Abstract:

Space flight induces a number of physiological changes including fluid shifts and cardiovascular deconditioning. While some of these changes have been evaluated on earlier missions, others (e.g., changes in gastrointestinal and hepatic function) have not been investigated. Availability of sensitive and flight-suitable methods of evaluation limits implementation of these studies in space. Identification and evaluation of these physiological parameters and resulting changes in the pharmacokinetics and pharmacodynamics of therapeutic agents administered during space flight are essential for designing and developing effective treatment regimes for the space medical operations.

Gastrointestinal and hepatic function research in the laboratory focuses on developing simple, noninvasive techniques to conduct these studies in space. Ground-based simulation models of microgravity (e.g., antiorthostatic bed rest) are used to evaluate and validate these techniques for their flight suitability. Using these validated, noninvasive methods, in-flight investigations are conducted to evaluate changes in the gastrointestinal and hepatic function during space flight.

Pharmacokinetics research includes:
- Development of simple and noninvasive drug-monitoring methods that are flight suitable
- Evaluation of pharmacokinetic changes of drugs during antiorthostatic bed rest
- Pharmacodynamic implications of these changes
- Other changes such as protein binding and metabolism of drugs

In-flight pharmacokinetics and pharmacodynamics are characterized using methods developed in ground-based research. Research in the area of pharmaceutical development involves designing and testing noninvasive and nonparenteral drug dosage forms that are suitable for use in space. Development and testing of sustained release and intranasal dosage forms of antimotion sickness drugs are actively pursued.

Chronotherapeutics is another important area of pharmacotherapeutics research at the Johnson Space Center. Space travelers experience ultra-short day/night cycles as the shuttle orbits the Earth every 90 minutes. Anecdotal data in the form of personal communications by astronauts and cosmonauts suggest that sleep disruption is a common occurrence during flights. Extended mission duration and work demands require overextended crew schedules during a number of future flights. Reports of fatigue-related performance decrements in shift workers and other sleep-deprived groups indicate that space flight crews may be subjected to similar decreased operational efficiency resulting from alterations in their work-rest efficiency. The Pharmacotherapeutics group evaluates methods for the assessment of sleep deficits, medication use and resulting decrements in work-time alertness and performance. Laboratory activities also focus on designing and developing ground-based and in-flight countermeasure strategies for improving sleep quality and health during space flight.

An objective of the chronotherapeutics research is to generate information and identify ground-based models that can assist in the development of practical, appropriate, reliable, and effective intervention technologies and regimens that can augment health and well being to support sleep-work activity schedules of long duration flights and for a prolonged stay in the microgravity environment. Specific objectives of this investigation are to identify and characterize changes in the physiological and biochemical indices of chronophysiologic adjustments in space, to elucidate the effect of these adjustments on pharmacotherapeutics during space flights; and to develop and validate effective operational monitoring tools and countermeasures that will improve performance and maintain health of crew members during short and long duration missions.