

Letter to the editor:-

Errors of fact in the recent paper by Westerhof, Segers and Westerhof

Short Title: Serious mathematical errors in Westerhof paper

Justin E Davies, Alun D Hughes and Kim H Parker

JD, KP, Imperial College London,

UK AH, UCL, UK

Correspondence to: Dr

Justin E Davies

Consultant Cardiologist

Imperial College London

justindavies@heart123.com

tel +44(0)2075941024

fax +44(0)2075941706

*False facts are highly injurious to the progress of science,
for they often endure long... – Charles Darwin¹*

The recent paper in *Hypertension* by Westerhof, Segers and Westerhof² expressed very strong conclusions about both reservoir pressure and the instantaneous wave-free ratio (iFR). We welcome robust debate of scientific concepts but we fear that in seeking to produce what they term a ‘controversy series article’ Westerhof *et al.* have allowed polemical enthusiasm to override accuracy. As three of the originators of iFR and the concept of reservoir pressure, we feel obliged to point out that the paper contains a number of errors or ‘false facts’ that nullify their conclusions.

Throughout the paper they persistently assert that iFR is the ratio of measured pressure and flow. Quoting two instances: ”The iFR is the ratio of pressure and flow in the latter 75% of diastole.” and ”their instantaneous ratio thus $P^m(t)/Q^m(t)$ ” where $P^m(t)$ is measured pressure and $Q^m(t)$ is measured flow. This is not true.

iFR is defined as the ratio of the distal-to-proximal pressure across a coronary stenosis during the period during diastole when waves identified as peaks in the wave intensity are minimal, which we defined as the ‘wave-free’ period in the first paper describing it³:

$$iFR = \frac{\overline{Pd}_{wfp}}{\overline{Pa}_{wfp}}$$

where \overline{Pd}_{wfp} is the pressure distal to the stenosis and \overline{Pa}_{wfp} is the pressure proximal to the stenosis during the ‘wave-free’ period.

The article contains other misrepresentations and errors. They state that the reservoir pressure is the same as Frank’s Windkessel pressure when, in fact, we coined the term ‘reservoir pressure’ expressly to emphasise that it was not the same as the Windkessel pressure. They also assume that reservoir pressure and iFR are somehow related mechanistically when, in fact, they share nothing, except some

authors.

These errors, particularly the erroneous definition of iFR, invalidate their discussion and their conclusions about iFR and reservoir pressure.

Disclosure: JD has IP pertaining to this technology which is under license to commercial partners. No other author has a conflict to declare.

References

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2. Westerhof N, Segers P, Westerhof BE. Wave separation, wave intensity, the reservoir- wave concept, and the instantaneous wave-free ratio. Hypertension (in press).
3. Sen S, Escaned J, Malik IS, Mikhail GW, Foale RA, Mila R, Tarkin J, Petraco R, Broyd C, Jabbour R, Sethi A, Baker CS, Bellamy M, Al-Bustami M, Hackett D, Khan M, Lefroy D, Parker KH, Hughes AD, Francis DP, Di Mario C, Mayet J, Davies JE. Development and validation of a new adenosine-independent index of stenosis severity from coronary wave-intensity analysis. J Am Coll Cardiol. 2012;59:1392-402.