Acceptable Risk

Open Global Community NEO Workshop

George Washington University
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Jack Stuster, PhD, CPE
Anacapa Sciences, Inc.
Santa Barbara, California
Isolation and Confinement
Learning From Previous Expeditions

Expeditions and polar winter-over experiences resemble in many ways the conditions that will be experienced by future space explorers.
Belgian Antarctic Expedition

Commandant
Adrien de Gerlache
1898-1899
First Expedition to Winter-Over in Antarctica
Multi-National Crew

The Belgica Locked in the Ice

“Insanity and disease stalked the decks of the Belgica that winter.”
- Roald Amundsen
Roald Amundsen

“The human factor is three quarters of any expedition.”
– Roald Amundsen
Ernest Shackleton

British Trans-Antarctic Expedition, 1914-1916

The *Endurance* in the ice

Shackleton and Crew at Patience Camp
“Truly, the whole secret lies in arranging things sensibly, and especially in being careful about the food.”

- Fridtjof Nansen
Norwegian Polar Expedition

Nansen and Johansen lived for nine months in a 6-foot by 10-foot hut made of stones and walrus hides.

Entrance to the Hut

Life in Our Hut, by Fridtjof Nansen
The conditions will be different, but most of the problems that will confront future space explorers are the same problems that troubled explorers in the past.
Risk, Exposure, and Duration

► Long Stay
  - 180 Days Out
  - 545 Days on Surface
  - 180 Days Return
  - 905 Days Total (30 months)

► Short Stay
  - 313 Days Out
  - 40 Days on Surface
  - 308 Days Return
  - 661 Days Total (22 months)
## Risk, Exposure, and Duration

**Behavioral Problem**
Otto 6.4%; ANARE 4.5%; Matusov 3.2%; Gunderson 3%; Lugg 1.8%; Rivolier & Bachelard 1%
Assumption: 3.3% incidence of serious behavioral problems per year (average of the 6).

<table>
<thead>
<tr>
<th>Risk Factor/Definition</th>
<th>Long Stay Option</th>
<th>Short Stay Option</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Days</td>
<td>Expect in Crew of</td>
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<td></td>
<td>Outbound</td>
<td>Surface</td>
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<td>0.016</td>
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<tr>
<td>Differential</td>
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<tr>
<td>Physical Injury</td>
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<td>0.395</td>
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<tr>
<td>Differential</td>
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<td>0.049</td>
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</tbody>
</table>

**Physical Injury**
Rivolier & Bachelard (Dumont d'Urville Station, Antarctica): Crew of 30 with 20 consultations per month; 10-20% are functional, most involve trauma to the hands.
[20 divided by 30 = .667 x .10 x 12 = .804 incidence of serious physical injury per year.]
Assumption (Adjusted): A rate of .667 consultations per person per month with 5% for functional medical problems en route and on the surface of Mars, rather than 10% as in Antarctica.
Assumption (Differential): The incidence of functional problems will be 1.25% enroute and 5% on Mars surface.
## Risk, Exposure, and Duration

**Behavioral Problem**
Assumption: The incidence of serious behavioral problems will be 6% en route and 2% on Mars surface.

<table>
<thead>
<tr>
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<th>Long Stay Option</th>
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<th>Expect In Crew of 6</th>
<th>Short Stay Option</th>
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<tr>
<td></td>
<td>Outbound Days</td>
<td>Surface Days</td>
<td>Return Days</td>
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<td>Outbound Days</td>
<td>Surface Days</td>
<td>Return Days</td>
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<td>905</td>
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<td>0.030</td>
<td>0.030</td>
<td>0.030</td>
<td>0.089</td>
<td>0.534</td>
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<td>0.075</td>
<td>0.010</td>
<td>0.094</td>
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<td>0.005</td>
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</table>
More than 250 NEOs have been discovered since January 1st of this year. A 600 m asteroid is passing only 56 lunar distances from us today (22 February) and several other notable visitors are expected, including a 400 m asteroid (2005 TU55) on 8 November, that will pass between Earth and the moon.

The number of known NEOs increases almost daily, with many asteroids detected only as they approach within one lunar distance from Earth.
Mars vs. NEO Exploration

► Mars Expedition
  ▪ 661 – 905 Days Total
  ▪ Behavioral Risk: High
  ▪ Physical Risk: High
  ▪ Equipment Risk: Unknown

► NEO Expeditions
  ▪ 150 – 200 Days Total
  ▪ Behavioral Risk: Lower
  ▪ Physical Risk: Lower
  ▪ Equipment Risk: .25 x Unknown

NEO Expeditions: Lower risks for behavioral, physical, medical, and equipment problems. High payoff in science, engineering, operational experience, and planetary defense.
Mars vs. NEO Exploration
Mars vs. NEO Exploration

2 Orion-Type Capsules @ 11m³ each
1 Habitation Module with water jacket shielding/storage @ 84m³
Total = 106m³
The Future...

Mars attracts our attention.
The NEOs demand it.