“What we know is little, and what we are ignorant of is immense”

Sergio A. Carrillo, MD

From the Children's Heart Center Nevada and the Department of Surgery, University of Nevada, Las Vegas (UNLV), Las Vegas, Nev.

Disclosures: Author has nothing to disclose with regard to commercial support.

Received for publication Aug 28, 2017; accepted for publication Aug 30, 2017; available ahead of print Sept 28, 2017.

Address for reprints: Sergio A. Carrillo, MD, Staff Pediatric Heart Surgeon, Children's Heart Center Nevada, 3006 S Maryland Pkwy, Suite 690, Las Vegas, NV 89109 (E-mail: scarrillo@childrensheartcenter.com).

J Thorac Cardiovasc Surg 2017;154:2052-3

0022-5223/\$36.00

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<https://doi.org/10.1016/j.jtcvs.2017.08.111>

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Central Message

Consideration of elastance (as a measure of afterload) is important before congenital heart surgery. It can be used to risk stratify a preterm neonate undergoing ductus arteriosus ligation.

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“What we know is little, and what we are ignorant of is immense.” These are the reported last words of Marquis Pierre Simon de Laplace (1749-1827).¹ Known in Europe as the “French Newton,” Laplace was an influential scholar whose work fundamentally influenced 18th and 19th century mathematics, statistics, physics, and astronomy. Laplace's contributions built on the work of British polymath and physician Thomas Young (1773-1829), who rendered Laplace's observations on surface tension of liquids as a mathematical formula.² Today, more than 200 years later, the Law of Laplace has an important role in cardiovascular physiology. It explains the mechanisms of a wide range of physiologic phenomena, including capillary action, peripheral edema, and compartment syndrome.³

Before congenital heart surgery is undertaken, the assessment of left ventricular contractility, preload, and afterload is important for preoperative planning to obtain satisfactory clinical outcomes. Afterload is left ventricular wall stress during systole. Wall stress results from the interaction of pressure, chamber radius, and wall thickness. Arterial elastance is another way of measuring afterload. Elastance is the reciprocal of compliance, and it is a measurement of an organ or vessel's recoil to its original dimensions on removal of a distending or compressing force. Because the measure of elastance is derived from the slope of the relationship between pressure and volume, elastance captures both the pulsatile and the resistive components of afterload.⁴

Gray and colleagues' report⁵ in this issue of the *Journal* stresses the importance of preoperative left ventricular mechanics in the outcome of preterm infants undergoing patent ductus arteriosus ligation. The noninvasive measurement of arterial elastance and left ventricular end-systolic elastance as measures of afterload (in lieu of wall stress) are central to ascertaining the state of the left ventricle before surgery. Gray and colleagues⁵ conclude that preoperative increased end-systolic elastance (increased contractility) and decreased arterial elastance (decreased afterload) are

associated with increased postoperative hemodynamic vasoactive support and with poorer clinical outcomes. This concept is novel and clinically relevant.

The criterion for the measurement of elastance is by conductance during cardiac catheterization. Gray and colleagues⁵ provide an alternative method, one that is based on their previous clinical work⁶ and uses transthoracic echocardiography. Their method was derived from data on predominantly healthy subjects after transplant with normal pulmonary to systemic flow ratio determined by 3-dimensional echocardiography with measurements averaged over three beats. This method has not been validated in healthy premature and term infants, however, as a basis to support conclusions about the physiology in the cohort of patients in the study of Gray and colleagues.⁵ Furthermore, elastance data measurements in other disease states are not provided. Moreover, their primary outcome of peak postoperative vasoactive inotropic score has not been validated as a predictor of morbidity and mortality in patients after closed-heart operations.⁷

Preterm neonates are largely cared for and managed by neonatologists, who have their own treatment protocols. Although the concept remains controversial, some have advocated avoiding therapeutic closure of the patent ductus arteriosus in premature neonates.⁸ Furthermore, some fear

postligation syndrome, which has been suggested as a contributor to bronchopulmonary dysplasia and neurodevelopmental impairment.^{8,9} Perhaps with the use of fine-grain preoperative noninvasive echocardiographic measurements,⁵ such as elastance, a better risk stratification profile for preterm babies with patent ductus arteriosus can be formulated and sway the pendulum toward medical optimization followed by surgical ligation when indicated.

In today's world, what we know is immense and what we are ignorant of is less!

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