## Sensory aspects of airway protection in ageing and Parkinson's disease

**Li Pyn Leow[1,2,3], Maggie-Lee Huckabee[1,3], Tim Anderson[1,4]**

1. **Department of Communication Disorders, University of Canterbury, Christchurch**
2. **Tan Tock Seng Hospital, Singapore**
3. **Van der Veer Institute for Parkinson's and Brain Research, Christchurch**
4. **Department of Medicine, Christchurch School of Medicine & Health Sciences, Christchurch**

The aim of this study was to evaluate sensory aspects of airway protection in healthy ageing and in Parkinson's disease (PD) using nasendoscopy and inhalation cough challenge. Forty-eight participants, gender equally represented, were divided into 3 groups: Group 1- healthy, young adults, mean age 25.1; Group 2- healthy elders, mean age 72.8 and Group 3- patients with Idiopathic PD, mean age 71.7. All underwent sensory testing during nasendoscopy during which sensation was tested using the tip of the endoscope at bilateral base of tongue (BOT), posterior pharyngeal wall (PPW) and aryepiglittic fold (AEF). Inhalation cough challenge using citric acid was administered. There were no differences in sensitivity at BOT, PPW and AEF between young adults and elders. Patients with PD had significantly less sensation in the (R) and (L) BOT compared to healthy elders. In healthy young adults, elders and PD normal cough threshold was always significantly lower than the suppressed cough threshold (p=.001). There was no difference between young adults and elders for natural cough thresholds (p=.102), but a significant difference in suppressed cough thresholds (p=.021). Elders have a significantly lower suppressed cough threshold when compared to young adults. Natural and suppressed cough did not differ between healthy elders and those with PD. Young adults are better able to suppress cough compared to elders. This may suggesting reduced tolerance for noxious stimuli in elders and/or reduced cognitive control when asked to suppress cough. Reduced BOT sensation in patients may account for a delay in swallowing process, thereby increasing aspiration risk

## Microfluidics for bioartificial livers

**Volker Nock[1], Richard Blaikie[1], Tim David[2]**

1. **MacDiarmid Institute, Department of Electrical and Computer Engineering, University of Canterbury, Christchurch**
2. **Centre for Bioengineering, Department of Mechanical Engineering, University of Canterbury, Christchurch**

Bioartificial Liver (BAL) is a term for medical devices designed to replace natural liver functions. The idea behind the use of artificial livers is to either externally support an injured liver to recovery or bridge a patient with a failing liver to transplantation. Our aim was to investigate the effect of microfluidic channel geometry on the modulation of oxygen transport to liver cells cultured in a Bioartificial Liver (BAL) bioreactor. Analytical calculations and finite-element simulations of fluid dynamics in microchannels were used to determine the influence

 

of wall-shear stress on oxygen transport in a microchannel containing a liver cells culture. To ensure hepatocyte survival over the full length of the bioreactor, an optimum channel shape for a constant oxygen concentration was calculated and a prototype bioreactor device was fabricated in Polydimethylsiloxane (PDMS) using soft lithography techniques. Fluid-dynamics simulation results regarding the effect of channel geometry on oxygen transport show good agreement with the analytical model able to predict channel geometry. Cell cultures in straight rectangular bioreactors are shown to be limited by high oxygen metabolism of hepatocytes. Through channel tapering wall-shear stress can be made to increase linearly within biological limits, while as a result oxygen concentration remains constant over the length of the bioreactor. Tapered bioreactors are fabricated in PDMS and bonded onto a glass substrate. Successful fluid flow and sealing is shown by application of a dye coloured liquid. A two layer design with 36 bioreactors demonstrates the feasibility of device scale-up towards a clinical size BAL. A geometrical approach to overcome transport constraints in micro-scale bioreactors has been introduced. Simulation results show that oxygen transport can be modified by customizing the shape of the reactor channel. Prototype bioreactors have been fabricated and tested. Selective cell seeding and the integration of a sensor to experimentally verify oxygen concentrations are currently being investigated.

## Diagnosing cardiac disease states using a minimal cardiovascular model

**C. Starfinger[1], C. E. Hann[1], J. G. Chase[1], G. M. Shaw[2]**

1. **Centre for Bioengineering, Department of Mechanical Engineering, University of Canterbury, Christchurch**
2. **Department of Intensive Care Medicine, Christchurch Hospital, Christchurch**

Cardiovascular disease states are difficult to diagnose due to a variety of underlying dysfunctions combined with reflex mechanisms. To provide more consistent care a cardiovascular system model is combined with an efficient patient-specific parameter identification method. The goal is to identify the patient's condition and to predict the future patient-specific reaction, making this approach a potential means for model-based guided therapy. The model and parameter-identification method are validated using clinical haemodynamic data measured during drug induced porcine pulmonary embolism experiments (N=6) and PEEP titration experiments (N=6). Identified model parameters are correlated to create predictive measures of haemodynamic changes to clinical therapy or patient condition. Prediction is tested for observed changes in arterial pressure (AP), pulmonary arterial pressure (PAP) and stroke volume (SV) as caused by a clinical change in PEEP. The parameter-identification method tracked pulmonary embolism in porcine data from an initial healthy to the disease state. The full range of haemodynamic responses was captured with mean errors of 4.1% in the pressures and 3.1% in the volumes. Pulmonary resistance increased significantly with the onset of embolism, as expected, with the percentage increase ranging from 89.98% to 261.44% of the initial state. Changes in AP, PAP and SV due to an increase in PEEP were predicted with a mean absolute percentage error less than 10%

 