The ESA-NASA '*CHOICE*' Study: Winterover at Concordia Station, Interior Antarctica, as an Analog for Spaceflight-Associated Immune Dysregulation

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BACKGROUND

For ground-based space physiological research, the choice of analog must carefully match the system of interest. Antarctica winter-over at the European Concordia Station is potentially a ground-analog for spaceflight-associated immune dysregulation (SAID). Concordia missions consist of prolonged durations in an extreme/dangerous environment, station-based habitation, isolation, disrupted circadian rhythms and international crews.

The ESA-NASA *CHOICE* study assesses innate and adaptive immunity, viral reactivation and stress factors during Concordia winterover deployment. Initial data obtained from the first winterover (2009 mission; 'n' of 6) will be presented . To date, not all samples have yet been analyzed. Here, only data will be preliminary presented for those parameters where sample/data analysis is completed.

CONCOARDIA BASE, DOME C, High ANTARCTICA Plateau

Concordia base is located on Dome C, Antarctica (figure 1). The vast majority of Antarctic bases are coastal, Concordia is one of only 3 interior bases. The isolation and environmental conditions for interior bases are more extreme than for coastal bases. Specific conditions that make winterover at Concordia Station potentially a superior spaceflight analog are as follows:

Environmental factors:
- -Difficult travel in/out
- -Extreme isolation, even greater than ISS
- -Altitude 3200m (10,500 ft)
- -Air pressure 645hPa (mbar)
- -12-13 Vol% of O_2
- - Lack of CO2 in air
- -Higher ionization in air (increases oxidative metabolism)
- -Relative humidity 3-5%
- -Snowfall ~1cm/yr
- -High winds
- -Elevated UV exposure (summer), UV deficiency (winter)
- -Mean winter temperature -60 C (-72 F)
- -Mean summer temperature -30 C (-22 F)
- -Disrupted circadian rhythms.

Human factors:
- -Station-based lifestyle
- -Isolation, confinement for prolonged duration
- -Limited communication capability
- -International crew, multiple languages
- -Sleep/wake cycles disrupted
- -Actual deployment w/ associated risks
- -Winterover crew: 12 (February-November)
- -Summer crew: ~50 (November-February)

METHODS

•All NASA general immune and viral assessment methods used for this study (and data within this presentation) were performed as previously described:
•*Aviation and Space Environmental Medicine, 2009 May, 80(5 Suppl): A37-44.*

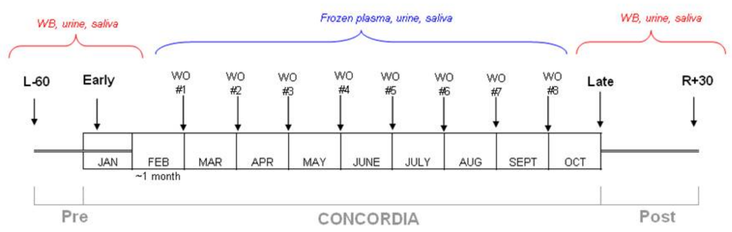
ASSAYS

(ESA)
PMN number, function, bactericidal
In-vitro DTH
Apoptosis/necrosis
Cellular mRNA expression
Plasma purine markers of inflammation/hypoxia
Erythropoietin activity
Stress test
Stress hormones
Components of exhaled air

(NASA)
Leukocyte subsets*
T cell function*
Intracellular/secreted cytokine profiles*
Virus specific T cell number/function
Latent herpesvirus reactivation
Circadian rhythm analysis

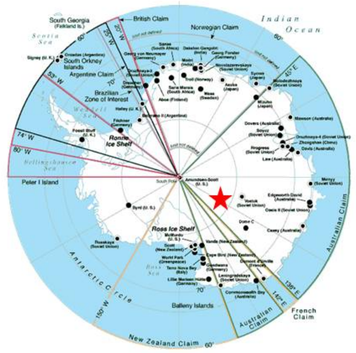
**data included in this presentation*

SAMPLING SCHEDULE



Sample acquisition and analysis on a Partec flow cytometer instrument at Concordia Station during winterover 2009. (Photo courtesy Dr. A. Salam)

Figure 1: Antarctic base locations (Concordia location indicated); base photograph



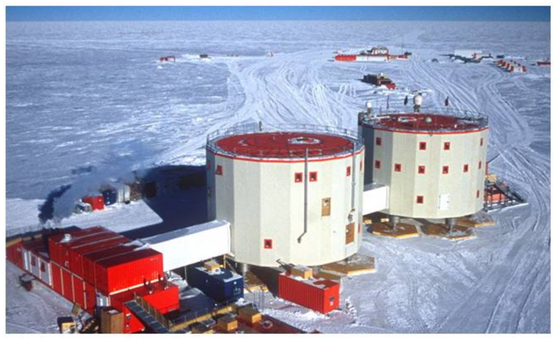


Figure 2: Mean Peripheral Leukocyte Subsets during Antarctic winterover (n=6)

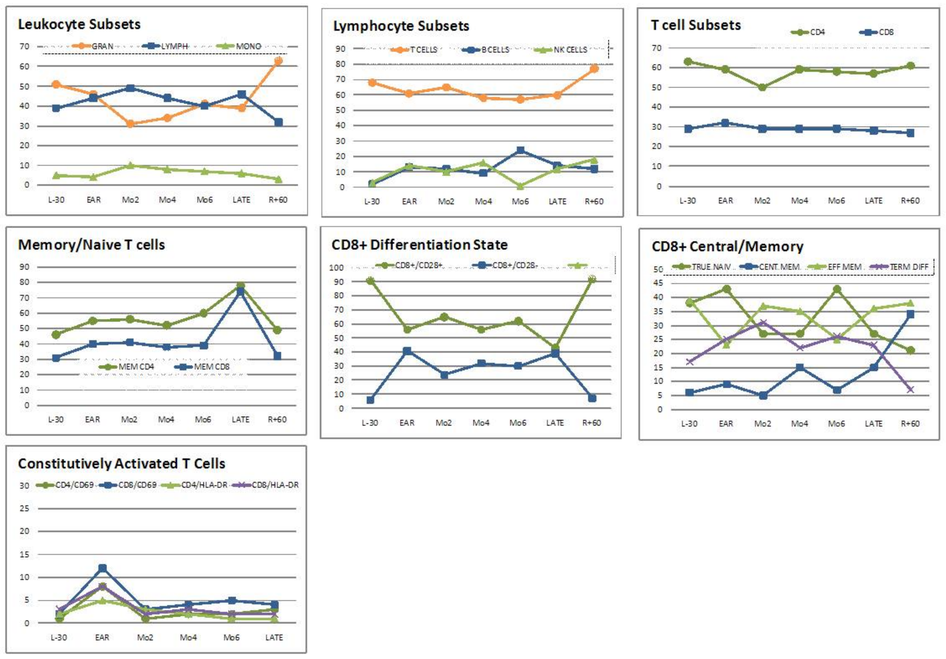


Figure 3: Mean T Cell Function, Early Blastogenesis during Antarctic winterover (n=6)

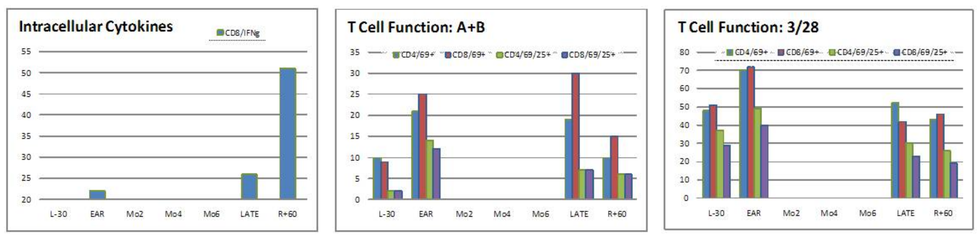
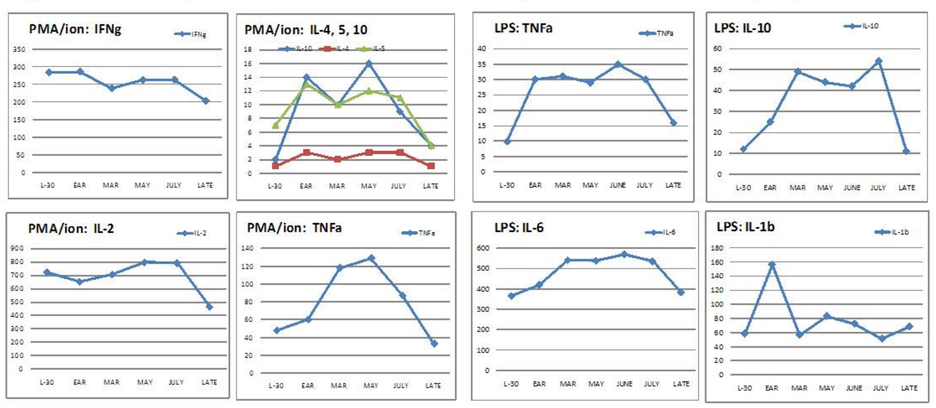


Figure 4: Mean Cytokine Production Profiles during Antarctic winterover (n=6)



CHOICE: Consequences of longterm-Confinement and Hypobaric HypOxia on Immunity in the Antarctic Concordia Environment

RESULTS

•The total WBC increased and alterations in some peripheral leukocyte populations were observed during winterover at Concordia Station (figure 1).

•Percentages of lymphocytes and monocytes increased, and levels of senescent CD8+ T cells were increased during deployment (figure 1).

•Transient increases in constitutively activated T cell subsets were observed, at entry time point associated with endemic disease outbreaks during summer transition period (figure 1).

•T cell function (early blastogenesis, CD69/25 expression following mitogenic stimulation) was increased near the entry/exit deployment phases; secretion of most measured cytokines following mitogenic stimulation increased during deployment (figure 2).

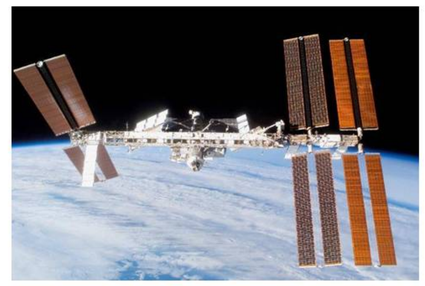
•The granulocyte activity- when primed with TNF-alpha and activated with fMLP- was more inhibited through the hypoxia sensitive adenosine A2A receptor pathway (data not shown).

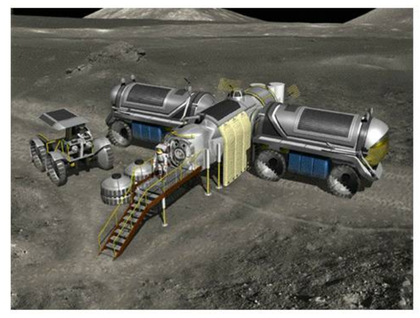
•Salivary cortisol demonstrated high variability during winterover, but was generally increased (data not shown).

•A 2-point circadian rhythm of cortisol measurement (morning/evening) was unaltered while perceived stress was mildly elevated during winterover (data not shown).

•All other measures, including in-vitro DTH assessment, viral specific T cell number/function and latent herpesvirus reactivation are under current analyses but have not yet been completed for the 2009 winterover subjects.

Analogous?





CONCLUSION

Based on preliminary data, alterations in immune cell distribution and function appear to persist during Antarctic winterover at Concordia Station. Some of these changes are similar to those observed in Astronauts, either during or immediately following spaceflight. Others are unique to the Concordia analog. Based on some initial immune data and environmental conditions, Concordia winterover may be an appropriate analog for some flight-associated immune changes. Completion of the full data compliment will be required for final study conclusions.

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