

SPACEFLIGHT ASSOCIATED NEURO-OCULAR SYNDROME (SANS): 2023 CLINICAL UPDATE

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INTRODUCTION

Spaceflight Associated Neuro-ocular Syndrome (SANS) is a condition unique to long-duration spaceflight, with an unclear pathogenesis and pathophysiology, and no perfect terrestrial analog. Approximately 66% of long duration spaceflight (LDSF) astronauts present with the *earliest indication of SANS*, which is defined as development of any of the following signs in at least one eye during or immediately following spaceflight: 1) optic disc edema (ODE; represented by an increase of ≥ 20 microns in peripapillary total retinal thickness [Δ TRT]); 2) chorioretinal folds; 3) globe flattening; and 4) excessive shift in refractive error ($\geq +0.75$ D). Each of these signs presents potential risk to a crewmember's vision and mission effectiveness, with ODE posing the highest risk overall. It is not yet known what severity and/or duration of these signs might lead to acute or permanent impacts to ocular anatomy or visual performance. Brain anatomical changes also occur during long-duration spaceflight and are being monitored in the astronaut population; however, these changes have not yet been associated with functional decrements or with SANS. An update will be provided on the latest SANS clinical analyses, diagnostics, and program initiatives.

METHODS

Data were obtained from clinical records and SANS subject matter experts (SMEs) to compile a SANS clinical update. Areas of interest include: 1) prevalence of SANS signs, 2) defining clinical thresholds for SANS, and 3) an overview of current and planned SANS clinical efforts.

DISCUSSION

SANS Sign Prevalence: Analysis at the time of this abstract submission indicates that the approximate prevalence of primary SANS findings in USOS LDSF crewmembers is: 64% for ODE (≥ 20 -micron Δ TRT), 15% for chorioretinal folds, 26% for globe flattening, and 14% for hyperopic shifts in refractive error ($\geq +0.75$ D).

Clinical Thresholds:

- The *Earliest Indication of SANS* was presented publicly for the first time at the 2020 NASA Human Research Program Investigators' Workshop. See definition in Introduction section (above).
- *Clinically Concerning SANS* – Development of any of the following signs during or immediately following spaceflight: 1) ODE (≥ 55 -micron Δ TRT* and/or Frisén grade ≥ 1 *), 2) sharp chorioretinal folds in the vicinity of the macula, or 3) moderate globe flattening.
- *Pathological SANS with an Acute Functional Impact* – Development of any of the following signs/symptoms during or immediately following spaceflight: 1) visual field loss (e.g., enlarged blindspot), 2) distorted central vision, or 3) shift in refractive error beyond power of available correction (e.g., “space anticipation glasses”).
- *Pathological SANS affecting Long-Term Health* – Development of any of the following signs/symptoms during or following spaceflight: 1) permanent visual field loss, 2) reduced retinal nerve fiber layer (RNFL) thickness, 3) permanently distorted central vision, 4) atrophy of retinal pigment epithelium (RPE) or photoreceptors, or 5) choroidal neovascularization.

Current & Planned Clinical Efforts (accurate at time of abstract submission): All *SANS diagnostic hardware* are performing nominally onboard the International Space Station: vision screening, fundoscope, optical coherence tomography (OCT) device, ultrasound, and tonometer. The *Goggle-Based Visual Field (GBVF) device* is nearing completion of its clinical validation study at Ohio State University and is planned for parabolic flight testing in fiscal year 2023 (FY23); pending positive results, this sequence may pave the way towards an ISS technology demonstration in FY24.

* NASA astronauts meeting this ODE threshold are recommended for a lumbar puncture within 7-14 days of return