WHAT, WHY, HOW & HOW MUCH?

- Natural or Synthetic
- Prevent
  - Treat
  - Reduce symptoms
  - Diagnose a health problem or disease
- Replace
  - Mimic
  - Interfere
  - Antagonise
- Effectiveness – Toxicity
Need to Know

**Stability** — shelf life

**Dose** — Effectiveness
  - Disadvantages
  - Absorption
  - Distribution
  - Metabolism

**Action** — how it works

**Interactions**
Is the Dose You Need in Space the Same as You Need on Earth?
Body Changes Without G:

- Dehydration/ kidney stones
- Anemia
- Muscle mass/ muscle strength/ back-pain
- Resistance to insulin
- Bone density loss/ Reduced Ca absorption/ decreased Vitamin D
- Sleep/ circadian rhythms
- Immune system/ reactivation of viruses
- Bacterial infection
- Antibiotic absorption reduced/sensitivity
- Wound healing/bone fracture repair delayed
- Heart size & function/ baroreflex sensitivity
NASA

BEFORE

CLUB

AFTER

BED
On Return from Flight

Orthostatic Hypotension

Nausea/vomiting

Aerobic stamina 25% reduced

Decreased muscle strength

Balance and Coordination Problems

Aching joints, tender soles

Backache
Other Medical Issues

- Environment
- Human Factors
- Occupational
- Radiation
- Medical Incidents
Why would you Need Drugs in Space?

- Countermeasures – Preventive or Corrective
- Rehabilitation after Landing
- Medical Support
- Emergency Care
Mercury
1961-1963

- Private medical conferences
  - Reliance on voice communication

- Vital function monitoring
  - Heart rate
  - Respiration
  - EKG

- I.M. injectors
  - Anti-motion sickness medication
  - Stimulant
  - Vasoconstrictor
Mercury 1961-1963

Bill Douglas MD, does preflight exam on Shepherd

- Drugs made available for emergency use only
- Injectors made it possible for the astronaut to self-administer drugs through the pressure suit
- First four missions these I.M. drugs included
  - Pain relief (Anodyne)
  - Stimulant
  - Vasoconstrictor for treatment of shock
- Later Changed to
  - Tigan IM (anti-motion-sickness)
  - Demerol IM
  - Dextro-amphetamine sulfate PO
- Last Mercury flight
  - Note: First use of medication on U.S. flight
The automatic medical injectors shown above were carried by Astronaut L. Gordon Cooper on his 22-orbit flight. Two drugs were provided—Tigan, for motion sickness, and Demerol, for pain. The tubes encased in the blocks were stowed in the astronaut’s survival kit; the single injection tubes were placed in a pocket of his space suit for availability in case of possible emergency during the flight.
Project Gemini
1965 – 1966

- **Medical goal**
  - Study the “long term effects” of space flight and EVA (intervals long enough to complete a lunar mission)

- **Medical strategy**
  - Voice communication
  - Vital sign monitoring
  - **Augmented medical kit**

- **Medical findings** (longest orbital flight, 14 days)
  - Mild dehydration
  - Transient orthostatic intolerance
  - Reduced red cell mass and plasma volume
  - Bone mineral loss
  - Reduced postflight exercise tolerance

Charles Conrad has heart rate checked by Dr. Howie Minners
# Gemini VII Medical Kit

<table>
<thead>
<tr>
<th>Medication</th>
<th>Dose</th>
<th>Label</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral Merizine</td>
<td>50mg.</td>
<td>Motion Sickness</td>
<td>#8</td>
</tr>
<tr>
<td>Parenteral Merizine</td>
<td>45 mg.</td>
<td>Motion sickness</td>
<td>#2</td>
</tr>
<tr>
<td>d-Amphetamine sulfate</td>
<td>5mg.</td>
<td>Stimulant</td>
<td>#8</td>
</tr>
<tr>
<td>APC</td>
<td></td>
<td>APC</td>
<td>#16</td>
</tr>
<tr>
<td>Oral Meperidine HCl</td>
<td>100mg.</td>
<td>Decongestant</td>
<td>#16</td>
</tr>
<tr>
<td>Parenteral Meperidine</td>
<td>90 mg.</td>
<td>Pain</td>
<td>#2</td>
</tr>
<tr>
<td>Actifed</td>
<td>2.5mg.</td>
<td>Decongestant</td>
<td>#16</td>
</tr>
<tr>
<td>Sudafed</td>
<td>60mg.</td>
<td>Decongestant</td>
<td>#16</td>
</tr>
<tr>
<td>Lomotil</td>
<td>2.5mg.</td>
<td>Diarrhea</td>
<td>#16</td>
</tr>
<tr>
<td>Tetracycline HCl</td>
<td>250mg.</td>
<td>Antibiotic</td>
<td>#16</td>
</tr>
<tr>
<td>Methyl cellulose Sol.</td>
<td>15cc’s</td>
<td>Eye drops</td>
<td>#1</td>
</tr>
</tbody>
</table>

**Augmentations**
Project Apollo
Project Apollo

- **Medical goal**
  - Complete a lunar mission and bring the crew safely back to Earth

- **Medical strategy**
  - Voice communication
  - Physiologic monitoring
  - *Augmented Apollo medical kit*
  - Lunar module medical kit

- **Medical findings**
  - Mild dehydration
  - Transient orthostatic intolerance
  - Reduced red cell mass
  - Bone mineral loss
  - Reduced postflight exercise tolerance
  - Space motion sickness
  - *Transient cardiac arrhythmia*
Project Apollo

- **Medical goal**
  - Complete a lunar mission and bring the crew safely back to Earth

- **Medical strategy**
  - Voice communication
  - Physiologic monitoring
  - **Augmented Apollo medical kit**
  - Lunar module medical kit

- **Medical findings**
  - Mild dehydration
  - Transient orthostatic intolerance
  - Reduced red cell mass
  - Bone mineral loss
  - Reduced postflight exercise tolerance
  - Space motion sickness
  - **Transient cardiac arrhythmia**
<table>
<thead>
<tr>
<th>Apollo 15</th>
<th>Exercise-induced musculo-skeletal pain in right shoulder</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Transient arrhythmia</strong></td>
</tr>
<tr>
<td></td>
<td><strong>No treatment available</strong></td>
</tr>
<tr>
<td></td>
<td>ASA</td>
</tr>
<tr>
<td></td>
<td>Self prescribed decongestant prior to entry</td>
</tr>
<tr>
<td>Apollo 16</td>
<td>Difficulty with sleep</td>
</tr>
<tr>
<td></td>
<td>Seconal Cap.</td>
</tr>
<tr>
<td>Apollo 17</td>
<td>Difficulty with sleep</td>
</tr>
<tr>
<td></td>
<td>Flatulence</td>
</tr>
<tr>
<td></td>
<td>Loose stools</td>
</tr>
<tr>
<td></td>
<td>Seconal Cap.</td>
</tr>
<tr>
<td></td>
<td>Self prescribed Simethicone</td>
</tr>
<tr>
<td></td>
<td>Lomotil</td>
</tr>
<tr>
<td></td>
<td>Prophylactic Scop/Dex prior to entry</td>
</tr>
</tbody>
</table>
Skylab
1973-1974

- First use of data down-linking (12-24 hours after experiment)
- Telescience
- Inflight medical kit & exercise capability
- Evacuation capability (crew return vehicle)
- Inflight medical support system (IMSS)
- First dental kit
- First medical officer

Dental kit and dental exam
## Shuttle Orbiter Medical System (SOMS)

### Adrenergic Agonist Agents (2)
- Adrenalin (3 1ml syrs.)
- Epi-Pen (2 syrs.)

### Amphetamines
- Dexedrine (#30 5mg tabs.)

### Analgesic/Antipyretic (2)
- Tylenol (#60 325 mg tabs.)
- Ascriptin (#25 325mg tabs.)

### Analgesic/Narcotic (4)
- Meperidine (50mg/ml, 2 1ml syrs.)
- Fentanyl (1 patch, 2.5mg)
- Morphine sulfate (10mg/ml, 5 1ml syrs.)
- Hydrocodone & Tylenol (10mg/660mg#20)

### Antidiarrheal
- Lomotil (#32, 2mg.)
- Pepto-Bismol (#24, 262mg tab)

### Anesthetics-Local (2)
- Marcain (Bupivacaine) with/without epinephrine
- Xylocaine (lidocaine with and without epinephrine)

### Antacid (Ca carbonate/Mg Sulphate, 700mg/300mg)

### Antimicrobials (10)
- Amikacin
- Metronidazole
- Imipnem/Cilastatin
- Cefadroxil
- Azithromycin
- Augmentin
- Ciproflvoxin
- Bactrim
- Famciclovir
- Fluconazole
SOMS (Cont.)

**Antidote – Narcotics**
- Narcan (0.4mg/ml, 2, 1ml syrs)
- Antiemetic (P.O. & suppository)
- Promethazine (25mg # 30 tabs /14 sup)
- Promethazine (50mg/ml, 2, 1ml syrs)

**Antihistamines**
- Sedating
  - Benadryl (# 20 25mg caps.)
  - Benadryl (50mg/ml, 2, 1ml syrs)
- Nonsedating
  - Loratadine/Claritin (#20 10mg caps)
  - Antipsychotic
  - Haloperidol/Haldol (5mg/ml, 2, 1ml syrs)

**Antitussive**
- Dextromethorphan lozenges (#15, 5mg)

**Cardiotropics**
- Adrenergics
  - Adrenalin (1:10,000, 5 10ml syrs)
  - Nitroglycerin (tabs & patches)

**Antiarrythmics**
- Adenosine (3mg/ml, 2, 4ml syrs)
- Lidocaine (20mg/ml, 2, 5ml syrs)
- Propranolol (#24, 40mg tabs)
- Verapamil (2.5mg/ml, 2, 2ml syrs)
- Metoprolol (1mg/ml, 3, 5ml syrs)
- Procainamide (100mg/ml, 1, 10ml syrs)

**Anticholinergic agent**
- Atropine (1mg/ml, 2, 2ml syrs)
SOMS (Cont.)

**Electrolyte supplements**
- Ca Gluconate
- Mg Sulphate
- Potassium Chloride

**Corticosteroids**
- Dental- Kenalog in Orabase (5gm tube)
- Rectal – Anusol HC (6 suppositories)
- Systemic
- Decadron (10mg/ml, 2 1ml syrs)
- Prednisone (#30, 20mg tabs)

**Decongestants**
- Oral
  - Pseudoephedrine & Guaifensin (#40, 120mg/600mg)
- Nasal
  - Afrin (6 3ml containers)

**Dermatology medications**
- **Antibiotic – topical**
  - Bactroban (2%, 15gr tube)
  - Neosporin/Lidocaine (40mg 0.5oz)
  - Silvadene (1%, 20gms)
  - Topicort (0.25%, 15gms)
- **Antifungal – topical**
  - Lotrimin (1%, 15gm tube)

**Hormone therapy – female**
- Ovral 21 (#21 0.05mg & 0.5mg tabs)

**Hypnotics/Sedatives**
- Restoril (#40 15mg tabs)
- Valium (#30 5mg tabs)
- Versed (1 mg/ml, 1 5ml syrs)
- Ambien (#75 10mg tabs)

**Laxative**
- Dulcolax (#30 5mg tabs)
- Dulcolax (#5 10mg supp)
SOMS (Cont)

**Ophthalmics**

- Ophthalmic anesthetic, local
  - Alcaine (0.50%, 15ml)

- Ophthalmic antibiotic
  - Ciloxan 0.3%
  - Cortisporin
  - Genoptic 0.3%

- Ophthalmic antiviral
  - Vira-A 3.0%

- Ophthalmic Mydriatic
  - Cyclogyl 1.0%
ISS Medications

RUSSIAN SEGMENT
Medications
Anti-Inflammatory Agents
   Kits 1,2,3 and 4
Atiseptic Remedies Kit
Aspro Medical Kit
Burns and Wounds Kit
Cardiovascular Remedies Kit
Gastrointestinal and Urological Kit
Ointment Kit
Preventive Remedies
   Kits 1,2,3 and 4

Psychotropic Remedies Kit

U.S. SEGMENT
Medication Use Possible Side Effects
Acetaminophen (Tylenol)
   .Acetazolamide (Diamox Oral)
   Altitude sickness (Minimal with short-term therapy)
      Tingling sensation in extremities,
      Loss of appetite, increased urine output
      Occasional drowsiness, confusion
.Acyclovir (Zovirax Ointment)
   Antiviral ointment effective against herpes viruses
      Mild burning or stinging, itching

Etc, etc, etc…24 pages
...191 meds.
PROGRESS FROM MERCURY TO ISS

3 MEDICATIONS TO 191
ORAL PREPARATIONS
I.M. INJECTIONS
SUPPOSITORIES
OPHTHALMIC PREPARATIONS

CAPABILITY TO TREAT WIDE RANGE OF CONDITIONS
Medical Recommendations for Exploration Class Missions

- Need more medication shelf life data
- Need extensive pharmacokinetic studies
- Need a more robust autonomous medical system
  - On board physician with appropriate skill set and current medical practice experience
  - Expanded surgical capability
- Better understanding of general anesthesia in space and on return
- On board tutorial capability to maintain physician currency
Project Apollo