	0.0028	0.0159

Based on all crew



P=0.4412	Infection Rate	95% Confidence Limits	
Cath	0.4218	0.0178	0.9670
No cath	0.1746	0.0149	0.7472

- An astronaut with a bladder cath is **2.5x** more likely to have a UTI (not statistically significant; not enough cases to have adequate power)
 - **42% infection rate**
 - Includes cases that prophylaxed with antibiotics

Discussion

- It is unclear if spaceflight carries an increased postflight risk of kidney stones.
- Urinary retention
 - Female to male odds ratio is higher inflight compared to the general population where older males comprise almost all cases due to prostatic hypertrophy
 - The higher prevalence in females is even more concerning given the fact that there have been many more males in space than females
- Promethazine use increases the risk of developing urinary retention in spaceflight
- Urinary retention and urinary tract infection are highly associated
 - Both with or without bladder catheterization, but catheterization further increases risk of infection

So What?

- Urinary retention is a bigger issue than previously thought
- Standard treatment for urinary retention (cath) increases risk of UTI
 - Aseptic techniques can be especially challenging with an inexperienced provider in a free-floating environment
 - Consider using touch free catheter systems to reduce infections
- UTIs treated with antibiotics
 - Medication supplies can become depleted
 - Exploration mission shelf life issues and potentially decreased antibiotic effectiveness
 - Potential for bacterial resistance
 - Theoretical increased pathogen virulence
 - Altered immune function
 - Inadequately treated UTI may lead to pyelonephritis and sepsis → evacuation or mission impact
- **Inflight urinary retention and UTI have proven to be associated and their risks should be considered collectively when planning for spaceflight.**

Backup

Terrestrial Data on Urinary Retention

- Urinary retention in men becomes more common with age.
 - In men 40 to 83 years old, the overall incidence of urinary retention is 4.5 to 6.8 per 1,000 men.
 - For men in their 70s, the overall incidence increases to 100 per 1,000 men.
 - For men in their 80s, the incidence of acute urinary retention is 300 per 1,000 men.
- Urinary retention in women is less common, though not rare.
- The incidence of urinary retention in women has not been well studied because researchers have primarily thought of urinary retention as a male problem related to the prostate.

NIH, <http://www.niddk.nih.gov/health-information/health-topics/urologic-disease/urinary-retention/Pages/facts.aspx>