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In This Issue

The Role of Echocardiography in the Evaluation of Preterm Infants with Patent Ductus Arteriosus

By P. Syamasundar Rao, MD
~Page 1

Upcoming Medical Meetings

~Page 11

NICU Staff Education in Providing Psychosocial Support for Parents of Babies in the Neonatal Intensive Care Unit

By Sue Hall, MD
~Page 12

Honoring Changemakers at 'Tinis for Preemies'

By Christa Terry
~Page 157

Synopsis of the 8th Phoenix Fetal Cardiology Symposium

By Christopher L. Lindblade, MD
~Page 17

Isn't It Time for a Little Kangaroo in Your NICU?

By Michael Narvey, MD.
~Page 20

Real-time Reporting with Twitter - Social and Mobile Media in Neonatology

By Clara H. Song, MD
~Page 24

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The Role of Echocardiography in the Evaluation of Preterm Infants with Patent Ductus Arteriosus

By P. Syamasundar Rao, MD

Introduction

Ductus arteriosus is a vascular structure that connects the main pulmonary artery with the descending thoracic aorta. In the fetus, the ductus arteriosus diverts deoxygenated blood from the pulmonary artery into the descending aorta and from there to the placenta for oxygenation.^{1,2} It closes spontaneously at birth,^{1,2} and is considered patent if it persists beyond 72 hours of life.³ The incidence of Patent Ductus Arteriosus (PDA) is 0.05% in full-term infants,^{4,5} and constitutes 10% of all Congenital Heart Defects (CHD). The incidence of PDA is high in preterm babies; the earlier the gestational age, the higher the incidence.³⁻⁶ The ductus remains open in 90% of babies born at 24 weeks gestation, in 80% of babies born between 25 to 28 weeks gestation and in 10% of infants born between 30 and 37 weeks gestation.⁶ The patency rates are also related to birth weight; 80% in babies weighing less than 1,200g and 40% in infants weighing less than 2,000g have PDAs.⁴ The adverse effects of PDA in the preterm babies have been addressed in previous reviews.^{4,5,7,8} The clinical, roentgenographic and biomarker profiles are helpful in evaluating the significance of PDA in the premature; however, echocardiography appears to be the prime modality for detection and quantification of PDA in the preterm infants. The purpose of this paper is to review the role of Echo-Doppler studies in the assessment of PDA in the premature infants.

Echocardiography

An echocardiogram is commonly performed in conjunction with Doppler studies and may be called an Echo-Doppler study. Such studies are recommended if there is a clinical suspicion of PDA. Indeed, it may be considered the procedure of choice for diagnosis and quantification of PDA. An Echo-Doppler study is also useful in excluding any congenital cardiac defects. Rarely, a question of aortic coarctation may be raised and most of the time can be confirmed/excluded by carefully reviewing the 2-dimensional (2D) and color, pulsed and

“The incidence of PDA is high in preterm babies; the earlier the gestational age, the higher the incidence.³⁻⁶ The ductus remains open in 90% of babies born at 24 weeks gestation, in 80% of babies born between 25 to 28 weeks gestation and in 10% of infants born between 30 and 37 weeks gestation.⁶”

continuous wave Doppler recordings with occasional need for angiography.⁹ Echo-Doppler studies along with clinical data are useful in assessing the severity of PDA, including identification of hemodynamically significant Patent Ductus Arteriosus (hsPDA), which in turn help in managing the premature babies.^{4,10-12}

Echo-Doppler Protocol

Two-dimensional (2D), M-mode and Doppler examination is performed in parasternal long and short axis, apical four- and two-chamber, subcostal and suprasternal notch views. Pulsed, continuous wave and color Doppler in multiple views should be recorded with particular attention to defining the size of the PDA and its hemodynamic effects. Recording maximal Doppler flow velocity magnitudes across the ductus is also undertaken. Doppler recordings that are useful in estimation of pulmonary arterial pressures should also be made. Finally, recording the patterns of descending aortic diastolic flow should also be undertaken in order to demonstrate normal antegrade diastolic flow, absent diastolic flow or retrograde diastolic flow, as the case may be. Important aspects germane in the evaluation of PDA will be reviewed.



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Left Atrium

The left atrial (LA) size may be subjectively estimated in an apical four-chamber view (Figure 1), but such an evaluation is not optimal. The size of the LA may be measured on M-mode recording in parasternal short axis view as shown in Figure 2; this may be compared with normal standards. However, the normal values for several weight categories in the preterm infants have not been set up. The left atrial volume may be estimated using the biplane area-length method in apical 4-chamber (Figure 3) and apical 2-chamber views. But again, normal values do not exist for some weight categories in the premature infants. The LA to the aortic root (LA/Ao) ratio (Figure 2) was shown to be useful in measuring the degree of shunting across the PDA.¹³ LA:Ao ratio is less than 1.2:1 in a normal infant. In small PDAs this ratio is between 1.2:1 and 1.4:1. In moderate-sized PDAs, the ratio is likely to be between 1.4:1 and 1.6:1 while in large PDA, the ratio is expected to be ≥ 1.6 . While these ratios are usually dependable, false positives as seen in babies with mitral valve insufficiency, and false negatives may occur in infants in whom fluid restriction has been undertaken.

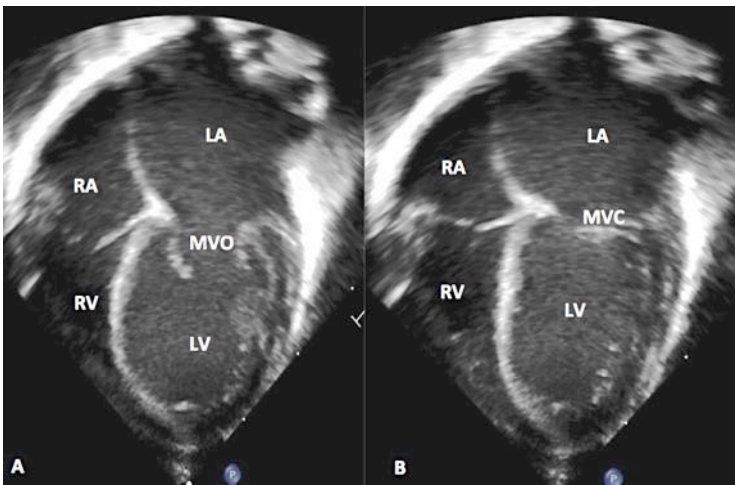


Figure 1. Echocardiographic frames from an apical four-chamber view demonstrating enlarged left atrium (LA) and left ventricle (LV). The mitral valve (MVO) is open in A and closed (MVC) in B. But, this enlarged LA and LV appearance is subjective. RA, right atrium; RV, right ventricle.

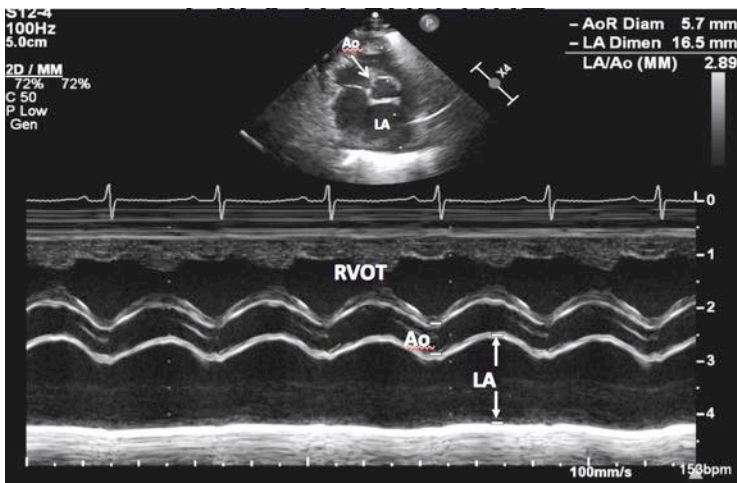


Figure 2. M-mode tracing in the parasternal short axis view demonstrating measurements of the aorta (Ao) and left atrium (LA) (arrows). Note that the LA/Ao ratio is increased (2.89:1). RVOT, right ventricular outflow tract.

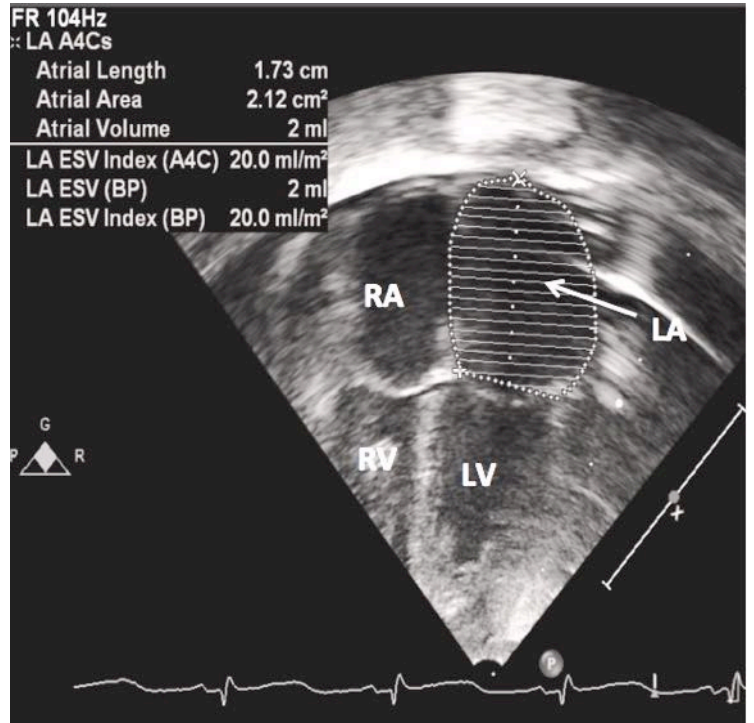


Figure 3. Echocardiographic frames in an apical four chamber view showing mapping of the left atrial (LA) area. While the calculations are not difficult to make (insert to the left upper corner), there are no established normal values for several preterm infant groups. LV, left ventricle, RA, right atrium; RV, right ventricle. The LA is also mapped in apical two-chamber view, but is not shown in the figure.

Left Ventricle

The size of the left ventricle (LV) is recorded in parasternal long- and short-axis views (Figure 4) and LV internal dimension in end-diastole (LVIDd) and systole (LVIDs) are measured. These recordings are made at the tips of the mitral valve to ensure comparison with established norms. Normal values have not been established for some weight categories, and in such cases, visual estimate as in Figure 1 may be helpful.

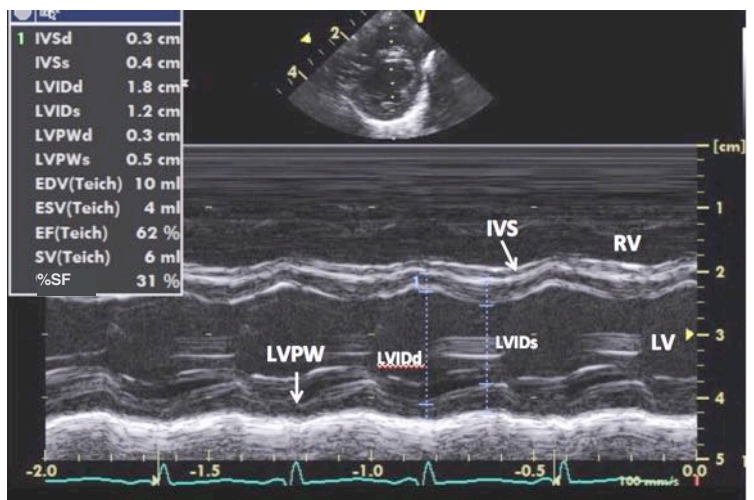


Figure 4. Echocardiographic frames from the parasternal short axis view demonstrating the left ventricular (LV) internal dimension in end-diastole (LVIDd) and systole (LVIDs). These measurements are used to calculate shortening fraction (%SF) as well as other parameters as indicated in the insert. IVS, inter-ventricular septum, LVPW, left ventricular posterior wall, RV, right ventricle.

Left Ventricular Function

In the past, a number of echocardiographic methods have been utilized to evaluate the function of the LV; these were reviewed elsewhere.¹⁴⁻¹⁶ LV shortening fraction using M-mode echo (Figure 4) and Simpson's LV area shortening on 2D echocardiogram (Figure 5) are useful techniques in both the term and preterm neonate.

LV Shortening Fraction. LV shortening fraction (Figure 4) was described in the early 1970s as a useful echo technique to assess LV function.¹⁷ It is a commonly used technique and is useful for rapid estimation of global LV systolic function. It may be derived as follows:

$$SF = [(LVIDd - LVIDs) / LVIDd] \times 100$$

Where SF is shortening fraction, LVIDd is left ventricular internal dimension in end-diastole and LVIDs is left ventricular end-systolic dimension.

The SF is independent of age and heart rate, but is load-dependent. The typical value is $33\% \pm 5\%$. In infants less than 5 days of age, and those with increased right ventricular systolic pressure, flattened interventricular septum may make the shortening fraction less reliable.

LV Area Shortening. Another technique that is valuable in both the full term and premature babies¹⁸ is area shortening of the LV using Simpson's rule (Figure 5); the LV area shortening may be calculated:

$$AS = (LVAd - LVAs) / LVAd$$

Where AS is area shortening, LVAd is LV area in diastole and LVAs is LV area in systole.

This technique of assessment of LV function is helpful, even if flat to paradoxical ventricular septal motion is present or LV dysnergy exists. But, it is also load-dependent. The standard norms are 50% to 60%.

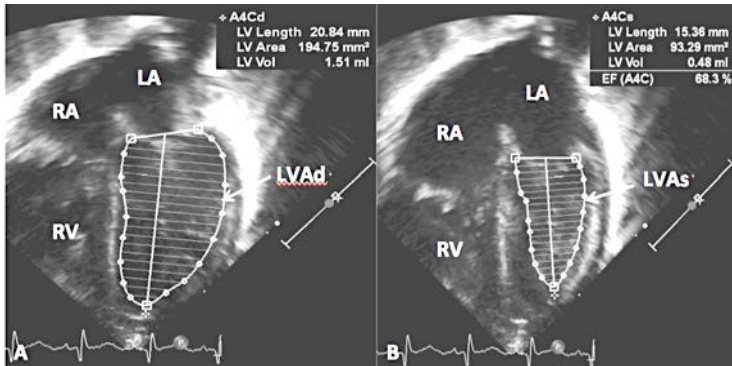


Figure 5. Echocardiographic frames from an apical four-chamber view demonstrating measurement of left ventricular area in diastole (LVAd) and in end-systole (LVAs) respectively in A and B. The area shortening of the LV is calculated using Simpson's rule (B). The LV area shortening is 68% (see insert in B); normal values are above 50%. LA, left atrium; RA, right atrium; RV, right ventricle.

PDA Diameter

Color flow Doppler imaging is a useful technique in identifying the PDA and in determining its size. It is also useful in estimating the degree of ductal shunting. Color Doppler is exceptionally sensitive and may detect even a tiny PDA with color flow image appearing in the main pulmonary artery near the origin of left pulmonary artery. Because the degree of left-to-right shunt across the PDA is mainly

determined by its narrowest diameter, minimal ductal diameter determined by angiography¹⁹ has been used to categorize the sizes of the ductus. But, it has been observed that echocardiographic assessment of angiographic minimal ductal diameter is not precise.²⁰ However, echo is the technique of clinical relevance for the preterm infants. Color flow Doppler imaging of the ductus should be performed in multiple views in order to identify narrowest diameter; the color is deleted (Figure 6) and 2D diameter measured. Both the color flow and 2D diameters are used to measure the ductal size. Illustrations of small (Figure 7), medium (Figure 8) and large (Figure 9) PDAs are shown. The higher the Doppler flow velocity, the lower is the pulmonary artery pressure and smaller is the ductus.

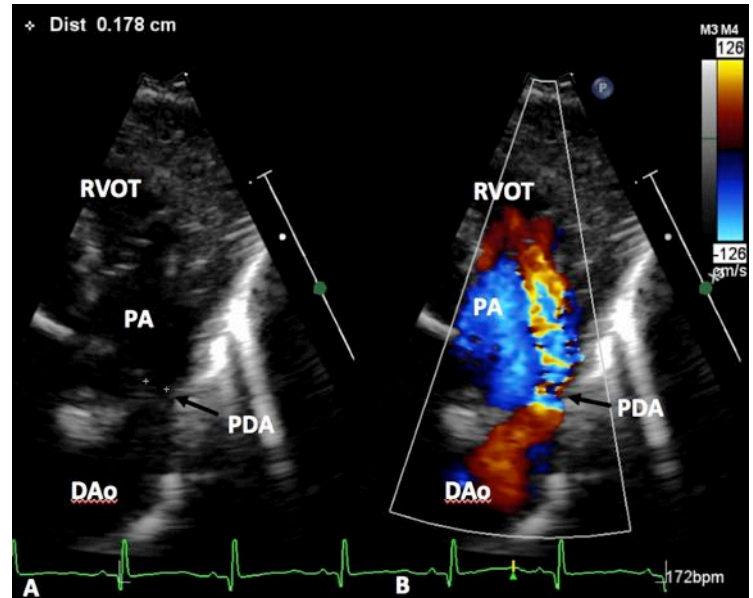


Figure 6. Echocardiographic frames from the parasternal short axis view demonstrating measurement of minimal diameter of the PDA. The color flow signal in B is deleted and 2-dimensional (2D) minimal ductal diameter measured in A. DAo, descending aorta; PA, pulmonary artery; RVOT, right ventricular outflow tract.

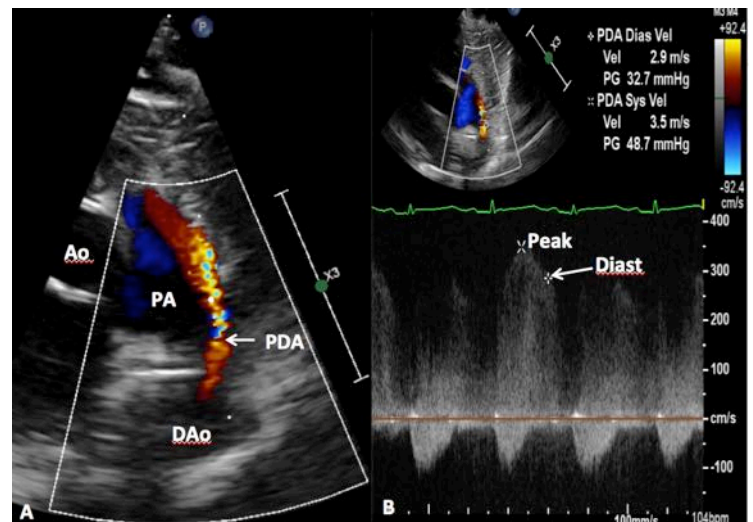


Figure 7. A. Echocardiographic frame from the parasternal short axis view illustrating PDA with left to right shunt. B. Continuous wave Doppler recording across the PDA demonstrates high Doppler velocity suggesting relatively low pulmonary artery pressure. Diastolic (Diast) (arrow) velocity (2.9 m/s) is used to calculate pulmonary artery (PA) diastolic pressure (See the text for further discussion). Ao, aorta, DAo, descending aorta.

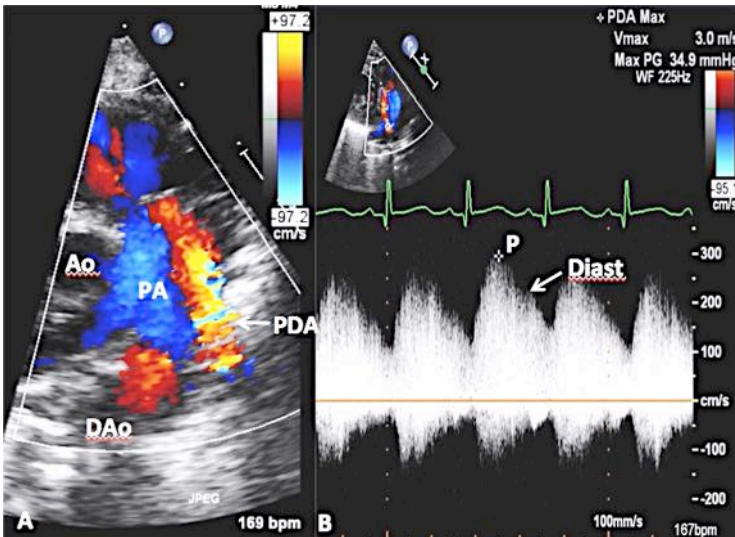


Figure 8. This figure is similar to Figure 7 from a different preterm baby demonstrating a moderate sized PDA. The estimation of pulmonary artery (PA) diastolic (Diast) (arrow) pressure may be made in a manner similar to that shown in Figure 7. The estimated PA pressure is likely to be higher than that shown in Figure 7. Ao, aorta; DAo, descending aorta; P, peak velocity.

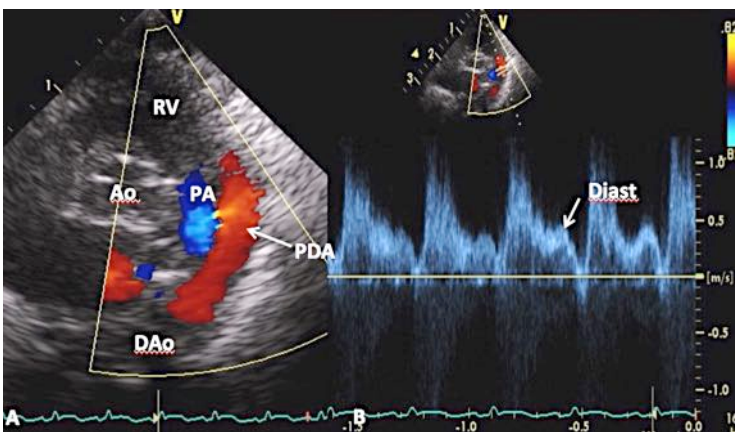


Figure 9. This figure is also similar to Figures 7 and 8 from a different preterm baby showing a large PDA. The estimation of pulmonary artery (PA) diastolic (Diast) (arrow) pressure may be similar to Figures 7 and 8 and is likely to be higher than those in Figures 7 and 8. Note laminar flow across the PDA. This along with low PDA Doppler velocity (< 0.5 m/s) indicates near systemic PA pressures. Ao, aorta; DAo, descending aorta; RV, right ventricle.

Studies in the mid-1990s suggested that narrowest PDA diameter larger than 1.5 mm is seen with a later need for PDA treatment (sensitivity of 81% and a specificity of 85%).^{21,22} In a study published in 2013, a PDA diameter of 1.5 mm or larger was also found to predict development of symptomatic ductus with high sensitivity (91%) and specificity (100%).²³ A more recent study indicated that PDA size ≥ 2 mm and peak-systolic-to-end-diastolic Doppler velocity ratio ≥ 2 on Days 3 and 7 of Life are seen with need for PDA treatment subsequently.²⁴ Because the size of the patient and the extent of maturation differ, the absolute ductal diameter may not, by itself, be a dependable marker of its size. Therefore, normalization of ductal size, for example, mm/Kg or mm/BSA [body surface area] may help establish significance of ductal diameter. A PDA diameter of 1.4 mm/kg was indicative of significant ductus in one study;²⁵ however, the number of babies examined in this paper was small. The ratio of minimal ductal diameter to width of the left pulmonary artery at its origin (PDA:

LPA ratio) was recommended as a method of quantification of the size of the ductus;²⁶ this ratio is < 0.5 in small PDAs, between 0.5 and 1.0 in moderate PDAs and ≥ 1.0 in large PDAs.

Pulmonary Artery Pressure

Echo-Doppler studies are valuable in estimating the pulmonary artery pressures in most infants; these methods were examined in detail elsewhere.²⁷ Doppler jets across tricuspid and pulmonary valve should be recorded in multiple views in all infants; the Doppler jet velocity (V) is used to calculate pressure difference (ΔP) between the cardiac chambers by using a modified Bernoulli equation:

$$\text{Gradient } (\Delta P) = 4V^2$$

Simultaneous measurement of arm systolic blood pressure is useful in assessing the magnitude of elevation of pulmonary artery pressure.

Tricuspid Insufficiency Jet. Physiologic tricuspid insufficiency is present in most babies; this Doppler signal should be recorded in multiple views. The maximum peak velocity should be noted. The right ventricular (RV) outflow tract is examined to exclude pulmonary stenosis. If there is no RV outflow tract obstruction, the RV and pulmonary artery systolic pressures may be assumed to be similar. The peak velocity of the tricuspid regurgitant jet (V) is utilized to estimate pulmonary artery systolic pressure (Figure 10):

$$\text{PAP} = \text{RVP} = 4V^2 + 5 \text{ mmHg}$$

Where PAP is pulmonary artery systolic pressure, RVP is right ventricular systolic pressure and V is regurgitant tricuspid jet velocity. The pressure in the right atrium is assumed to be 5 mmHg. Recording adequate envelope of the tricuspid insufficiency jet is vital to give confidence to this method of PA pressure determination.

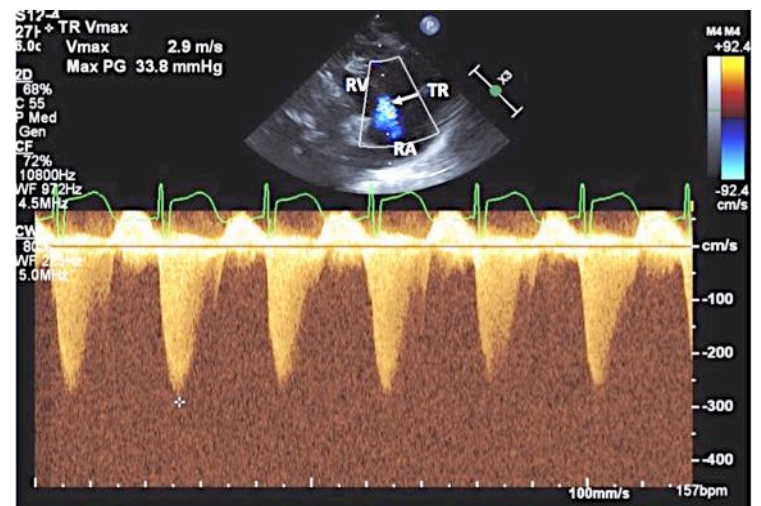


Figure 10. Two-dimensional and color Doppler recording to demonstrate tricuspid regurgitant (TR) jet (top) along with continuous wave Doppler recording of TR jet (bottom) is shown. This is used to calculate the pulmonary artery systolic pressure: peak velocity of 2.9 indicates 34 mmHg gradient (by modified Bernoulli equation) across the tricuspid valve. To this an assumed right atrial (RA) pressure of 5 mmHg is added to calculate the pulmonary artery pressure, assuming that there is no pulmonary outflow tract obstruction (see the text for details). RV, right ventricle.

Pulmonary Insufficiency Jet. Physiologic pulmonary insufficiency jet (Figure 11) may be used to estimate pulmonary artery diastolic pressure:

$$PA \text{ diastolic pressure} = 4V^2 + 5 \text{ mmHg}$$

Where PA is pulmonary artery and V is pulmonary insufficiency jet velocity. Right ventricular end-diastolic pressure is assumed to be 5 mmHg.

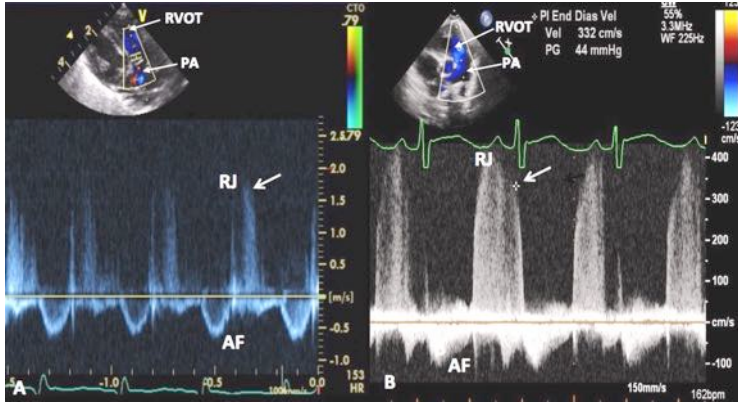


Figure 11. A. Pulse Doppler recording in the parasternal short axis view as shown in the insert at the top demonstrating pulmonary valve regurgitant jet (RJ). This is low (arrow) (1.6 m/s), suggesting low pulmonary artery pressure (See the text for further discussion). B. Continuous wave Doppler recording in the parasternal short axis view as shown in the insert at the top exemplifying high pulmonary valve RJ (arrow) (3.3 m/s). This high velocity indicates high pulmonary artery pressure (See the text for further clarification). AF, antegrade pulmonary flow. PA pulmonary artery, RVOT, right ventricular outflow tract.

Patent Ductus Arteriosus Jet. As mentioned in the preceding section, PDA Doppler velocity should be recorded in multiple views; this helps in assessing the pulmonary artery diastolic pressure (Figures 7, 8 and 9):

$$PA \text{ pressure} = BP - 4V^2$$

Where PA is pulmonary artery, BP is arm blood pressure (or pressure recorded via an indwelling umbilical artery catheter) and V is PDA flow velocity.

If the PDA Doppler velocity is high (Figure 7), the PA pressure is likely to be low; whereas, a low PDA velocity (Figure 9) implies high PA pressure. If the PDA Doppler velocity is mild to moderately elevated the PA pressure is mildly increased (Figure 8).

If no adequate recording of Doppler jets in the right heart could be secured, indirect signs may be used: right atrial and right ventricular dilatation, right ventricular hypertrophy, pulmonary artery dilatation and flattening of the interventricular septum may indicate increased PA pressures, but the degree of elevation may not be predicted. "Spike and dome" appearance of the PA Doppler flow velocity curve and short acceleration time (<100 msec) indicate elevated PA pressure.

Descending Aortic Flow Pattern

The finding of retrograde descending aortic flow in early diastole with continuation into the diastole was noted in babies who had aortic run-off lesions including PDA in early 1980s.³⁰ In one study it was suggested that absent antegrade diastolic or retrograde diastolic flow in the descending aorta in an infant with minimal PDA diameter ≥ 1.5 mm may signify hsPDA.³¹ The pattern of descending aortic diastolic flow may also indicate the amount of left-to-right shunt:²⁶ normal antegrade diastolic flow - ratio of pulmonary to systemic blood flow (Qp:Qs) of 1, absent diastolic flow - Qp:Qs of 1.3, and retrograde diastolic flow - Qp:Qs of 1.7 or greater. Illustrations of normal antegrade (Figure 12) and abnormal retrograde (Figure 13) diastolic flow patterns are shown.

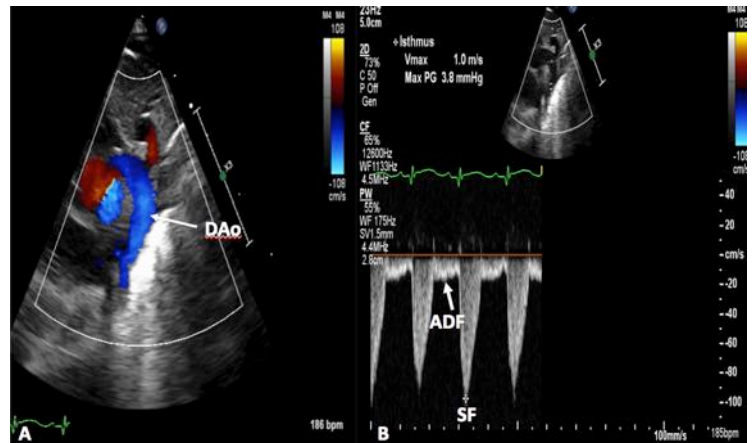


Figure 12. A. Echocardiographic frame from a suprasternal notch view illustrating laminar flow in the descending aorta (DAo) in a premature infant with a small ductus (not shown). B. Continuous wave Doppler recording in the same infant shows normal systolic flow (SF) (*) and normal antegrade diastolic flow (ADF) in the DAo; the diastolic flow is seen below the baseline.

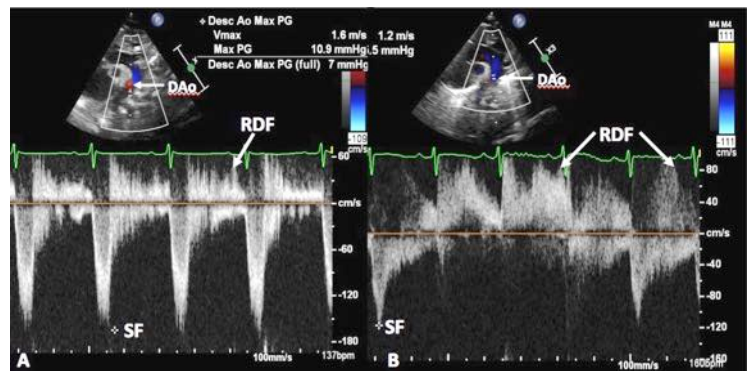


Figure 13. Doppler recordings from a suprasternal notch view demonstrating retrograde diastolic flow (RDF) in the descending aorta (DAo) in two different premature babies (A & B respectively) with large PDA indicating that there is likely to be hemodynamically significant PDA. Systolic flow (SF) (*) suggests no evidence for obstruction.



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Summary of Echo-Doppler Findings of PDA (Table)

The LA, LA:Ao ratio (<1.4:1) and LV are likely to be normal in size in small PDAs, and the LV function is normal. The LA and LV are dilated and LA:Ao ratio is increased (>1.6:1) in large PDAs. In the beginning, the LV function is normal or hyper-dynamic and with time, LV function may deteriorate resulting in increased LV end-diastolic and LA pressures with consequent deterioration of the respiratory status. In moderate PDAs, the values are in the middle with moderate dilatation of LA (LA:Ao ratio of 1.4 to 1.6) and LV. In most, the LV function is preserved.

The minimal ductal diameter is small with high Doppler velocity across it in small PDAs (Figure 7); whereas, the minimal ductal diameter is large with low Doppler velocity across the ductus in large PDAs (Figure 9). These values are in the middle in moderate-sized PDAs (Figure 8). In small PDAs the PA pressures are usually normal while they are likely to be high in large PDAs. While the above assertions are largely correct, the PA pressures also depend upon the degree of pulmonary parenchyma disease. In addition, in very low birth weight infants, the PA pressure may not be elevated parallel to the Pulmonary Parenchymal Disease because of under-developed pulmonary vasculature in the premature.

Finally, normal anterograde descending aortic diastolic flow is seen in small PDAs (Figure 12); whereas, the descending aortic diastolic flow is either retrograde (Figure 13) or no normal anterograde descending aortic diastolic flow is seen in large PDAs.

It should be known that no single parameter reviewed in the preceding paragraphs is correct by itself. A mixture of the above discussed parameters is likely to be useful in quantifying the significance of the ductus. The PDA may be labeled as small when the minimal PDA diameter is ≤ 1.4 mm, LA:Ao ratio $\leq 1.4:1$ and the descending aortic diastolic flow is anterograde, whereas a PDA diameter ≥ 2.0 mm and LA:Ao ratio ≥ 1.6 along with retrograde descending aortic diastolic flow may signify a large or hsPDA. Values in-between indicate moderate PDA (Table).

Table. Echo-Doppler Characteristics of Patent Ductus Arteriosus in the Preterm Infant

Parameter	Small PDA	Moderate PDA*	Large PDA*
Size of the Left Atrium	Normal	Mildly dilated	Moderate to severely dilated
LA:Ao Ratio	$\leq 1.4:1$	1.4 to 1.6	≥ 1.6
Size of the Left Ventricle	Normal	Mildly dilated	Moderate to severely dilated
Systolic Function of the Left Ventricle	Normal	Normal	Normal, hyper-contractile or diminished function
Estimated Pulmonary Artery Pressure	Normal	Mildly elevated	Moderate to severely elevated
Minimal Diameter of the PDA	≤ 1.4 mm	1.4 to 2.0 mm	≥ 2.0 mm
Doppler Velocity across the PDA	High (3.0 to 4.0 m/s)	~ 2.0 m/s	Low (~ 1.0 m/s)
Descending Aortic Doppler Flow Velocity Pattern	Normal anterograde flow (Figure 12)	Normal anterograde flow (Figure 12)	Normal or absent anterograde flow or presence of retrograde flow (Figure 13)

* Likely to be a hemodynamically significant Patent Ductus Arteriosus (hsPDA) if associated with deterioration of respiratory function or fail to wean from respiratory support at a normal rate.

Ao, aorta; LA, left atrium; mm, millimeter; m/s, meters per second; PDA, Patent Ductus Arteriosus; PA, pulmonary artery.

Severity of PDA- Hemodynamically Significant (hsPDA) vs. Non-Significant PDA (PDA)

Hemodynamically significant PDA (hsPDA) has variously been defined.^{4,10,32} The available studies utilized diverse criteria to define hsPDA which makes it hard to compare the outcomes of one study with those of others. Clinical implication of PDA and stratification as hsPDA vs. not significant PDA is usually based on: clinical (presence of bradycardia or apnea, feeding intolerance, oxygenation difficulty, need for respiratory support, systemic hypotension, oliguria with increased plasma creatinine, need for inotropic agent(s) and others), roentgenographic (cardiomegaly and increased pulmonary vascular markings) and echocardiographic (LA size, LA:Ao ratio, left ventricular size and function, minimal ductal diameter, Doppler flow characteristics across the ductus, and flow pattern in the descending aorta) features.^{12,32}

A medium to large-sized ductus as defined in the table in preterm babies who deteriorate in their clinical status, needing more intense ventilatory management and requiring more frequent diuretic administration, or babies who fail to progress in efforts to wean off respiratory support may be considered to have hsPDA.⁸

Investigations attempting to characterize hsPDA will be reviewed. Babies weighing less than 1,500g needing mechanical ventilation in the first 30 hours of life and a PDA diameter of 1.5 mm or more have a high probability of requiring future management for PDA; the sensitivity was 83% with a specificity of 90%.²² In a more recent, but retrospective study of 29 infants less than 29 weeks gestation indicated that infants with a minimal ductal diameter more than 1.5 mm between 6-48 hours of life are likely to become hsPDA; this was with a sensitivity of 91% and a specificity of 100%.²³ Babies with LA:Ao ratio greater than 1.5

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on echocardiography after first Day of Life are likely to exhibit hsPDA later, with 88% sensitivity and 95% specificity.^{10,11} Retrograde diastolic descending aortic flow or absence of antegrade diastolic flow may suggest hsPDA when associated minimal ductal diameter is ≥ 1.5 mm.²⁸ The serum brain natriuretic peptide (BNP) levels also seem to be helpful in predicting hsPDA; BNP above 70 pg/mL imply hsPDA with a high sensitivity (92.9%) and a modest specificity (73.3%).³³ The BNP levels return to normal after successful treatment.³³ Finally, low perfusion index (PI) with reduced perfusion to lower extremities secondary to large left-to-right shunt across the PDA may identify hsPDA.³⁴

Summary and Conclusions

The ductus arteriosus is a muscular structure that connects the main pulmonary artery with the descending thoracic aorta. In the fetal circulation the ductus diverts less oxygenated blood from the pulmonary artery into the descending aorta, umbilical arteries and placenta for oxygenation. The ductus closes spontaneously shortly after birth, but persistence patency beyond 72 hours after birth is defined as a PDA. The ductal patency is more frequent in the preterm than in the term babies; the lower the gestational age, the higher the incidence. The PDA causes left-to-right shunt, mainly proportional to the minimal ductal diameter. Such a shunt may cause pulmonary and cardiac compromise. While clinical features, chest roentgenogram and serum BNP levels may help identify a PDA, hemodynamically significant PDAs may be best detected and quantitated by echo-Doppler studies. The size of the LA, LA:Ao ratio, the diameter of the LV, estimated pulmonary artery pressures, minimal ductal diameter, Doppler flow velocity across the PDA and descending aortic Doppler flow pattern help us to identify the size of the PDA (Table). When a medium to large PDA is present along with respiratory compromise, a hemodynamically significant PDAs may be diagnosed.

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NICU Staff Education in Providing Psychosocial Support for Parents of Babies in the Neonatal Intensive Care Unit

By Sue Hall, MD

Members of the NPA write a regular column in *Neonatology Today*.



Neonatology has a history of increasing success in saving the lives of babies born ill or premature. Much research, new technologies, and the dedication of countless healthcare professionals have made it possible for more babies born at very early gestational ages to survive with fewer physical and mental disabilities. For several decades we have been aware

of the critical role families play in supporting the physiological and emotional wellbeing of their babies in the Neonatal Intensive Care Unit (NICU). The Family-Centered Care model has been accepted by hospitals and healthcare organizations as a proven way to improve care for patients of all ages and has been adapted to the NICU as the Family-Centered Developmental Care model and, more recently, the Family Integrated Care model. While the philosophy of this model of care is readily acknowledged as being beneficial to babies and families, the actual practice of it in many NICUs falls far behind the goals it espouses. One reason for this discrepancy between beliefs and practice may be that NICU staff are not taught the specific skills needed to effectively support families.

The National Perinatal Association (www.nationalperinatal.org) has joined with Patient + Family Care (www.patientfamilycare.com) and The Premie Parent Alliance (www.preemieparentalliance.org) to offer a solution to help NICU staff implement comprehensive family support. These three organizations have collaborated to produce a 7-module online NICU staff education course called "Caring for Babies and their Families: Providing Psychosocial Support in the NICU." The goal of this course is to provide support, through provision of both knowledge and skill development, to NICU staff so that they are more attuned and more confident in their interactions with parents under stress. Another goal is to provide staff with a model for coaching and mentoring parents, and involving them in the care of their babies using a collaborative team-based approach. These skills are increasingly important as NICUs move to embrace the family-integrated care model, which calls upon parents to spend more time and to be more involved with their baby at the bedside. Some staff are inadequately prepared to cope with the new demands of providing this model of care. The ultimate goal, of course, is to improve outcomes of both babies and families.

NICU parents desire and benefit from psychosocial support from staff,¹ yet many neonatologists and neonatal nurses do not feel they have adequate communication skills to provide this, particularly when having conversations around resuscitation at the edge of viability, transitioning

to palliative care, and delivering bad news.² Parents indicate that communication with the NICU medical team colors their view of their NICU experience regardless of the level or quality of medical care their baby received.³ With the well-documented increased risks that NICU parents face for postpartum depression and post-traumatic stress disorder,⁴ supporting parents through what for some is a traumatic experience is key to mitigating long-term adverse consequences for both them and their babies.⁵

The course content is based on the "Recommendations for Psychosocial Support of NICU Parents" published in December, 2015,⁶ as well as "The Neonatal Intensive Parenting Unit (NIPU): An Introduction."⁷ The seven modules, which are available for continuing education credits, are clinically relevant, evidence-based, story-driven, trauma-informed, resource-rich, and family-centered, and include the following topics:

- Communication Skills
- Emotional Support of NICU Parents
- Peer-to-Peer Support
- Family-Centered Developmental Care
- Palliative and Bereavement Care
- Discharge Planning and Follow-Up Support
- Caring for the Caregiver (Staff Support)

The three organizations that collaborated to create this educational course recognized the value that input from graduate NICU parents could have, as it would reflect both parents' needs and experiences. Including the "parent voice" was deemed essential, and this interprofessional collaboration with parents can be considered a new paradigm in the education of NICU professionals, both physicians and nurses. To reach this standard, 15 graduate NICU parents were recruited and several were assigned to each of the seven content modules. An online survey about parents' experiences in the NICU received 128 responses.

The graduate parents—"experts by experience"—helped to:

- 1) select quotes to use from the parent survey,
- 2) author trauma-informed care scripts for caregiver interactions with parents,
- 3) produce audio clips of their experiences,
- 4) review content written by the professionals, and
- 5) supply resources to support course content.
- 6) A graduate parent will also be a moderator, along with a NICU professional, of the online *Discussion Forum* that is an integral part of the course.

The goal is for entire NICU staffs to take this course, so as to simultaneously develop a deeper and more personalized awareness of parents' emotional needs, and gain skills for addressing them. This shift in the culture of the NICU can be undertaken as a quality improvement initiative, as individual NICUs focus on identifying the areas in which they can collectively improve parents' experiences, as well as their satisfaction with these experiences.⁸

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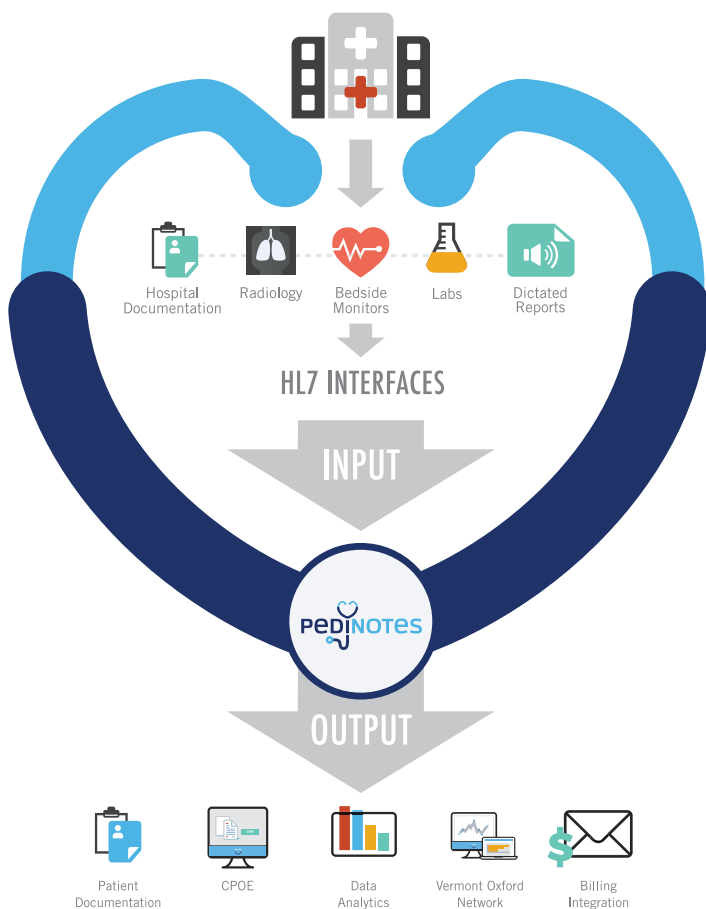


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“For several decades we have been aware of the critical role families play in supporting the physiological and emotional wellbeing of their babies in the NICU. The Family-Centered Care model has been accepted by hospitals and healthcare organizations as a proven way to improve care for patients of all ages and has been adapted to the NICU as the Family-Centered Developmental Care model and, more recently, the Family Integrated Care model.”

An added feature is that the course can be customized for individual NICUs, so as to include information, policies, and procedures that are specifically relevant for that NICU. Therefore, it can serve as a way to bring staff up-to-date with any changes in practice being implemented by that NICU.

Research on the course’s potential to change staff awareness and sensitivity of NICU parental distress, and to increase confidence in their own skill levels to meet parents’ emotional needs for support, is currently being conducted.

The course is now available online at www.mynicunetwork.com. If you are interested in helping your NICU staff become better equipped to support parents in the NICU, please contact neonatologist Sue Hall, MD at: suehallmd@gmail.com for further information about this exciting educational opportunity.

Disclosure: The NICU Staff Education Course, “Caring for Babies and their Families,” is receiving commercial support from Medela (www.medela.us). Dr. Hall has a consulting agreement with The Wellness Network (<https://www.thewellnessnetwork.net>).

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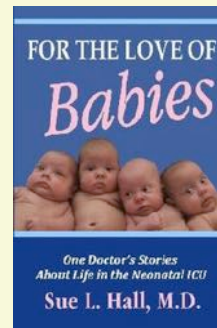
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About the Author

Dr. Sue Hall has a been a doctor specializing in Neonatology (Newborn Intensive Care) for nearly twenty-five years. Before becoming a physician, she was a practicing social worker. As she works to improve the health and well-being of the babies under her care, she offers support to their families, bringing her singular insight into their circumstances and their challenges. Every family hopes to bring a healthy baby home from the hospital. That is Dr. Hall's wish for every family also. She's been helping to make it happen throughout her career.

Dr. Hall has chronicled some of her experiences with babies and families in crisis in her debut book, FOR THE LOVE OF BABIES: One Doctor's Stories About Life in the Neonatal ICU, published June, 2011 by WorldMaker Media.



The book is available on Amazon.



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Honoring Changemakers at 'Tinis for Premies

By Christa Terry

Graham's Foundation honored Heidelise Als, PhD, and Liza Gene Cooper, LMSW, at their recent 'Tinis for Premies gala in New York City. Each year Graham's Foundation honors those who make a significant contribution to the NICU community and to improving outcomes of premature infants at this signature fundraiser benefitting the organization.

Both honorees were presented with a special award - a painting by Reece Hall, daughter of Graham's Foundation founders Nick and Jenn Hall and the surviving twin of the organization's namesake Graham.



Left-to-right (back row): Joan Rice, Kathleen McLane, Maria Messina, Janet Roth, (front row): Bill McLane, Jude McLane and Xena Ugrinsky.



Dr. Heidelise Als, Harvard-Medical School and Boston Childrens Hospital, 2017 Miracle Award Honoree.

MIRACLES Award Honoree Dr. Als -- founder of NIDCAP (Newborn Individualized Developmental Care and Assessment Program) and Professor of Psychology at Harvard Medical School and of Boston Children's Hospital -- was chosen because she champions innovation and change in the development of individualized best care practices and tirelessly advocates for comprehensive services and education for newborns, infants and young children with disabilities and for their families.

At the event, she spoke of the challenges faced by many parents as premature birth rates steadily increase around the world. She noted that more than 50% of children born preterm show learning disabilities' attention deficits, behavior problems, emotional issues, and school failure.

HOPE Award Honoree Cooper has been supporting families of premature babies and infants born with birth defects in the Newborn Intensive Care Unit for two decades. Today, she provides leadership for Youth and Family Partnership programs, including the Family and Youth Advisory Councils and the Senior Family



2017 Hope Award Honoree Liza Gene Cooper, LMSW.

Advisor program, as well as Child and Family Education as a member of the Sala Institute for Child and Family-Centered Care at the Hassenfeld Children's Hospital at NYU Langone Health.

In 2001, she joined the March of Dimes National Office where she created and led the national NICU Family Support program, an initiative that during her tenure brought information and comfort to 300,000 families through NICUs in every state in the U.S.

Prior to the award ceremony, guests at the gala savored Asian-inspired foods and drinks at the beautiful Glasshouses overlooking the NYC skyline. A live auction provided entertainment in between speaker presentations, and included items like: Gary Komarin Cake Art, Alan Spitzer original artwork, Colorado and Costa Rica getaways, and a foursome at the Bayonne Golf Club. But the star of the auction was the organization's newly redesigned care packages -- which inspired some bidders to give \$1,000 or more! Tito's handmade

Vodka matched every dollar up to \$2,000.

All told, the event brought in so much support of Graham's Foundation's mission and helped forge new connections between influencers in the Neonatology world.

"These signature events are more than just fundraisers," said Graham's Foundation President Nick Hall. "While attracting support for the mission is obviously a primary goal of our 'Tinis for Premies' series, these special evenings also represent an opportunity for those whose lives have been touched by premature birth to connect with one another and to give back."

'Tinis for Premies' was powered by Pampers with additional support from Medolac, Mead Johnson Nutrition, Dana Wechsler Linden and Larry Linden, Xena Ugrinsky and Kathleen McLane, Alira Health, Mia Wechsler Doron and Mednax. Additional support was provided by Dawn Melanie Designs, Neonatology Today, The Glasshouses, Thomas Preti Caterers,

ticket purchasers, auction item donors, and major individual and corporate sponsors.

Graham's Foundation empowers parents of premature babies through support, advocacy and research to improve outcomes for their preemies and themselves.

Learn more about Graham's Foundation at www.grahamsfoundation.org.

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Synopsis of the 8th Phoenix Fetal Cardiology Symposium

By Christopher L. Lindblade, MD

The 8th Phoenix Fetal Cardiology Symposium was one for the record books. Nearly 260 physicians, sonographers, nurses, genetic counselors, and trainees attended the Symposium October 27th-31st, 2017 at the luxury boutique Camby Hotel in Phoenix, Arizona. The Phoenix weather was perfect for the poolside Welcome Reception, and for the attendees to enjoy themselves during their time in Arizona.

On October 27th, over 70 people attended the two pre-conference tracks. Diane Spicer and Norman Silverman presented exquisite cardiac specimens demonstrating the anatomic details of a wide variety of Congenital Heart Defects (CHD). A second pre-conference course on Preparation for the ARDMS Fetal Echocardiography Certification Exam provided a solid foundation for those preparing for the exam. Those who attended this course also received a thumb drive with a bank of over 200 sample test questions written by the faculty and echo images of pertinent cardiac findings. This thumb drive is still available for purchase for \$25. Contact the organizers at fetalcardio@phoenixchildrens.com, if you are interested in purchasing one!

The General Session started early October 28th after Dan Ostlie, Surgeon-in-Chief at Phoenix Children's Hospital, welcomed the attendees to the Symposium. The faculty with world-renowned expertise in Fetal Cardiology, Maternal-Fetal Medicine, Pathology, Radiology, and Surgery presented a wide range of fetal cardiology topics. Lectures on structural Fetal Cardiac Disease, such as abnormalities of the conus, venous anomalies, isomerism, and tricuspid valve abnormalities discussed the embryology, evaluation, and outcomes of these lesions. The assessment and innovative treatment of both tachy- and bradyarrhythmias was presented, spurring a great discussion with the faculty and attendees. Several individuals took advantage of attending the General Session remotely, including Professor Maria Respondek-Liberska and her colleagues in Poland.

There was a 1 ½ day focus on the State of the Art of Fetal Therapy and the Cardiovascular Implications of Cardiac and Non-Cardiac Intervention. Exquisite ultrasound and MRI images showed cardiac and non-cardiac lesions, laying the foundation for evaluation of the fetal candidate for therapeutic intervention.



Two hundred-sixty physicians, sonographers, nurses, and genetic counselors attended the Symposium over 5 days.



The 2017 Symposium Co-directors were (left-to-right): Norman Silverman, Julia Soloman, Christopher Lindblade, and Anita Moon-Grady.

Experts in the field of fetal intervention shared their experience treating Twin-Twin Transfusion Syndrome, diaphragmatic hernia, neural tube defects, aortic stenosis, and restrictive atrial septal physiology.

The Fetal Heart Society had their inaugural in-person meeting for members and those interested in membership during the Symposium. Current research studies and future studies for potential multi-site enrollment were presented. For more information about Fetal Heart Society membership and these studies, please go to fetalheartsociety.org.

Selected scientific abstract presentations provided trainees with the opportunity to share their research and discuss their

“There was a 1 ½ day focus on the State of the Art of Fetal Therapy and the Cardiovascular Implications of Cardiac and Non-Cardiac Intervention.”



Nurse coordinators from fetal cardiology programs across North America shared their insight and expertise during the break out session.



Attendees were given the opportunity to scan live patients with cardiac and extra-cardiac pathology alongside the faculty during the Symposium.

findings with faculty and other attendees. The accepted abstracts will be published in the journal *Pediatric Cardiology* in early 2018! Additionally, after a selection process by the organizing committee, several fun, interactive fetal cardiac case presentations, in the session called “The Case that Gave Me Chest Pain”, demonstrated the rare lesions that challenge even the astute diagnostician.

On October 29th, the fetal cardiology nurse coordinators from institutions across North America presented on a wide array of topics focused on care coordination. They shared

innovative ideas during this breakout session, and are ready to apply them back to their own practice. Dr. Mary Donofrio, President of the Fetal Heart Society, welcomed the nurse coordinators to join the Fetal Heart Society as they play such a valuable role in the care of the fetal cardiac family. All who attended this breakout session left energized and focused on future organizational structure for this passionate group.

To summarize, the Phoenix Fetal Cardiology Symposium continues to play an important role in the advancement and education of

fetal cardiac disease. It is a unique experience to gather so many leaders in the field to share their experience and ideas for future development to improve the care of the fetus with abnormal cardiac physiology.

“Phoenix Fetal Cardiology Symposium continues to play an important role in the advancement and education of fetal cardiac disease. It [The Phoenix Fetal Cardiology Symposium] is a unique experience to gather so many leaders in the field to share their experience and ideas for future development to improve the care of the fetus with abnormal cardiac physiology.”

The organizers are already planning for the 9th Phoenix Fetal Cardiology Symposium, November 2nd-6th, 2018 in Phoenix, Arizona. For more information about this year’s faculty and lectures, and to learn more about next year’s Symposium, please go to: www.fetalcardio.com. We hope to see you in 2018!

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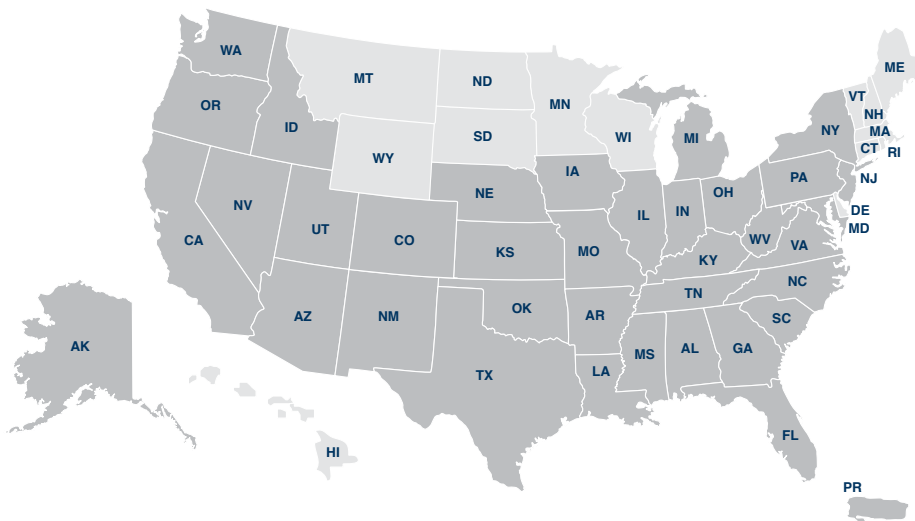
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Take on leadership roles, driving patient safety and quality improvement initiatives.

Gain peace of mind knowing that new graduates receive ongoing mentorship and guidance needed to thrive personally and professionally.

Isn't It Time for a Little Kangaroo in Your NICU?

Michael Narvey, MD

Originally Published on:

All Things Neonatal

<http://www.allthingsneonatal.com>

May 11, 2017; Republished here with permission.



Aside from me donning the costume in the above picture for the Kangaroo Challenge 2017, I learned something new today. Before I get into what I learned, let me say that I had the opportunity to put so many smiles on parents faces by walking around in this full body costume that I am grateful to Diane for finding this costume and Sue (you both know who you are) for purchasing it. Handing out cookies to the parents and children at the bedside, and seeing them smile, while knowing that they were under significant stress, gave me the opportunity to interact with parents in a very different way than I am accustomed to as a Neonatologist. I am so thankful to have had that experience, and yes, if called upon I will do it again!

We Even Made the Local News! CTV Newscast

I posted the above picture on my Facebook page, and to my surprise many of the comments led me to believe that Kangaroo Care is still something that needs a little nudging to get the word out. I found this actually quite surprising, given how immersed we are in Winnipeg with this strategy. When I think about new interventions in Neonatology, it is synonymous in virtually all cases with an influx of dollars to achieve and usher in the new program.

Here is a program that is virtually free, but only requires a commitment from families to spend the time at the bedside with their baby in the Neonatal Intensive Care Unit (NICU).

I have been asked by many of my nursing colleagues to write something about Kangaroo Care on this site [All Things Neonatal], and so, here it is...

What is it?

You have likely heard of Kangaroo Care and you may have even seen some children receiving it in your hospital. Why is this so important?

Kangaroo Care (KC) or Skin-to-Skin Care (STS) is an ideal method of involving parents in the care of their premature infant. It fosters bonding between parents and their hospitalized infant, encourages the family to be with their child, and thereby, exposes them to other elements of neonatal care that they can take part in. While we know that many units are practising Kangaroo Care, there is a big difference between having KC in your unit, and doing everything you can to maximize the opportunity that your families have to participate.

There is much more to KC than simply holding a baby against your chest. For a demonstration of KC, please watch the accompanying video (link below) and show it to any one in your units that may need a visual demonstration. This excellent video is from Nationwide Children's Hospital, and walks you through all of the important steps to get it right and maximize benefit.

https://www.youtube.com/watch?v=_MateX87u9k

Before you reach the conclusion that KC only serves to enhance the parental experience, it does so much more than that. The practice began in Bogota, Columbia in 1979 in order to deal with a shortage of incubators and associated rampant hospital infections.

The results of their intervention were dramatic, and lead to the spread of this strategy worldwide. The person credited with helping to spread the word and establish KC as a standard of care in many NICUs is Nils Bergman, and his story and commentary can be found here <http://bit.ly/1cqIXlm>.

The effects of KC are dramatic and effective in reducing many important morbidities, and conclusively, has led to a reduction in death, arguably the most important outcome. An analysis of effect has been the subject of several Cochrane Collaboration reviews, with the most recent one being found here.

To summarize, though, the use of KC or STS care has resulted in the following overall benefits to premature infants at discharge or 40 – 41 weeks' postmenstrual age:

Reduction in:

- **Mortality** (typical RR 0.68, 95% CI 0.48 to 0.96)
- **Nosocomial Infection/Sepsis** (typical RR 0.57, 95% CI 0.40 to 0.80)
- **Hypothermia** (typical RR 0.23, 95% CI 0.10 to 0.55)

And Increase in:

KMC was found to increase some measures of infant growth, breastfeeding, and mother-infant attachment.

Join us for St. Boniface Hospital First Annual
KANGAROO-A-THON

April 13 – 27th, 2015

Kangaroo care or skin to skin is known to be extremely important in the growth and development of babies particularly, preterm babies. Did you know that while it is good for babies, it is also crucial for the health and wellbeing of the parents?

The NICU at Sunnybrook has challenged other NICUs across Canada to compete in this competition. We are very interested to see how much time we hold our babies skin to skin. Please join us in this exciting challenge!!

We would encourage you at anytime to hold your baby skin to skin as long and as often as you are able but especially during these 2 focus weeks. If your baby's condition prevents him or her from coming to you, you can hold your baby by hand hugging. The staff will be happy to assist you in which ever method is best for your baby.

When you hold your baby, we will post a kangaroo to mark the occasion. This kangaroo should be hung at your baby's bedside. You will have the opportunity to win a beautiful gift basket. Ask your bedside nurse to mark each time you take your baby out for a hold or hold using modified kangarooing on your kangaroo record.

Happy Holding!



To put this in perspective, medicine is littered with great medications that never achieved such impact as simply putting your child against your chest. This is another shining example of doing more with less. This is not to say that modern medicine and technology does not have its place in the NICU, but KC is simply too

powerful a strategy not to use and promote routinely in the NICU.

Please join me in championing this wonderful technique and make a difference to all of our babies!

“Please join me in championing this wonderful technique and make a difference to all of our babies!”

A sample of our parent letter to promote KC. You can also download this letter in a Word .doc file at the following link:
(<http://www.allthingsneonatal.com/wp-content/uploads/2015/04/parent-letter-ii.docx>)

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Real-time Reporting with Twitter - Social and Mobile Media in Neonatology

By Clara Song, MD

“Social & Mobile Media for the Neonatologist” by Dr. Song, is a periodic column in *Neonatology Today*. Dr. Song created and moderates the social media outlets for the American Academy of Pediatrics, Section on Neonatal-Perinatal Pediatrics, as well as the NICU at the Children’s Hospital at OU Medical Center. She holds workshops and speaks regionally and nationally on the topic of social communication for the healthcare professional, including: the AAP Perinatal Section Spring meeting, yearly, and the 2011 *NEO: The Conference for Neonatology*.

Everyday at this moment, millions of new stories are being reported by millions of people on the web around the world. Many of the stories on your social media accounts are fleeting bits of small talk; whereas, others, are incredibly informative. The running, ever-changing daily feed has become the main source of daily news for some people. I must admit, I am among those who have substituted Twitter for the nightly TV news because of the instantaneous gratification it supplies. And why Twitter? As I said, the information it delivers depends on the tweeter, so often it is instant, in real-time and from a first-person, ground-level view. Twitter can also be tailored to deliver the news that I specifically want to hear. I can get breaking global news, briefs from the White House, as well as updates from colleagues in my field. Since not everyone can be everywhere at once, Twitter, in particular, has the unique setup that allows any user to become an instant reporter, with the world as its audience.

Sharing information on Twitter for me is like a new way of note-taking. I have the privilege of being a part of some awesome committees. This involves attending conferences and hearing many great speakers. I am able to summarize key points and organize them with tags on my Twitter feed. At the same time, any and all followers in the Twitters-verse can benefit from my attendance. I understand now that what I tweet matters and is being read. As such, I feel a responsibility to



Sample Tweets from the AAP Meeting

report accurately. This keeps my note-tweeting accountable to myself and my fellow learners. Not only do I have a real-time account of key points with hashtags, but I now have a retrievable record of events. In the end, I believe this can only be helpful sharing knowledge.

So, how do we start? First, we get on our social media platform of choice. As you can probably already tell, I like Twitter, but it's not intuitive to many. There is quite a bit of noise to cut through, but once you are through, there can be much to gain. It is much like looking for the true events amid all the false alarms and noise on the cardiopulmonary monitoring in the Neonatal Intensive Care Unit (NICU). Next, decide when and from where you will report. Distinct and specific events are easier as initial targets. How will you locate your posts or tweets for future reference? Tag them. Organizing each and every post, note and tweet with hashtags will prevent confusion for you and your followers. It will also guide all followers of that subject to tag their post as well. For example, the

American Academy of Pediatrics National Convention & Exhibition occurred this past September in Chicago. The Section on Neonatal-Perinatal Medicine held a 3-day

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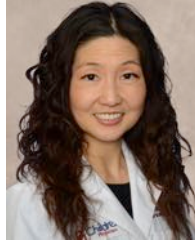
program with joint sessions with pediatric pulmonary specialists, pediatric nephrologists, and pediatric surgeons. Under our official Twitter handle @AAPneonatal, as well as my own @songMD, I was able to tweet highlights of the entire program, organized by the hashtags #SONPM17 and #AAP17. (I further fanned the tweets out to LinkedIn and Instagram, but we can leave that discussion for another time.) Other program attendees tweeted from their Twitter handles, and tagged their tweets with #SONPM17. This way when searching for our conference program hashtag, all pertinent tweets appear using #SONPM17. This results in multiple reports from several points of views from the ground at the scene, in real-time. On the flip side, when I am the one at home, who is following on Twitter, I appreciate the benefit of others' sharing without added cost of travel and time from work.

A movement called #FOAMed or Free Open Access Medical Education is well underway. It encompasses any and all resources to augment current medical education and training, including discussions, lectures, journal clubs and real-time conference reporting on web platforms. The one objective of #FOAMed is "to make the world a better place." Do

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you know who is behind the movement? It is people like you and me. You are an expert in our field of medicine. You can contribute to #FOAMed as well as benefit. No joke, I literally just tweeted, #LearningEveryday.

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