

Height Moves the Pressure on a Vessel's Wall but Not the Difference That Drives the Flow

— A column of blood adds **0.779695** mmHg per centimetre, so lowering the arm **30** cm adds **23.3908** mmHg and the feet of a standing person gain **101.3603** mmHg — the separator is whether one asks about the pressure on the wall or the difference that drives the flow — [Paper 849]

Yuuki YAMAGISHI (山岸 勇輝)

Yamagishi Complexity Torus Lab, Japan

September 2026

YOI: <https://www.yamagishiyuuki.com/yoi/849>

— *From thinking to syncing.* —

Abstract

Blood pressure is to be measured “at heart level”. This paper counts what height moves and what it does not. No new theorem or law is claimed. First, a column of blood adds pressure centimetre by centimetre: at a density of 1060 kg/m^3 , **0.779695** mmHg per centimetre (Section 2). Second, an error in height goes straight into the reading: lowering the arm 10 cm adds 7.7969 and 30 cm adds **23.3908** mmHg (Section 2). Third, within a standing body top and bottom differ greatly: +101.3603 at the feet (130 cm below), −31.1878 at the head (40 cm above), a difference of **132.5481** mmHg (Section 2). Fourth, the pressure on the wall more than doubles at the feet: an arterial 100 becomes **201.3603**, a factor of **2.013603** (Section 3). Fifth, and this is the core. The difference that drives the flow does not move: the same column rests on artery and vein, so the difference is 95.0000 mmHg at the heart and at the feet alike (Section 3). Sixth, the separator is whether one asks about the pressure on the wall or the difference that drives the flow: the one word “blood pressure” can be used for a quantity that moves with height and one that does not (Section 4). **Keywords:** blood pressure, hydrostatic pressure, liquid column, transmural pressure, driving pressure, model.

Scope of this paper (scope note): No new theorem or law is claimed: that the pressure of a liquid column is density times gravitational acceleration times height, that the arm is placed at heart level when measuring blood pressure, that vessels in the feet of a standing person bear higher pressure, and that equal columns on artery and vein leave their difference unchanged, are all known. No medical advice is given: how to measure, and which values are normal, are not stated. No real person's values are claimed: arterial 100 and venous 5 mmHg, 130 cm to the feet and 40 cm to the head are model values. Vessels are treated as static columns: elasticity, pulsation, venous valves and flow resistance are not included. The body's responses are not treated: reflexes on standing up and the baroreceptors are not entered. Relation to earlier papers: Paper 454 showed that water pressure grows as the square while the dam need only grow in proportion, placing hydrostatic pressure among the known. This paper does not sit in that seat but stands beside it: there the wall of a dam, here the wall of a vessel. Paper 794 showed that trees pull water up rather than push it, the limit set by its weight plus the resistance to flow. There weight and resistance were added; here weight is counted as acting on the wall alone and vanishing from the difference that drives the flow. What is added is computing the pressure per centimetre and laying out the effect of height errors, measuring that the wall pressure at the feet rises by 2.013603, confirming to 1.421×10^{-14} that the driving difference does not move with height, and placing the separator on wall pressure versus driving difference.

1. Notation and the Question

Setting: let ρ be the density of blood, g the gravitational acceleration and Δz the height below the heart. The pressure at depth Δz is the heart-level pressure plus the column.

$$p(\Delta z) = p_0 + \rho g \Delta z, \quad (p_a + \rho g \Delta z) - (p_v + \rho g \Delta z) = p_a - p_v$$

Write p_a for arterial and p_v for venous pressure. Here $\rho = 1060 \text{ kg/m}^3$ and $g = 9.80665 \text{ m/s}^2$.

Question: when height changes, which pressures move and which do not?

2. Height Errors Go Into the Reading

Computation 2.1: the pressure added by the column of blood was computed.

place	pressure added
per centimetre of column	0.779695 mmHg
arm lowered 10 cm	+7.7969 mmHg
arm lowered 30 cm	+23.3908 mmHg
head (40 cm above)	−31.1878 mmHg
feet (130 cm below, standing)	+101.3603 mmHg
head to feet	132.5481 mmHg

Observation 2.2

a height error goes straight into the reading. Lowering the arm 30 cm reads 23.3908 mmHg higher: placing the arm at heart level is not etiquette but the convention fixing which height is meant.

Observation 2.3

a centimetre adds less than 1 mmHg. Blood is lighter than mercury, so the same height of column adds less: the unit mmHg is a height of mercury, not of blood.

3. The Wall Pressure Moves; the Difference Does Not

Computation 3.1: with arterial 100 and venous 5 mmHg at heart level, values at the feet of a standing person (130 cm below) were computed.

quantity	at heart level	at the feet
arterial pressure	100.0000	201.3603
venous pressure	5.0000	106.3603
difference driving the flow	95.0000	95.0000

Observation 3.2

the wall pressure more than doubles at the feet. Arterial pressure rises by a factor of 2.013603: the vessel wall bears the full weight of the column at that height.

Observation 3.3

this is the core. The driving difference does not move. It is 95.0000 at the heart and at the feet, the two differing by only 1.421×10^{-14} , because the same column rests on artery and vein and cancels in the subtraction.

Observation 3.4

so high pressure in the feet does not mean better flow there. The difference that sets the flow is the same at every height: height acts only in the direction of distending the vessel.

4. The Separator

Observation 4.1

the separator is whether one asks about the pressure on the wall or the difference that drives the flow. The first moves by 2.013603 with height; the second stays at 95.0000: one word “blood pressure” can point at a quantity that moves and one that does not.

Observation 4.2

placed beside Papers 454 and 794. 454 showed how a dam bears water pressure that grows with depth. There the wall of a dam, here the wall of a vessel: both about the wall. 794 showed that the limit on trees lifting water is set by its weight plus the resistance to flow. There weight and resistance were added; here weight acts on the wall and vanishes from the driving difference. The same column’s weight divides by where it acts.

Observation 4.3

what is not said. How to measure, normal values, elasticity, valves and reflexes are not treated. What is shown is that height moves the wall pressure and leaves the driving difference unchanged.

5. Census and Closing

1. **0.779695** mmHg per centimetre (Computation 2.1): **lighter than mercury**.
2. **arm down 30 cm: +23.3908** (Computation 2.1): **errors go in**.
3. **feet: +101.3603** (Computation 2.1): **standing**.
4. **head to feet 132.5481** (Computation 2.1): **top and bottom**.
5. **arterial at the feet 201.3603** (Computation 3.1): **wall pressure**.
6. **a factor of 2.013603** (Observation 3.2): **more than double**.
7. **driving difference stays 95.0000** (Computation 3.1): **the core**.
8. **discrepancy 1.421×10^{-14}** (Observation 3.3): **cancels on subtraction**.
9. **high pressure, no extra flow** (Observation 3.4): **height only distends**.
10. **wall pressure, or driving difference** (Observation 4.1): **the separator; Papers 454, 794**.

Closing: Height moves the pressure on a vessel's wall but not the difference that drives the flow. A column of blood adds 0.779695 mmHg per centimetre, so lowering the arm 30 cm reads 23.3908 mmHg higher, and a standing body differs by 132.5481 mmHg from head to feet, because placing the arm at heart level is the convention that fixes which height is meant. With arterial 100 and venous 5 at heart level, arterial pressure at the feet is 201.3603, a factor of 2.013603, while the driving difference stays at 95.0000, off by only 1.421×10^{-14} , because the same column rests on artery and vein and cancels in the subtraction. High pressure in the feet therefore does not mean better flow there; height acts only to distend the vessel. Placed among the earlier papers: beside Paper 454's dam wall as a vessel wall, and beside Paper 794's weight-plus-resistance as the case where weight drops out of the driving difference. To be honest: vessels are treated as static columns, and arterial 100 and venous 5 are model values.

References

1. Hall, J. E., & Hall, M. E. (2020). *Guyton and Hall Textbook of Medical Physiology*. Elsevier.
2. Yamagishi, Y. (2026). *The Water Load Grows as the Square, and the Dam Only as the First Power* [Paper 454]. YOI: <https://www.yamagishiyuuki.com/yoi/454>; DOI: 10.5281/zenodo.22732989

3. Yamagishi, Y. (2026). *Trees Pull Water Up Rather Than Push It, and the Limit Is Set by Its Weight Plus the Resistance to Flow* [Paper 794]. YOI: <https://www.yamagishiyuuki.com/yoi/794>; DOI: 10.5281/zenodo.23015380

— *From thinking to syncing.* —

Yuuki YAMAGISHI (山岸 勇輝)

© 2026 Yamagishi Complexity Torus Lab, Japan · Licensed under Creative Commons Attribution 4.0 International (CC BY 4.0)