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Steady streaming and conditional turbulence in high-frequency ventilation[1] JUSTIN LEONTINI, CHINTHAKA JACOB, Swinburne University of Technology, DAVID TINGAY, Murdoch Children's Research Institute — High-frequency ventilation (HFV) is a technique used to ventilate neonates and patients with critical respiratory distress syndrome. It uses very fast yet shallow inflations, resulting in small peak pressures, thereby protecting lungs from over-distension. There are several mechanisms proposed for the gas transport during HFV, and here we investigate two of the primary ones; turbulent mixing and mean streaming. We have conducted direct numerical simulations of these high-frequency reciprocating flows in 1:2 bifurcations with geometric proportions relevant to the first five generations of the neonatal airway. Conditional turbulence is observed in the first three generations of the airway, the turbulence occurring when the flow rate is near its maximum. The results suggest this turbulence is generated via an instability of the Dean vortices generated via the curvature of the bifurcation. This mechanism differs from that which leads to conditional turbulence in the reciprocating flow in a straight pipe. We also quantify the recirculating flow rate due to mean streaming and find it to be around 5% of the maximum flow rate in the upper airway - this is enough to provide adequate gas exchange during HFV.

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