Special Session Title:

Engineering and Medicine in Extreme Environments

Special Session Organizer Name & Affiliation:

Tobias Cibis, Joint Research Centre for AI in Health an Wellness, University of Technology Sydney, Australia and Ontario Tech University, Canada and Ontario Tech University, Canada
Carolyn McGregor, Joint Research Centre for AI in Health and Wellness, Ontario Tech University, Canada and University of Technology Sydney, Australia

Special Session Speaker Name & Affiliation 1:

Dino Poimann, Sport Psychologist VfB Stuttgart, German Bundesliga

Special Session Speaker Name & Affiliation 2:

Stephen Barkwell, Deputy Fire Chief, Oshawa Fire Department, Ontario, Canada

Special Session Speaker Name & Affiliation 3:

Dr Edward Pugh, Neonatologist, McMaster Children's Hospital

Carolyn McGregor, Joint Research Centre for AI in Health and Wellness, Ontario Tech University, Canada

Special Session Speaker Name & Affiliation 4:

Diving (?)

Theme:

- (•) 01. Biomedical Signal Processing
- ( ) 02. Biomedical Imaging and Image Processing
- ( ) 03. Micro/ Nano-bioengineering: Cellular/ Tissue Engineering &
- ( ) 04. Computational Systems & Synthetic Biology; Multiscale modeling
- ( ) 05. Cardiovascular and Respiratory Systems Engineering
- ( ) 06. Neural and Rehabilitation Engineering
- ( ) 07. Biomedical Sensors and Wearable Systems
- ( ) 08. Biorobotics and Biomechanics
- ( ) 09. Therapeutic & Diagnostic Systems and Technologies
- ( ) 10. Biomedical & Health Informatics
- ( ) 11. Biomedical Engineering Education and Society
- ( ) 12. Translational Engineering for Healthcare Innovation and Commercialization

Special Session Synopsis— Max 2000 Characters

Extreme environments, such as natural (underwater, altitude, space, geographic poles, volcanoes, desert,…) or forced/man-made (extreme sports, emergency forces, armed forces) are conditions where specific physiological adaptations in the human body are triggered to maintain physiological functionality and to ensure survival.

The general goal in the medical and engineering areas can be formulated as: to enhance human comfort, performance and survival in extreme environments.

This Mini-Symposia will present world-leading experts in varying research fields ranging from engineering and medicine in space applications, the extremes of firefighting, the challenges for elite athletes, and the extremes of premature birth.

Elite Sports as an Extreme Environment

Dino Poimann, VfB Stuttgart, German Bundesliga

Abstract— **Elite sports refers to an environment as "the top competitions in a sport and the training process with the purpose to compete/succeed in this competition." This presentation discusses the main characteristics and challenges associated with the elite sports environment.**

I. INTRODUCTION

The term "sport" usually comprises a variety of different activities which commonly require a subject to master the features: movement, abilities development, time constraints and differing roles. Thereby, elite athletes require manifested physical and mental skill in order to succeed in their competition.

Elite sports is not only extreme when it comes to extraordinary physical and mental demands imposed by the competition, but also in respect to special social and more or less superficial environment in which it takes place.

The main challenge of elite sports is to deal with physical, psychological and social stress, often on daily exposure. High loads of physical and biopsychological stress are often utilized to optimize fitness and promote training process and optimal performance.

Firefighting as an Extreme Environment

Stephen Barkwell, Oshawa Fire, Ontario, Canada

Abstract— **The career of firefighter is an extreme environment. Their tasks include extinguishing structural and forest fires, rescuing victims from vehicular accidents, or other adverse events. They are exposed to many physical risks such as well as extreme heat and/or extreme cold due to fire and environmental conditions. In this talk we will explore firefighting as an extreme environment.**

II. INTRODUCTION

Firefighters, are exposed to dangerous and stressful situations when they are deployed. They are required to perform tasks under intense pressure that includes structural and forest fires, rescuing victims from vehicular accidents, or other adverse events. When they are deployed they can be exposed to many physical risks such as physical danger as well as extreme heat and/or extreme cold due to fire and environmental conditions. Ensuring their own safety and the safety of others, along with loss of life or the risk of injury causes mental stress. In this talk firefighting as an extreme environment will be presented. The extreme environments that firefighters have to operate within is also explored.

Stephen Barkwell is the Deputy Fire Chief at Oshawa Fire in Ontario, Canada. He has 20 years' experience as a firefighter with a demonstrated history of working in the government administration industry. He is skilled in Government, Emergency Management, Disaster Response, Fire Protection, and Fire Management. He is a strong protective services professional with a Firefighter – Pre-service, Education and Training focused in Fire Science/Fire-fighting in partnership with Durham College and Ontario Tech University.

Prematurity as an Extreme Environment

Edward Pugh, McMaster Children's Hospital, Hamilton, Ontario, Canada

Carolyn McGregor, Joint Research Centre for AI in Health and Wellness, Ontario Tech University, Canada and , University of Technology Sydney, Australia

III. INTRODUCTION

Premature infants are born before 37 weeks in a 40 week gestational cycle. They can be born up to 17 weeks early and still have potential to survive. Continuing their remaining development to 37 gestation weeks outside of the womb represents an extreme environment. These preterm infants have to deal with gravity and oxygen distribution from the lungs earlier than planned while many of their organs continue to try and develop. They are at risk of developing many conditions of prematurity that could result in death or long term disabilities and morbidities. This also represents an extreme healthcare context for the complex care team that care for preterm infants. The care of preterm infants is one of the most expensive healthcare care pathways. In this talk prematurity as an extreme environment will be explored.

Dr Edward Pugh is a staff neonatologist within the Neonatal Intensive Care Unit (NICU), McMaster Children's Hospital, Ontario, Canada. This NICU is the largest in born and out born NICU in Ontario.

Different Diving Modalities, Different Challenges

Tobias Cibis, Joint Research Centre for AI in Health and Wellness, University of Technology Sydney, Australia and Ontario Tech University Canada

Abstract— **Diving is an activity often performed in different ways and modalities, with each presenting their own set of challenges and demands on the diver to overcome. This presentation will provide an overview of different modalities and the challenges they pose for human physiology.**

V. INTRODUCTION

Diving and underwater exposure can be performed in many ways. Motivated by recreational curiosity or commercial duty, different diving modalities present a variety of demands on the human biology during exposure.

Breath-hold divers rely on the amount of oxygen they can store within their lungs, and the duration and depth of the dive are commonly limited by the amount of oxygen. If oxygen runs out the diver faces potential blackouts which may lead to drowning.

Saturation divers spent up to four weeks under heavily increased ambient pressure. These times are divided into working hours at the ocean's bottom and in a hyperbaric chamber which for the entire duration is pressurized to match the same conditions as are prevailed at the ocean's bottom.

During these extreme exposures, monitoring the diver is key to ensure that their health and performance remain in tact.

Different technology approaches are presented that can and are utilized to monitor and analyze diver's physiology prior, during and post exposure.