as mechanical noise to the soles of the feet, or when applied as electrical noise at the knee and to the back muscles.

SR using imperceptible stochastic electrical stimulation of the vestibular system (stochastic vestibular stimulation, SVS) applied to normal subjects has shown to improve the degree of association between the weak input periodic signals introduced via venous blood pressure receptors and the heart-rate responses. Also, application of SVS over 24 hours improves the long-term heart-rate dynamics and motor responsiveness as indicated by daytime trunk activity measurements in patients with multi-system atrophy, Parkinson’s disease, or both, including patients who were unresponsive to standard therapy for Parkinson’s disease. Recent studies conducted at the NASA JSC Neurosciences Laboratories showed that imperceptible SVS, when applied to normal, young, healthy subjects, leads to significantly improved balance performance during postural disturbances on unstable compliant surfaces. These studies have shown the benefit of SR noise characteristic optimization with imperceptible SVS in the frequency range of 0–30 Hz, and amplitudes of stimulation have ranged from 100 to 400 microamperes.

This work was done by Jacob Bloomberg and Millard Reschke of Johnson Space Center; Ajitkumar Mulavara and Scott Wood of USRA; Jorge Serrador of Dept. of Veterans Affairs NJ Healthcare System; Matthew Fiedler, Igor Kofman, and Brian T. Peters of Wyle; and Helen Cohen of Baylor College. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809.

MSC-25013-1

Developing Physiologic Models for Emergency Medical Procedures Under Microgravity

Lyndon B. Johnson Space Center, Houston, Texas

Several technological enhancements have been made to METI’s commercial Emergency Care Simulator (ECS) with regard to how microgravity affects human physiology. The ECS uses both a software-only lung simulation, and an integrated mannequin lung that uses a physical lung bag for creating chest excursions, and a digital simulation of lung mechanics and gas exchange. METI’s patient simulators incorporate models of human physiology that simulate lung and chest wall mechanics, as well as pulmonary gas exchange.

Microgravity affects how O2 and CO2 are exchanged in the lungs. Procedures were also developed to take into affect the Glasgow Coma Scale for determining levels of consciousness by varying the ECS eye-blinking function to partially indicate the level of consciousness of the patient. In addition, the ECS was modified to provide various levels of pulses from weak and thready to hyper-dynamic to assist in assessing patient conditions from the femoral, carotid, brachial, and pedal pulse locations.

This work was done by Nigel Parker and Veronica O’Quinn of Medical Education Tech, Inc. for Johnson Space Center. Further information is contained in a TSP (see page 1). MSC-23922-1

PMA-Linked Fluorescence for Rapid Detection of Viable Bacterial Endospores

This method has applications in the pharmaceutical, food microbiology, semiconductor, and other industries requiring surface sterilization.

NASA’s Jet Propulsion Laboratory, Pasadena, California

The most common approach for assessing the abundance of viable bacterial endospores is the culture-based plating method. However, culture-based approaches are heavily biased and oftentimes incompatible with upstream sample processing strategies, which make viable cells/spores uncultivable. This shortcoming highlights the need for rapid molecular diagnostic tools to assess more accurately the abundance of viable spacecraft-associated microbiota, perhaps most importantly bacterial endospores.

Propidium monoazide (PMA) has received a great deal of attention due to its ability to differentiate live, viable bacterial cells from dead ones. PMA gains access to the DNA of dead cells through compromised membranes. Once inside the cell, it intercalates and eventually covalently bonds with the double-helix structures upon photoactivation with visible light. The covalently bound DNA is significantly altered, and unavailable to downstream molecular-based manipulations and analyses. Microbiological samples can be treated with appropriate concentrations of PMA and exposed to visible light prior to undergoing total genomic DNA extraction, resulting in an extract comprised solely of DNA arising from viable cells. This ability to extract DNA selectively from living cells is extremely powerful, and bears great relevance to many microbiological arenas.

While this PMA-based selective chemistry has been applied to several polymerase chain reaction (PCR)-based molecular protocols, it has never been coupled with fluorescence in situ hybridization (FISH)-based microscopic methods. FISH microscopy is a powerful technique for visualizing and enumerating microorganisms present in a given sample, which relies on the ability of fluorescently labeled oligonucleotide probes to gain access to, and hybridize with, specific nucleic acid sequences within cells. Dogmatic princi-
Portable Intravenous Fluid Production Device for Ground Use

This small, portable device with high output produces medical injection-grade sterile water from potable water sources.

John F. Kennedy Space Center, Florida

There are several medical conditions that require intravenous (IV) fluids. Limitations of mass, volume, storage space, shelf-life, transportation, and local resources can restrict the availability of such important fluids. These limitations are expected in long-duration space exploration missions and in remote or austere environments on Earth. Current IV fluid production requires large factory-based processes. Easy, portable, on-site production of IV fluids can eliminate these limitations. Based on experience gained in developing a device for spaceflight, a ground-use device was developed.

This design uses regular drinking water that is pumped through two filters to produce, in minutes, sterile, ultrapure water that meets the stringent quality standards of the United States Pharmacopeia for Water for Injection (Total Bacteria, Conductivity, Endotoxins, Total Organic Carbon). The device weighs 2.2 lb (1 kg) and is 10 in. long, 5 in. wide, and 3 in. high (=25, 13, and 7.5 cm, respectively) in its storage configuration. This handheld device produces one liter of medical-grade water in 21 minutes. Total production capacity for this innovation is expected to be in the hundreds of liters.

The device contains one battery powered electric mini-pump. Alternatively, a manually powered pump can be attached and used. Drinking water enters the device from a source water bag, flows through two filters, and final sterile production water exits into a sealed, medical-grade collection bag. The collection bag contains pre-placed crystalline salts to mix with product water to form isotonic intravenous medical solutions. Alternatively, a hypertonic salt solution can be injected into a filled bag. The filled collection bag is detached from the device and is ready for use or storage. This device currently contains one collection bag, but a manifold of several pre-attached bags or replacement of single collection bags under sterile needle technique is possible for the production of multiple liters. The entire system will be flushed, sealed, and radiation-sterilized.

Operation of the device is easy and requires minimal training. Drinking water is placed into the collection bag. Inline stopcock flow valves at the source and collection bags are opened, and the mini-pump is turned on by a switch to begin fluid flow. When the collection bag is completely filled with the medical-grade water, the pump can be turned off. The pump is designed so it cannot pump air, and overfilling of the collection bag with fluid is avoided by placing an equal amount of water in the source bag. Backflow is avoided by in-