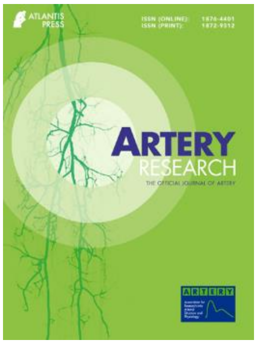


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# 5.5: IMPACT OF URBAN VERSUS RURAL ENVIRONMENT ON CENTRAL BLOOD PRESSURE, AORTIC STIFFNESS AND WAVE REFLECTIONS: THE PURSE-HIS STUDY

S. Thanikachalam, V. Harivanzan, S. Ramasamy, C.M. McEniery

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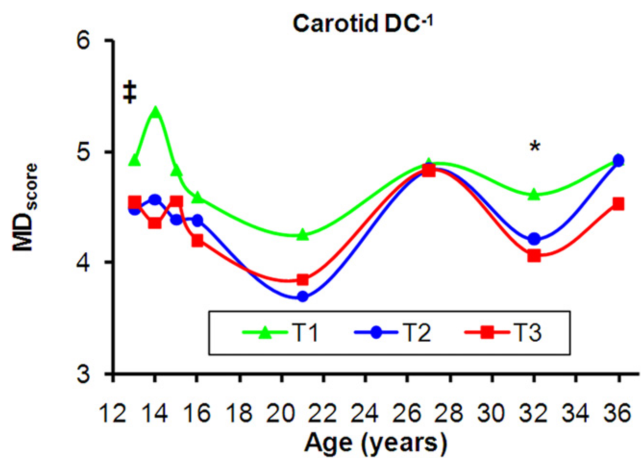
system, with the invasive gold standard (aortic PWV), as measured during cardiac catheterization on alternate days, in up to 659 patients: M1 (invasive aortic PWV), M2 ("conventional" subtraction: suprasternal notch-femoral site minus suprasternal notch-carotid), M3 (estimation from body height: TD = body height/4 + 7.28), M4 (direct measurement carotid-femoral site * 0.8), M5 (subtracted method as M2 but using straight caliper instead of a tape).
**Results:** Transit times, as assessed invasively and with the SphygmoCor system, were in good agreement (62.8 and 63.4 msec, respectively). TD and corresponding cfPWV, as measured with M2 and M3, met the invasive values — Table. M4 overestimated invasive TD by 3.5 cm, resulting in an overestimation of PWV by 0.3 m/sec. M5 underestimated TD by 4.5 cm, resulting in an underestimation of PWV by 0.9 m/sec. Correlations with invasive method and respective coefficients of determination were not improved, when M4 or M5 was used.
**Conclusion:** Non-invasive estimation of TD for cfPWV (often labelled as aortic PWV) remains problematic. A simplified method, based on body height, may be of value.

| | M1 | M2 | M3 | M4 | M5 |
|---|---|---|---|---|---|
| Patient number | 659 | 659 | 659 | | |
| TD cm | 50.6 | 50.8 | 50.4 | | |
| PWV m/sec | 8.6 | 8.4 | 8.4 | | |
| $R^2$ vs PWV invasive | | 0.378 | 0.373 | | |
| Patient number | 401 | 401 | 401 | 401 | |
| TD cm | 50.4 | 51.1 | 50.5 | 53.9 | |
| PWV m/sec | 8.5 | 8.4 | 8.3 | 8.8 | |
| $R^2$ vs PWV invasive | | 0.42 | 0.41 | 0.39 | |
| Patient number | 108 | 108 | 108 | | 108 |
| TD cm | 50.5 | 50.1 | 49.8 | | 46.0 |
| PWV m/sec | 8.9 | 8.7 | 8.7 | | 8.0 |
| $R^2$ vs PWV invasive | | 0.33 | 0.35 | | 0.32 |

### 5.4
### LIFETIME ADHERENCE TO A MEDITERRANEAN DIET (MD) PATTERN IS ASSOCIATED WITH LOWER CAROTID STIFFNESS IN YOUNG ADULTS: THE AMSTERDAM GROWTH AND HEALTH LONGITUDINAL STUDY

R. J. J. M. van de Laar [1], C. D. A. Stehouwer [1], B. C. T. van Bussel [1], M. H. Prins [1], J. W. R. Twisk [2], I. Ferreira [1]
[1]*Maastricht University Medical Centre, Maastricht, Netherlands*
[2]*VU University Medical Center, Amsterdam, Netherlands*

**Purpose:** To investigate whether lifetime adherence to an MD pattern (i.e., from adolescence to adulthood) is associated with arterial stiffness in adults.
**Methods:** Longitudinal data on dietary intake (2-8 repeated measures; ages 13-36) were retrieved for 373 subjects in whom carotid stiffness was assessed by means of ultrasonography at age 36. An $MD_{score}$ [range: 0 to 9 (higher values indicate better adherence)] was calculated based on values < or > the sex-specific medians or pre-defined cut-off values of vegetables, legumes, fruits/nuts, whole grains, fish, meat/poultry, dairy products, alcohol and the ratio of mono-unsaturated to saturated lipids intake. Adherence to an MD pattern (yes/no) was defined based on values > or < median of the $MD_{score}$. We used generalized estimating equations to compare, throughout the 24-yr longitudinal period, the $MD_{score}$ between subjects with increasing levels [i.e., tertiles (T)] of the *inversed* distensiblity ($DC^{-1}$) and compliance coefficients, and Young's elastic modulus.
**Results:** After adjustment for height, energy intake, physical activity, smoking and mean arterial pressure, and as compared to subjects with 'stiffer' arteries (i.e., in T3), those with 'less stiff' arteries (T1) had a higher lifetime mean $MD_{score}$ [e.g., +0.44 (95%CI: 0.20-0.69), when considering the $DC^{-1}$ levels - Figure]. Subjects with 'less stiff' arteries were also more likely to have had adhered to an MD pattern throughout the longitudinal period than those with 'stiffer' arteries [OR=1.68 (1.22-2.31)].
**Discussion:** Promoting adherence to the MD throughout the course of young life might offer an important means to prevent accelerated arterial stiffening later in life.




### 5.5
### IMPACT OF URBAN VERSUS RURAL ENVIRONMENT ON CENTRAL BLOOD PRESSURE, AORTIC STIFFNESS AND WAVE REFLECTIONS: THE PURSE-HIS STUDY

S. Thanikachalam [1], V. Harivanzan [1], S. Ramasamy [1], C. M. McEniery [2]
[1]*Sri Ramachandra University, Chennai, India*
[2]*University of Cambridge, Cambridge, United Kingdom*

Urbanisation of developing countries has had a marked impact on population health. In particular, in India, the prevalence of coronary heart disease is markedly increased in urban versus rural settings. The aim of the current study was to assess the impact of geographic location on large artery stiffness and central blood pressure (BP) as part of the PURSE-HIS study.
**Methods:** In all, 7676 individuals (4276 females) from three distinct geographical regions of Tamil Nadu, India were studied. The mean age was 44±10 years (range 19-79 years). Following completion of a detailed medical history questionnaire, all participants underwent haemodynamic screening including brachial and central BP, augmentation index (AIx) and aortic pulse wave velocity (PWV, SphygmoCor). Subjects were then grouped according to geographical region (urban, semi-urban and rural) and decade of age.
Clinic brachial and central BP increased significantly with age in all three geographical regions (P<0.001). However, both brachial and central pressures were significantly lower in rural participants at all ages (P<0.001 for all). Aortic PWV also significantly increased with age in all geographical regions (P<0.001 for all). However, the age-associated increase in PWV was significantly attenuated in rural participants (P<0.001), even after adjusting for confounders (Figure 1). In contrast, AIx was significantly higher in younger rural individuals (<40 years,P<0.001), although this difference was not evident in older individuals.
These data indicate that urban lifestyle adversely impacts on blood pressure and large artery stiffness in an Indian population, which may contribute to the increased cardiovascular risk observed in these individuals.

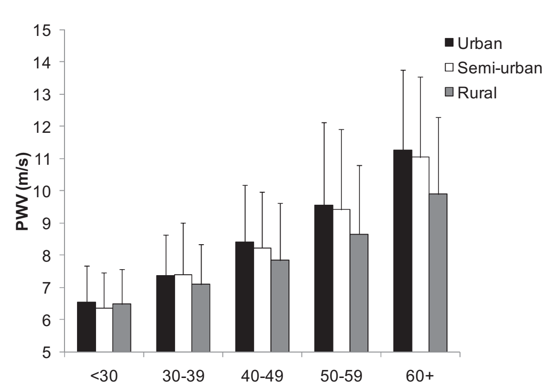
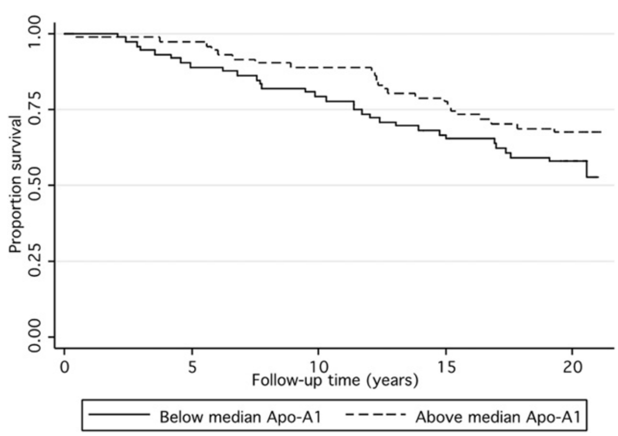


Figure 1

### 5.6
### INDEPENDENT RELATION BETWEEN ETHNICITY, BASELINE HAEMOSTATIC VARIABLES, ARTERIAL STIFFNESS AND MORTALITY: A 22-YEAR FOLLOW-UP STUDY

S. G. Anderson [1], A. H. Heald [1], J. K. Cruickshank [2]
[1]*University of Manchester, Manchester, United Kingdom*
[2]*King's College London, London, United Kingdom*

**Objectives:** To examine the relationship between haemostatic factors, pulse wave velocity (PWV), blood pressure (BP) and mortality in British Europeans, African-Caribbeans (AfC) and Gujarati Indians.
**Design and Methods:** Prospective cohort study of 331 subjects (40-79 years), followed-up over 21 years for mortality. PWV, Apolipoprotein-A1 (Apo-A1), apolipoprotein-B (Apo-B), factor VIIc (FVIIc), fibrinogen and vWF were measured at baseline in 118 Europeans, 100 AfC and 113 Gujaratis.
**Results:** 113 (34%) subjects died during a mean of 16.8 years follow-up with 57 cardiovascular deaths. Women had significantly higher, and AfC males the lowest FVIIc and Apo-A1 levels. HDL levels were lowest ($F = 3.13$; $P=0.04$) in Gujarati Indians. Baseline age-sex and ethnicity adjusted FVIIc levels were higher in those who died (133.9 vs. 117.6%; $P=0.03$), with similar levels of the other haemostatic factors by mortality status. In similarly adjusted partial correlations, Apo-A1 was inversely related to PWV ($\rho = -0.23$, $P=0.04$). No independent associations were found between fibrinogen, FVIIc, Apo-B, ApoB/Apo-A1 ratio, vWF and PWV. In Kaplan-Meier curves (Figure 1), those above, compared with those below the median of Apo-A1 levels, had reduced mortality. In Cox regressions, SBP (per 5mmHg) was associated with a 9%, PWV a 20% (per m/s), and FVIIc a 6% (per 10-unit; HR 1.06 (1.01, 1.10, $P=0.016$) increased risk of mortality.
**Conclusions:** The relationship between haemostatic variables with cardiovascular disease is well known, however few studies report their association with arterial stiffness. The results here are consistent with the independent effect of haemostatic variables influencing arterial stiffness and mortality.




## Oral Session 6
## Young Investigators' Presentations

### 6.1
### UNSUPERVISED NON-INVASIVE MEASUREMENT OF AORTIC PULSE TRANSIT TIME BY MEANS OF ELECTRICAL IMPEDANCE TOMOGRAPHY

J. Solà [1], A. Adler [2], A. Santos [3], G. Tusman [4], F. Suárez Sipmann [3,5], S. H. Bohm [1]
[1]*CSEM — Centre Suisse d'Electronique et de Microtechnique, Neuchâtel, Switzerland*
[2]*Systems and Computer Engineering, Carleton University, Ottawa, Canada*
[3]*Department of Critical Care, Fundación Jiménez Díaz-UTE, IIS-FJD,CIBERES, Madrid, Spain*
[4]*Department of Anesthesioloy, Hospital privado de Comunidad, Mar del Plata, Argentina*
[5]*Section of Anaesthesiology & Critical Care, Dept of Surgical Sciences, Uppsala University Hospital, Uppsala, Sweden*

**Objectives**: This study provides first experimental evidence on the feasibility of measuring Pulse Transit Time (PTT) values within the aorta by means of non-invasive and non-obtrusive Electrical Impedance Tomography (EIT) technology.
**Methods**: A wide range of pulse wave velocity scenarios were obtained by administrating noradrenalin and nitroglycerine to an anesthetized pig under mechanical ventilation. Two arterial lines were inserted into the ascending and the descending aorta for measuring reference PTT values. EIT images were generated from 32 impedance electrodes placed around the chest at the level of the axilla. Regions of Interest (ROI) such as the descending aorta were automatically identified by a novel time-based processing algorithm as the respective EIT pixels representing these structures [1]. Aortic EIT-PTT values were determined as the delay between the opening of the aortic valve (obtained from arterial line) and the arrival of pressure pulses at the aortic ROI within the EIT plane.
**Results**: For 9 experimental conditions, with mean BP ranging from 73 to 141 mmHg, strongly significant correlation ($r= 0.98$, $p<0.00001$) between aortic EIT-PTT and arterial line PTT was observed (Figure 1).
**Conclusion**: EIT is a novel candidate technology for the unsupervised monitoring of arterial stiffness.

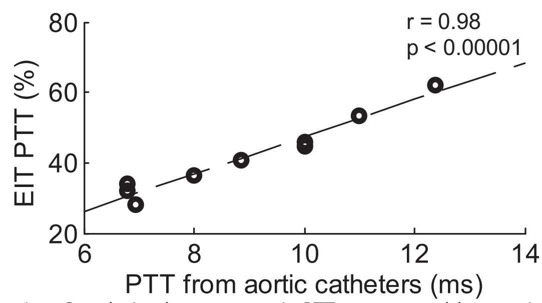



**Figure 1** Correlation between aortic PTT as measured by arterial lines and EIT technology at different hemodynamic conditions

[1] Solà, J. *et al*, Non-invasive monitoring of central blood pressure by Electrical Impedance Tomography (EIT): first experimental evidence , Med Biol Eng Comput, Epub ahead of print, 15 Mars 2011.

### 6.2
### PREDICTING THE FUNCTIONAL IMPACT OF RESIDUAL AORTIC COARCTATION LESIONS DURING EXERCISE USING ADVANCED COMPUTER MODEL SIMULATIONS

L. Taelman [1], J. Degroote [2], J. Bols [2], V. Muthurangu [3], S. Panzer [4], A. Swillens [1], J. Vierendeels [2], P. Segers [1]
[1]*IBiTech-bioMMeda, Ghent, Belgium*
[2]*Department of Flow, Heat and Combustion Mechanics, Ghent, Belgium*
[3]*Centre for cardiovascular MR, UCL Institute of Child Health, London, United Kingdom*
[4]*UZ Gent, Ghent, Belgium*

**Background**: Exercise can be used to unmask the functional impact of a residual narrowing and/or stiffening following treatment of aortic coarctation. Measurements of the hemodynamic response during exercise are, however, difficult to perform and not very accurate, as suspension of exercise during imaging can be required or a low temporal resolution might be insufficient at the high heart rates present during exercise. This work aims to predict central aortic hemodynamics during exercise using advanced modeling tools.
**Material and methods**: The geometry and the flow boundary conditions, used in this model, are obtained from MRI data at rest (Figure 1). As model simulations with rigid walls fail to capture important physiological phenomena such as wave propagation and reflections, the fluid-structure interaction between the blood flow and the deformation of the arterial wall is taken into account.
**Results**: The numerical model is first calibrated to the resting conditions such that the predicted aortic distensions match the measured values. Predicted velocities throughout the aorta are compared to 4D velocity measurements. Next, exercise conditions are simulated, with blood flows obtained using an MRI-compatible bycicle type ergometer, in which motion is restricted to the lower legs. Model output includes pressure along the aorta and velocity fields during exercise conditions.
**Conclusions**: Advanced modelling techniques allow to simulate aortic hemodynamics in 3D and are capable to provide complementary data that are difficult to obtain in vivo.