

# COE CST Fourth Annual Technical Meeting

## Task 256: Tolerance of Centrifuge-induced G-force by Disease State

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Co-I's: Rebecca Blue, MD; Tarah  
Castleberry, DO; Charles Mathers, MD

Students: James Pattarini, MD; David  
Reyes, MD; Robert Mulcahy, MD;  
Natacha Chough, MD; Eric Blacher, MD

*October 29-30, 2014  
Washington, DC*



# Agenda

- Team Members
- Task Description
- Schedule
- Goals
- Results
- Conclusions and Future Work

# Team Members

- People

- PI: James Vanderploeg, MD
- Co-Investigators: Rebecca Blue, MD; Tarah Castleberry, DO; Charles Mathers, MD
- Students: James Pattarini, MD; David Reyes, MD; Robert Mulcahy, MD; Natacha Chough, MD; Eric Blacher, MD

- Organizations:



# Task Description

- Purpose:
  - To evaluate research subjects with defined disease states under the G-loads expected during commercial spaceflight using centrifuge-induced acceleration
- Disease cohorts:
  - Cardiovascular disease
  - Hypertension
  - Diabetes
  - Pulmonary Disease
  - Spinal Disease or Injury



# Schedule

- Funding and IRB approval obtained during 2012
- Test subject recruiting and testing from December 2012 through November 2013
- Data analysis completed in April 2014
- Publication of results in July 2014

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## **Tolerance of Centrifuge-Simulated Suborbital Spaceflight by Medical Condition**

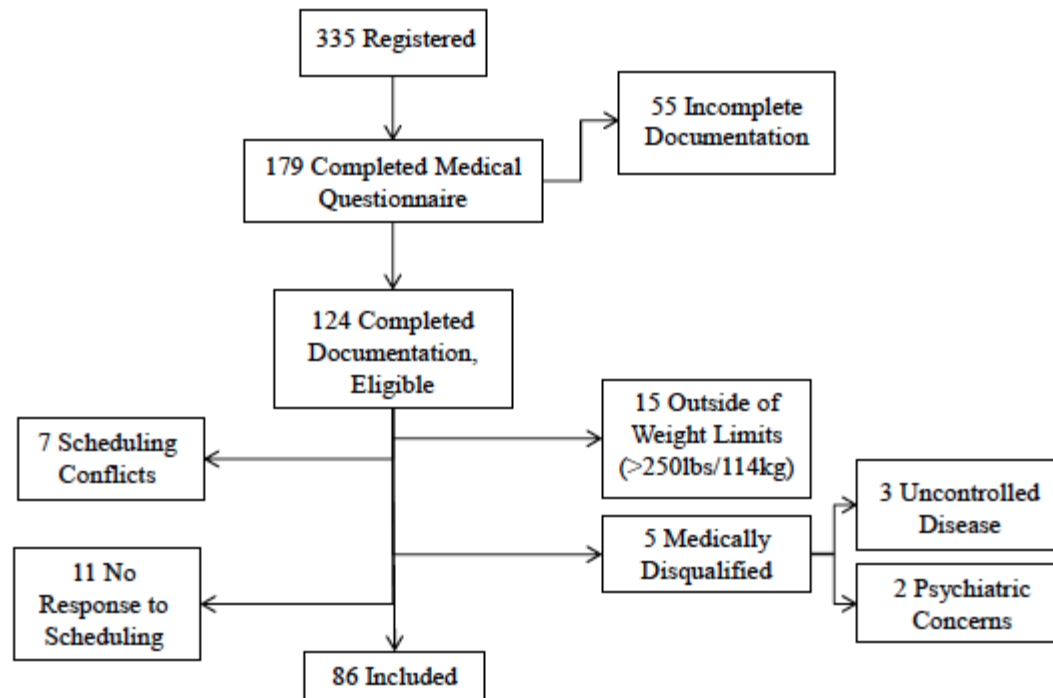
Rebecca S. Blue, James M. Pattarini, David P. Reyes,  
Robert A. Mulcahy, Alejandro Garbino, Charles H. Mathers,  
Johnené L. Vardiman, Tarah L. Castleberry, and James M.  
Vanderploeg

# Goals

- Goals of Task 256
  - How do “non-career astronauts” tolerate increased G-force acceleration profiles?
  - What are the diseases of greatest concern for commercial human spaceflight?
- Relevance to Commercial Space Industry
  - How do individuals with controlled, chronic medical conditions tolerate spaceflight acceleration profiles?
  - Can these people safely take a space flight?

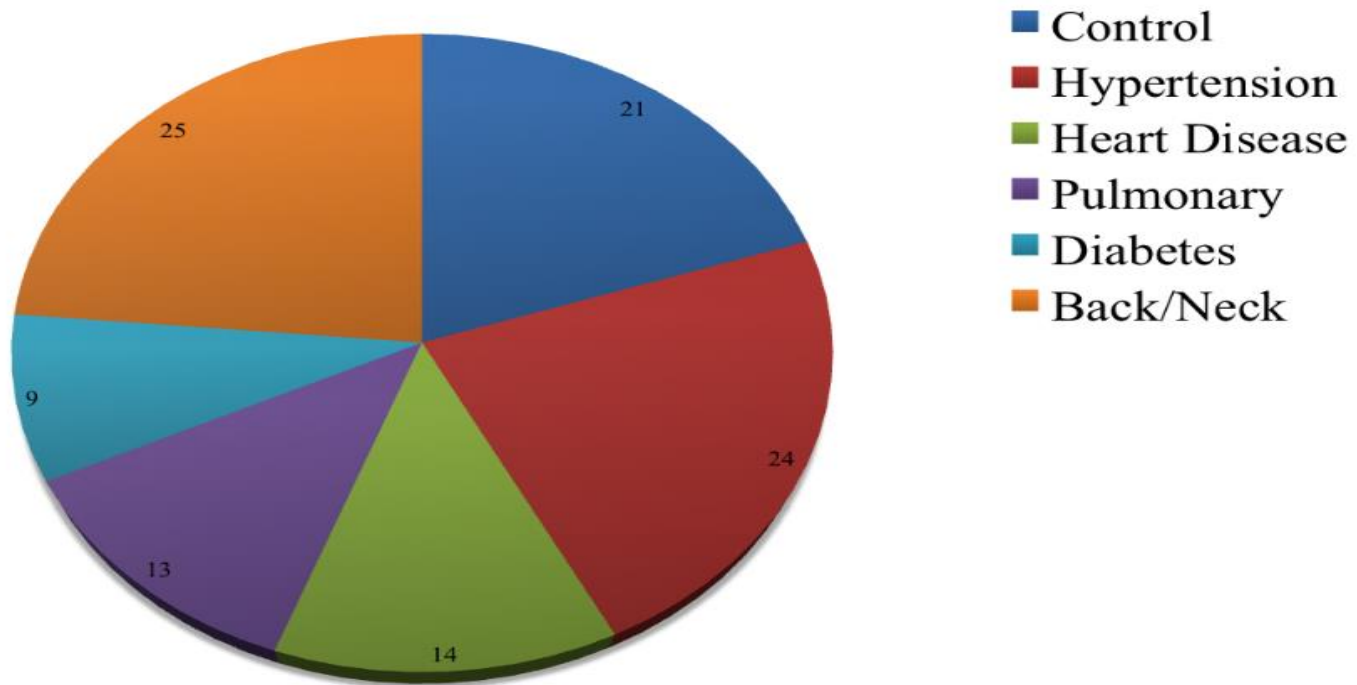
# Results

## Medical Prescreening Process and Inclusion/Exclusion of Subjects



# Results

## Past Medical History of Participants





# Results

- Five subjects voluntarily withdrew
  - Anxiety: 3 subjects
  - Back pain: 1 subject
  - Time constraints: 1 subject
- Despite significant medical history, NO subject experienced significant adverse or abnormal physiological responses to centrifuge profiles

# Results

- Technical Reports and Journal Articles
  - Two panel presentations at 2014 AsMA meeting
  - Three publications completed
    - Blue RS, Pattarini JM, Reyes DP, Mulcahy RA, Garbino A, Mathers CH, Vardiman JL, Castleberry TL, Vanderploeg JM. Tolerance of centrifuge-simulated suborbital spaceflight by medical condition. *Aviat Space Environ Med* 2014; 85(7): 721-9.
    - Mulcahy RA, Blue RS, Vardiman JL, Mathers CH, Castleberry TL, Vanderploeg JM. Subject Anxiety and Psychological Considerations for Centrifuge-Simulated Suborbital Spaceflight. *Aviat Space Environ Med* 2014; 85(8): 847-851.
    - Pattarini JM, Blue RS, Castleberry TL, Vanderploeg JM. Preflight screening techniques for centrifuge-simulated suborbital spaceflight. *Aviat Space Environ Med* 2014; 85(12).
  - Three additional manuscripts in preparation
    - Case study of subjects with a cardiac pacemaker
    - Case study of subjects with an implanted insulin pump
    - Case study of subject with congenital heart defects and valve replacement

# Conclusions and Future Work

Most individuals with well-controlled medical conditions should be able to tolerate a commercial spaceflight experience.

## Next Steps:

- Assessment of Screening and Training Requirements for SFPs regarding Anxiety during Repeated Exposures to Sustained High Acceleration
- Assessment of Screening and Training Requirements for Pilots with Repeated Exposures to Sustained High Acceleration
- Assessment of methods, procedures, and technologies available for protection of passenger-occupied space in commercial spaceflight vehicles

# Task 256: Tolerance of Centrifuge-induced G-force by Disease State



## Project At-A-Glance

- University: The University of Texas Medical Branch
- Principal Investigator: James Vanderploeg, MD
- Co-Investigators: Rebecca Blue, MD; Tarah Castleberry, DO; Charles Mathers, MD
- Residents: James Pattarini, MD; David Reyes, MD; Robert Mulcahy, MD; Natacha Chough, MD; Eric Blacher, MD

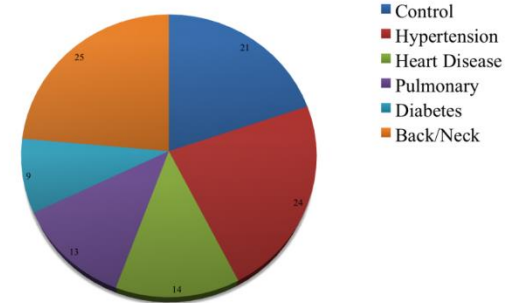
## Relevance to Commercial Spaceflight Industry

- There is little to no data on how individuals with chronic diseases will perform in a high-performance environment such as commercial spaceflight. This study provides data on how individuals with chronic diseases responded to G-force.

## Statement of Work

- Characterization of responses of individuals with common medical conditions to G-force
- Development of risk mitigation strategies for individuals with those medical conditions

Past Medical History of Participants



## Status

- Completed testing and evaluation using the NASTAR centrifuge
- Performed data analysis
- Published results

## Future Work

- Develop optimal acceleration training protocols for passengers
- Further evaluate role of training in reducing anxiety

# Task 308: Assessment of Screening and Training Requirements for SFPs regarding Anxiety during Repeated Exposures to Sustained High Acceleration

## Project At-A-Glance

- University: The University of Texas Medical Branch
- Principal Investigator: James Vanderploeg, MD
- Co-Investigators: Rebecca Blue, MD; Tarah Castleberry, DO; Charles Mathers, MD
- Residents: **Robert Mulcahy, MD**; Eric Blacher, MD; Ben Johansen, DO; James Pattarini, MD; Natacha Chough, MD

## Relevance to Commercial Spaceflight Industry

- Psychological stressors can be significant challenges in the operational environment. This study will provide data on how individuals with high anxiety levels can best be prepared for suborbital spaceflight through training and anxiety mitigation techniques.

## Statement of Work

- Identify individuals with high anxiety levels through screening questionnaires and psychological testing
- Develop risk mitigation strategies and training techniques for individuals with higher levels of anxiety
- Develop recommendations for optimum training protocols to reduce anxiety prior to and during suborbital flight



## Status

- Research protocol submitted to IRB
- Psychological testing methods defined

## Future Work

- Complete IRB approval process
- Recruit test subjects
- Conduct training and testing at NASTAR centrifuge throughout 2015

# Task 309: Assessment of Screening and Training Requirements for Pilots with Repeated Exposures to Sustained High Acceleration

## Project At-A-Glance

- University: The University of Texas Medical Branch
- Principal Investigator: James Vanderploeg, MD
- Co-Investigators: Rebecca Blue, MD; Tarah Castleberry, DO; Charles Mathers, MD
- Residents: **Eric Blacher, MD**; Benjamin Johansen, DO; Robert Mulcahy, MD; James Pattarini, MD; Natacha Chough, MD

## Relevance to Commercial Spaceflight Industry

- Repeated exposure of the crew to sustained high +Gx and +Gz acceleration in highly demanding spaceflight profiles is a new and untested paradigm. Identifying the unique physiological challenges and medical clearance requirements will enable spaceflight operators to ensure safe operations.

## Statement of Work

- Compare pilot performance and physiological response in aerobatic flights, centrifuge acceleration profiles, and actual spaceflight.
- Develop recommendations for pilot training and medical screening.



## Status

- Preliminary monitoring techniques for use in the Extra acrobatic plane are being conducted.
- IRB research protocol being prepared

## Future Work

- Complete IRB approval process
- Recruit pilots for research study
- Conduct aerobatic flights and NASTAR testing throughout 2015
- Conduct physiological monitoring during spaceflights in 2015 and 2016

# Task 310: Assessment of methods, procedures, and technologies available for protection of SFPs in commercial spaceflight vehicles

## Project At-A-Glance

- University: The University of Texas Medical Branch
- Principal Investigator: James Vanderploeg, MD
- Co-Investigators: Charles Mathers, MD; Rebecca Blue, MD; Tarah Castleberry, DO
- Residents: Benjamin Johansen, DO; Eric Blacher, MD; Robert Mulcahy, MD; James Pattarini, MD; Natacha Chough, MD

## Relevance to Commercial Spaceflight Industry

- Optimization of crew and passenger compartments to promote the survival of occupants during human spaceflight operations is a necessary component of vehicle interior fit out. Dedicated efforts towards the de-lethalization and advanced crashworthiness of spaceflight vehicles will improve the safety of commercial space endeavors.

## Statement of Work

- This project will evaluate methods for the de-lethalization of the cabin environment, space vehicle crashworthiness, individual restraint systems, emergency evacuation systems, and survival equipment.



## Status

- Literature search underway
- Students being trained in conducting and evaluating relevant literature review

## Future Work

- Complete literature review and analysis.
- Compare current spaceflight operators' interior cabin designs with historical precedents for cabin safety.