

Peclet Number Analysis is used to determine the ratio of convective heat transfer rate to the conductive heat transfer rate. The Peclet number is a dimensionless parameter commonly used in heat transfer and is defined as follows:

$$Pe = \frac{LU}{\alpha}$$

Where L is the characteristic length (in this case, radius of the jugular vein), U is the average flow velocity at the point of measurement, and α is the thermal diffusivity of the flowing blood. Representative values are listed in the table below. Measured blood flow velocity in the jugular bulb depends on temperature, therefore the Peclet number has been calculated for brain temperatures of 36°C and 28°C. Thermal diffusivity is $k/\rho C_p$ with $k=0.5$ W/mk, $\rho=1.05$ g/cc and $C_p=3.6$ J/gK.

Parameter	Value	
Radius of right internal jugular vein ¹	0.85 cm	
Blood flow velocity in right jugular bulb ²	2.8 cm/s @28°C	6.0 cm/s @36°C
Thermal diffusivity	1.3x10 ⁻³ cm ² /s	
Pe	1800 @28°C	3900 @36°C

This Peclet Number Analysis concludes that convective transfer to the probe tip is approximately 1800 times the rate of conductive transfer @28°C when blood flow velocity through the jugular bulb is lower, and 3900 @ 37°C when blood flow velocity is higher. Therefore, any interference in temperature measurements within the jugular bulb due to conduction is extremely small, as the temperature measured by the probe in the jugular bulb is determined almost exclusively by the temperature of the flowing blood from the brain.

1. Tartiere D, Seguin P, Juhel C, Laviolle B and Malledant Y. Estimation of the diameter and cross-sectional area of the internal jugular veins in adult patients. *Crit Care*. 2009; 13: R197.
2. Ohsumi H, Kitaguchi K, Nakajima T, Ohnishi Y and Kuro M. Internal jugular bulb blood velocity as a continuous indicator of cerebral blood flow during open heart surgery. *Anesthesiology*. 1994; 81: 325-32.