Applying a Novel Reservoir-Wave Concept to Describe the Pressure Drops and Resistances to Flow in the Pulmonary Circulation

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To aid in understanding disease conditions that affect the cardiovascular system, a new reservoir-wave concept has been applied to the pulmonary circulation. This concept considers blood pressure to have two components: 1) A volume-related reservoir pressure, increasing and decreasing each beat and 2) a wave-related pressure generated by the contracting and relaxing ventricle. Applying this concept to the arteries and veins provides a detailed description of the pressure drop and resistance along the vasculature. Pulmonary hypertension is caused by an abnormal resistance at some location along the pulmonary vasculature. The current measure of pulmonary vascular resistance is only based on the total pressure drop between the arteries and veins. Potentially, the application of this concept might enable earlier diagnosis of pulmonary hypertension by providing a more detailed description of the resistances than is currently possible. Canine experiments have been performed using different interventions that affected the resistance of different blood vessel segments. Three levels of volume loading were used (left ventricular end diastolic pressures of 6, 12 and 18 mmHg) to distend pulmonary blood vessels. At each volume load level, hypoxia was created by adjusting the percentage of inspired oxygen. After hypoxic vasoconstriction was observed, nitric oxide was administered to create vasodilation. Under control conditions, the resulting pressure drops correspond very well to segmental pulmonary pressures previously measured. According to the model, large-artery and arteriolar resistances involve arterial vessels greater than 40 μm in diameter, while the venular and large-vein resistances correspond to venous vessels greater than 30 μm.