

NEONATOLOGY TODAY

News and Information for BC/BE Neonatologists and Perinatologists

Volume 4 / Issue 8

August 2009

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NEONATOLOGY TODAY

Editorial and Subscription Offices
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Westerly, RI 02891 USA

www.NeonatologyToday.net

Neonatology Today (NT) is a monthly newsletter for BC/BE neonatologists and perinatologists that provides timely news and information regarding the care of newborns and the diagnosis and treatment of premature and/or sick infants.

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Recruitment Ads: Pages 2 and 11

Fetal Echocardiography I

By Gurur Biliciler-Denktaş, MD, FACC, FAAP

This is the first in a series of two articles. The second article, "Fetal Echocardiography II" is written by Monisha Gupta-Malhotra, MBBS of the University of Texas Houston Medical School & Children's Memorial Hermann Hospital, Houston, Texas, and will be published in the September issue of Neonatology Today.

Prenatal diagnosis of congenital heart disease is a very important subject for both the obstetrician and neonatal specialists for optimal care to be given to the mother, fetus and the newborn baby. With advances in ultrasound technology, fetal echocardiogram has proved to be a very important diagnostic imaging test to evaluate the structural or functional abnormalities of the fetal heart. In addition, fetal cardiac intervention is becoming a field of interest for some specific lesions like semilunar valve stenosis. In taking care of a fetus with congenital or functional heart disease, obstetricians, pediatric cardiologists and neonatologists work together for optimal outcome for the mother, fetus and the newborn baby.

Congenital heart disease affects 6-8 per 1000 live births, at least half of which should be detectable before birth. If the fetuses are screened for cardiac malformations according to the traditional high-risk groups, only about 20% of babies with heart disease would be identified.² In today's advanced era of imaging, fetal heart must be examined on all obstetric ultrasounds. The imaging of a four-chamber heart, outflow tracts with great vessel crossing, and arches, along with cardiac function and rhythm, should be routinely done on an OB ultrasound. Even the smallest suspicion should direct the patient to a center with

pediatric cardiologists specialized in fetal cardiac scanning and diagnosis.

Indications

Fetal and maternal factors and OB ultrasound findings are used to define high-risk populations for referring a fetus for detailed cardiac scanning.^{3,4}

1. **Fetal factors:** Chromosomal abnormalities, extracardiac defects (e.g. Omphalocele, diaphragmatic hernia, duodoneal atresia, tracheoesophageal fistula, abnormal visceral situs, 2 vessel cord, hydrocephalus, microcephalus, hydronephrosis, hydrops), multiple fetal pregnancy, fetal cardiac arrhythmia.
2. **Maternal factors:** Family or maternal history of CHD, familial inherited disorders (Marfan, Noonan's etc) diabetes mellitus, autoimmune disease (SLE, Sjogren's) phenylketonuria; decline of invasive prenatal diagnosis in advanced maternal age, abnormal triple screen.
3. **Exposure to Teratogens:** Drugs (warfarin, retinoic acid, lithium, anticonvulsants, alcohol, prostaglandin synthetase inhibitors); infections (rubella, parvovirus, coxsackie virus); high doses of ionizing radiation.
4. **Ultrasound findings:** Increased nuchal fold, suspicious OB scan, echogenic foci.

The likelihood of detecting a fetal cardiac defect is closely related to the experience of the ultrasonographer, the timing of the examination and the equipment used.³

Timing of Examination

Though fetal heart images can be obtained as early as 15 weeks by transabdominal scanning, the optimal timing for a fetal cardiac evaluation is between 18-22 weeks gestation.⁴

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Equipment

Fetal ultrasound transducers must be in the range of 5-3 MHz transmitted frequency and may be sector or linear array.¹ With wider near-field view, curvilinear probes may be more helpful.⁴ In addition to detailed two-dimensional imaging, M-Mode, Doppler, color-flow Doppler and image enlarging should be used during fetal cardiac scanning.¹

Examination

An uncomplicated, complete fetal cardiac exam can be performed in 30-60 minutes. The scan should include but not be limited to the examination of:¹

- Biparietal diameter for estimation of gestational age
- fetal lie and position
- fetal visceral situs
- cardiac position
- four-chamber anatomy
- great vessels and their relationships
- atrioventricular and semilunar valves
- aortic and ductal arches
- shunting at foramen ovale and ductus
- systemic and pulmonary veins
- cardiac chamber dimensions /cardio-thoracic index
- wall thicknesses
- valve/vessel dimensions
- fetal heart rate and rhythm
- umbilical cord
- pericardial and extracardiac spaces for fluid accumulation

In addition to 2D images from four chamber view, five chamber view, long axis views (from LV and RV outflow tracts), short axis view/sweep (3 vessel view), caval long axis view, ductal arch and aortic arch views along with systematic Doppler examination of atrioventricular and semilunar valves, systemic and pulmonary veins, ductus venosus, foramen ovale, ductus arteriosus, aortic arch, and umbilical vessels should be a part of a routine fetal cardiac examination.⁴

Although it is often not very easy to follow a sequence of scanning secondary to fetal (e.g. fetal lie) and maternal (e.g. obesity, previous intraabdominal surgery) factors, every effort should be made to evaluate the fetal heart according to the above recom-

mendations in which order they may be best obtained.

In an OB fetal ultrasound at least a four chamber heart along with five chamber view, outflow tracts with crossing over of the great vessels, and aortic and ductal arches should be visualized. The three-vessel view will also be an added asset in determination of fetal cardiac abnormalities. In this way, most of the cardiac abnormalities will be seen or suspected to have the patient evaluated in detail by a fetal echocardiographer.

A fetal cardiac scan should start with the number of fetuses and how they are positioned in the uterus. Cardiac position and visceral situs (PIC 1) should be determined before beginning a detailed scanning. Differentiating the fetal right side from the left may be challenging in some cases, especially for non-ob scanners. Cordes et al have proposed a simple way of determination of fetal right and left sides.⁵ During initial orientation, the fetal head is placed to the right side of the screen. From this sagittal plane, the transducer is rotated 90 de-

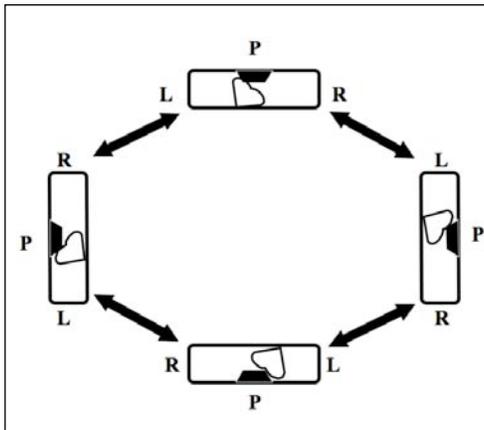


Figure 1. P: Posterior; L: Left; R: Right.

grees clockwise to get the fetus in transverse image. In this image, the fetus will always be visualized from caudal to cranial. Depending on the fetal lie (face up/down, left side/right side down), the fetal side can then be determined with a simple technique. If the left hand is assumed as the letter L with the tips of fingers pointing towards the sternum and the palm is placed on the spine, wherever the thumb is directed to will be the left side (letter L) of the fetus. Once the cardiac position and visceral situs is determined, then one can move to further delineation of anatomy (Figure 1).

Four-chamber view (PIC 2) of the heart is the most widely recognized view by the non-fetal echocardiographer. It is usually easy to get and gives the operator an idea about the chambers (atria and ventricles) with respect to their size and function, atrial and ventricu-



PIC 1: Stomach and aorta seen on the same side of the spine.



PIC 2: Four-chamber view. PFO flap bowing towards LA.



PIC 3a: Four chamber- crossing of great arteries- aorta.



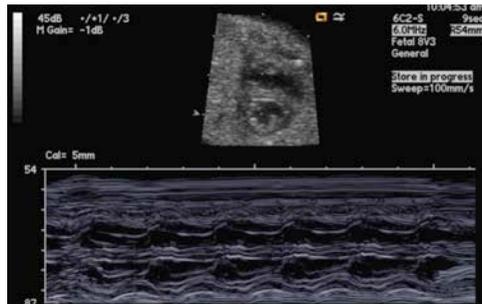
PIC 3b: Four chamber- crossing of great arteries- PA.

lar septums and atrioventricular valves. From this view, with minimal movement of the transducer, the heart should be scanned from posterior to anterior to see the coronary sinus and pulmonary veins posteriorly (PIC 4-5), and the aorta anteriorly (PIC 3). Moderator band and lower insertion of the TV leaflets to the crux of the heart compared to the insertion of mitral valve leaflets are hints for determination of the right ventricle.

“Where there is evidence of cardiac dysfunction or fetal distress, early delivery should be thought as an option.”



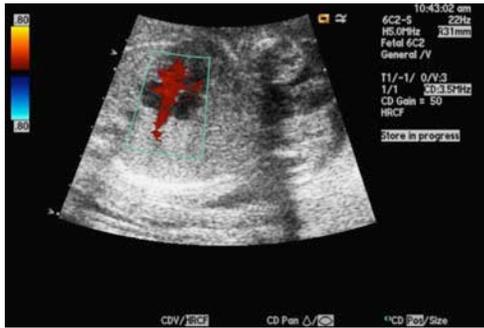
PIC 4: Pulmonary veins- color Doppler.



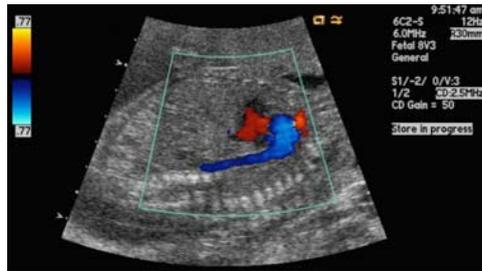
PIC 9: M-Mode of RV/LV to measure wall thickness.



PIC 13a: SVC-IVC.



PIC 5: RUPV color Doppler.



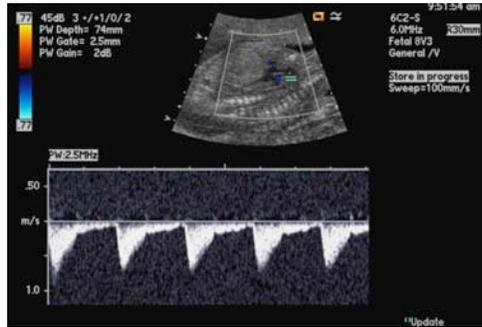
PIC 10: Aortic arch and branches with color Doppler.



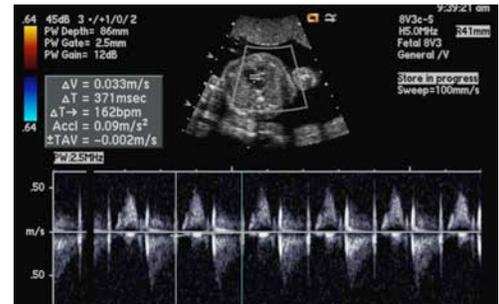
PIC 13b: SVC-IVC and foraminal flap.



PIC 6: Short axis of Ao and PA- PA branches.



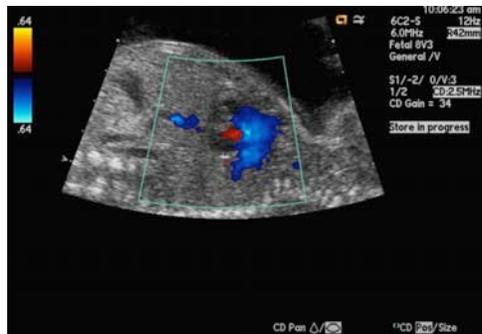
PIC 11: Aortic arch Doppler.



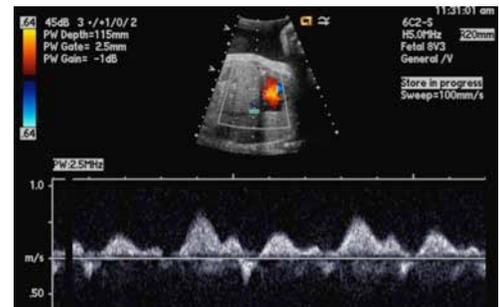
PIC 14: LVOT Doppler.



PIC 7: Aorta, PA Branches, SVC.



PIC 12: Ductal arch color Doppler.



PIC 15: IVC Doppler.



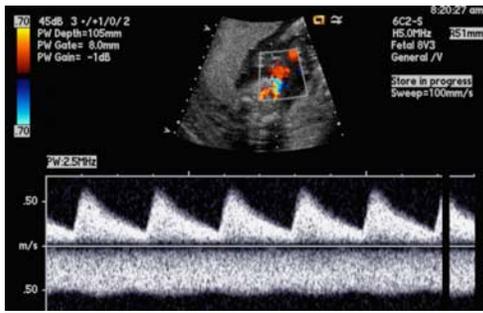
PIC 8: Short axis of RV/LV.

short axis of both ventricles, relationship of great arteries relative to their respective ventricles, pulmonary artery and its branches, inferior and superior vena cava and the 3-vessel view (SVC, AO, PA), ductus arteriosus and aortic arch with its branches.

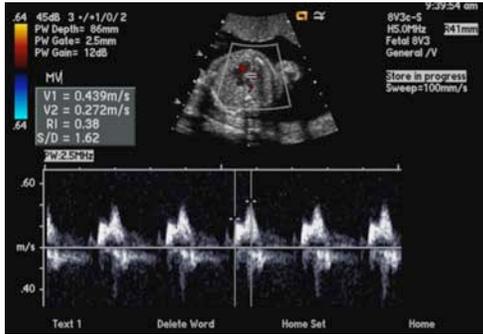
The ductal and aortic arches (PIC 10-12) can be visualized from the ductal/aortic arch view. In this view, the RVOT, MPA and the branch PAs can easily be seen. Aortic arch with its head and neck vessels, ascending/transverse and descending aorta as well as the entrance of ductus at isthmus with its flow normally directed towards the isthmus/aorta (right to left flow) are findings

The long axis view of the fetal heart will show the aortic mitral continuity and the ascending aorta. With further sweeping at this level, pulmonary arterial and aortic connections as well as ductus arteriosus will be seen.

When scanned perpendicularly from the long axis view, fetal cardiac short axis (PIC 6-8) view can be obtained. Cranial and inferior sweeps of fetal cardiac short axis will help with delineation of pulmonary veins,



PIC 16: Umbilical artery and vein Doppler.



PIC 17: MV inflow Doppler.



PIC 18: Cardiothoracic ratio.



PIC 19: Heart rate calculation.

that are observed sweeping from anterior right side of fetus to posterior left side.

The best view of the PFO/atrial septum is from caval long-axis view where long axis of SVC and IVC (PIC 13) and their continuity is also seen.

During visualization of the above mentioned cardiac structures, chamber, vessel, semilunar and atrioventricular valve annulus sizes should be measured and incorporated into the report. In addition to 2D measurements, Doppler interrogation of valves, systemic and pulmonary veins, aorta and ductus arteriosus, PFO, and umbilical vein and artery (PIC 11, 14-17) should be performed.

Cardiothoracic ratio should be measured from an optimal four-chamber view (PIC 18).

Different techniques have been studied to evaluate heart rate and rhythm. M mode, pulsed Doppler, pulsed tissue Doppler and recently tissue velocity imaging (TVI) are most commonly used modalities.⁶ In a normally conducting rhythm, calculation of baseline rate can be easily done from Doppler interrogation of the outflow tracts. (PIC 19).

For additional information, during M mode evaluation, simultaneous recordings of atrial and ventricular wall motion are done. Pulsed wave Doppler of ventricular outflow tract, along with the ventricular inflow where the "A" wave of atrial contraction can be differentiated, gives information about the type of arrhythmia (premature beats, etc). Extrasystoles (PAC) (conducted or blocked) are the most common arrhythmias encountered in a fetus. Though 1-3% of PACs may result in intermittent supraventricular tachycardias, usually PACs are benign findings that resolve by the time the patient seeks the attention of a fetal echocardiographer.⁶ Premature ventricular contractions (PVC) are rarely seen in fetuses, and may be benign findings though myocardial disease, cardiac tumors and decreased cardiac function should be ruled out. PVCs may require further postnatal evaluation.

Fetal tachyarrhythmias are usually SVTs that have a rate over 180 bpm. These arrhythmias warrant immediate attention, since as a result of this, cardiac compromise and hydrops can develop. Usually these arrhythmias are controlled by medical management but in rare instances may require early delivery.⁶ Ventricular tachyarrhythmias are very rare and, as mentioned before, may be the consequence of myocardial compromise or cardiac tumors and need immediate attention for treatment. Any fetus with tachyarrhythmias, even though hemodynamically stable, requires frequent follow-up imaging to evaluate the cardiac function and fetal hydrops.

Bradyarrhythmias (HR less than 110 bpm) are usually encountered during episodes of vagal stimulation, fetal distress or systemic disease. During cardiac ultrasound examination, short periods of self-recovering bradycardia are commonly encountered. Nonconducted PACs are also a reason for bradycardia though these are not deemed hemodynamically significant. Maternal autoim-

mune diseases (SLE or Jorgen Syndrome) are the main reasons for fetal bradycardia, usually fetal atrioventricular block. Any AV block in the fetus warrants maternal investigation since maternal autoimmune disease may not be symptomatic at the time of fetal bradyarrhythmia diagnosis. Certain medical treatments (maternal plasmapheresis, dexamethasone, B sympathomimetic treatment) are being tried in mothers of fetuses with AV block. Where there is evidence of cardiac dysfunction or fetal distress, early delivery should be thought as an option.

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Medical News, Products and Information

Multivitamins in Pregnancy Reduce Risk of Low Birth Weights

Prenatal multivitamin supplements are associated with a significantly reduced risk of babies with a low birth weight compared with prenatal iron-folic acid supplementation, found a new study in the *Canadian Medical Association Journal* (CMAJ) www.cmaj.ca/press/pgE99.pdf (www.cmaj.ca).

The World Health Organization currently recommends iron-folic acid supplements for all pregnant women. Previous studies have not shown an advantage from prenatal multi-micronutrient supplementation over iron-folic acid supplementation.

"Low birth weight and related complications are considered the most common cause of global infant mortality under the age of 5 years," write Dr. Prakash Shah and study co-authors from Mount Sinai Hospital in Toronto. "With the possibility of reducing low birth weight rates by 17%, micronutrients supplementation to pregnant women, we believe, offers the highest possible return for the investment. These results are synthesized findings from 15 studies published worldwide."

It is estimated that of the total 133 million births worldwide per year, 15.5% are low birth weight babies. The authors suggest that approximately 1.5 million babies born with a low birth weight could be avoided each year globally, if all mothers receive prenatal multi-micronutrient supplementation.

The research is limited by variability among the included studies, including timing, duration, composition of micronutrients, and characteristics of the study populations.

In a related commentary www.cmaj.ca/press/pg1188.pdf, Dr. Zulfiqar Bhutta and Dr. Batool Azra Haider of the Aga Khan University in Karachi, Pakistan recommend that multimicronutrient supplementation during pregnancy replace iron and folate supplements in susceptible populations if it is proven safe and effective. They note that multiple interventions in developing countries may be necessary to improve maternal nutrition and fetal status such as fortified food supplements, interventions that address specific nutrient deficiencies, and measures to reduce the burden of HIV, malaria and other diseases.

Scientists Have Developed a New Technique to Quickly Identify Stem Cells with the Goal of Fast-Tracking Medical Advancements

Recent breakthroughs in stem cell research have enabled scientists to induce human

skin cells to become stem cells, but these stem cells are hard to find. A research team led by The Hospital for Sick Children (SickKids) has developed a method to efficiently identify human stem cells by turning them fluorescent green. The findings were reported in the April 26 online edition of *Nature Methods*.

"This new technique is simple and reliable and allows us to isolate the best stem cells quickly," says Dr. James Ellis, principal investigator of the study, SickKids Senior Scientist and Associate Professor of Molecular Genetics at the University of Toronto. "This has exciting implications for studying disease and for future cell therapies."

The new development is on the heels of the recent discovery that human skin cells can be induced or "reprogrammed" to become stem cells (induced pluripotent stem cells or iPS cells). After two to four weeks, stem cell colonies emerge, but it has been challenging to find the best ones to study. Using their new method, the SickKids scientists can simply look for the green colonies to find the most suitable ones. These colonies can then be expanded into useful stem cell lines that can produce any cell type in the body.

To test the new technique, they isolated stem cells to study a form of autism called Rett Syndrome. They turned them green by using a virus to transfer the Green Fluorescent Protein gene into human and mouse skin cells.

"We designed the green gene to be off in skin cells, but to turn on when they are reprogrammed to become stem cells," says Dr. Akitsu Hotta, lead author of the study and a post-doctoral Fellow from Japan (funded by SickKids Restrcomp Award). "We can then pick the best stem cell colonies that glow green under the microscope and expand them to study human disease." To make the system even more efficient, researchers also included a drug-resistance gene alongside the green gene. This ensures only the best stem cells grow in the presence of the drug and the rest of the cells are unable to survive.

After showing the system worked on normal mouse and human cells, it was used to isolate stem cells from both a patient and a mouse with Rett Syndrome, an autism spectrum disorder that affects girls. It is caused by a mutation in the MECP2 gene and affects nerve cell maturation in the brain. The researchers showed they could make nerve cells from the patient stem cells. These cells can be used in the future to investigate how nerve cells mature in patients with autism, signal to their neighbours and to find drugs to correct the defects.

Ellis says this new screening method has even further applications. He explains that with some diseases or injuries, mature cells made from stem cells could be used for transplantation therapy, but there is a risk that any stem cells left in the culture could form tumours in the recipient.

"We noticed that tumours did not form if we transferred pure populations of mature cells into mice, but if green stem cells were also present, tumours were quickly established," says Ellis, Co-Director of The Ontario Human iPS Cell Facility located at SickKids, where researchers have used this new technique to isolate iPS cells from 10 patients with diseases such as cystic fibrosis. "The green gene effectively signals the presence of tumour-forming stem cells, and these could be removed before transplantation is performed."

Future research initiatives would be to include a gene that would kill stem cells that could potentially form tumours. The researchers are currently modifying their method so that the green cells also come equipped with this type of suicide gene.

The research was supported by the Ontario Ministry of Research and Innovation, the Canadian Institutes of Health Research, the Stem Cell Network, SickKids Foundation and the International Rett Syndrome Foundation and SickKids Restrcomp Award.

The Research Training Competition (RESTRACOMP) provides stipend funding for graduate students pursuing a Master's or Doctoral degree in the biomedical sciences, and research fellows who have obtained a PhD, MD or equivalent, and are pursuing at least two years of research training. The competition runs biannually (deadlines are usually April 15 and October 15 of each year). Applicants are evaluated by a committee on a number of criteria, including academic performance, publication activity, and other research, academic and professional development activities.

The Hospital for Sick Children (SickKids), affiliated with the University of Toronto, is Canada's most research-intensive hospital and the largest centre dedicated to improving children's health in the country. As innovators in child health, SickKids improves the health of children by integrating care, research and teaching. Its stated mission is to provide the best in complex and specialized care by creating scientific and clinical advancements, sharing our knowledge and expertise and championing the development of an accessible, comprehensive and sustainable child health system. For more information, visit www.sickkids.ca.

Children's National Opens New NICU

By Billie Short, MD; Linda Talley, MS, RN;
and Tara Taylor, MPH, RN

On May 17, Children's National moved into a new state-of-the-art 54 bed Neonatal Intensive Care Unit on the 6th floor of the East Inpatient Tower. The NICU admits almost 700 patients annually from counties around the region. The new unit is ideally suited to accommodate the needs of the critically ill newborn and its family in an area that is now approximately four times larger than the old space.

Designing the Unit

Planning for the move to the NICU began several years ago, with physicians, nurses, staff, and families actively engaged in the design of the new unit. Children's moved from a centralized space, comprised of six bays, with a total of 44 beds, to a decentralized, larger space. It was imperative that we were prepared and adequately trained for this new environment. Clinicians and parents teamed up with architects and designers for careful review to ensure that no detail was overlooked.

The idea of a private-room NICU was one that the team wanted to fully understand. After many years of functioning in a more traditional open bay environment, it was important that any private room design incorporated ways to ensure the safety of patients. We wanted to ease the transition for direct care providers as well. The "footprint" of the building meant that the team would need to incorporate very long hallways into space planning, and nurses and others were immediately concerned about needing to walk long distances for supplies, etc. To address these issues, we worked collaboratively with our architecture team from early on, bringing them into the unit to speak with direct care providers and observe a typical day in the NICU.

The resulting design took decentralization to a new level, providing efficiency in care by minimizing the distance a bedside nurse has to walk to obtain equipment or supplies. In addition, the decentralization we were able to achieve in design ensures that providers and families alike can spend most of their time where they want to be: with their tiny patients. From the idea of a single medication



Twenty-eight babies were successfully moved to the new NICU at Children's National in May 2009.

room we created six medication alcoves, each serving no more than 12 nearby patient beds with a medication Pyxis and locked medication cart. Similarly, a single nourishment room became six separate nourishment alcoves, each equipped with an undercounter freezer and help-yourself supplies for lactating moms. Slide-in signboards in every room direct parents and caregivers to the correct alcove for each patient.

Early on we realized that family input from our past patients was integral in our process. Many of our families have babies in our facility for several months or more, and these families know what amenities are needed for this special population better than anyone else on the design team. Members of the Parent Advisory proposed and ultimately selected the colors and theme of the unit. In addition, these members reviewed all furniture options and chose the rocker/sleep chair found in each patient room. They also helped us design the layout of the lactation room.

Ultimately, we created a unit that features the latest technology and best practice care delivery. Some of the special features of the new NICU include:

- Private patient rooms designed with input from families and staff.
- Two-parent transition sleep rooms with private bath and a washer and dryer, allow parents to spend the night with their child for pre-discharge readiness.



Picture of the old NICU.



Private room in the new NICU.

- Patient monitor alarms are located at the bedside and ring directly to nurse phones.
- Remote EEG monitoring.
- Eight of the NICU beds are designated neonatal neurology beds for dedicated neuroprotection focus and intensive care.
- Combination rocking chair/recliner, as well as a locked storage area for family belongings.
- Refrigerators in each room allowing mothers to pump fresh milk.
- Soft/indirect lighting is used in the NICU to improve developmental care. This is a nationwide best practice in the care for premature neonates to protect developing retinas.
- Two family waiting areas, one of which has a dedicated sibling play zone. The other is a quiet room available for reading or meditation.
- Acoustic-backed flooring that absorbs sound.
- PVC-free finishes in flooring and furniture.

SPECIALTY
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Save the Date





Ribbon-cutting of the new NICU by NICU graduates and Children's National leadership.

Staffing the New Unit

With the move to a decentralized and larger unit, we wanted to ensure that our staffing levels were more than adequate to maintain our nurse/patient ratios and continue to provide the highest quality of care to our patients. In the midst of nursing staff shortages around the country, the NICU team in the two years immediately prior to the move was able to hire 62 new staff nurses, surpassing our goal of 50 new nurses. Prior to the move, we eliminated use of agency/traveler nurses, and staff morale and engagement was high as measured through staff satisfaction surveys. Nurses formed relationships with each other early on, improving communication skills and teamwork. This environment and communication was necessary for a successful move and implementation of a new care delivery model.

Our unit was able to bring onboard these new nurses through an improved and expanded NICU Internship and Fellowship Program. Interns are carefully matched with preceptors based on preferred learning style. The program includes a mix of clinical and didactic learning sessions. Each specialty within the hospital is en-

gaged in the training, which strengthens interdepartmental relationships and provides the new nurses with exposure to a wide-range of specialized skills. Members of the NICU Parent Advisory Council even speak to the interns and fellows about their firsthand experiences to further emphasize the importance of family-centered care.

In addition, to prepare for the move, we hired two additional attending physicians, increasing the team to seven board-certified neonatal/perinatal specialists.

The Move

One year prior to the actual move date, Children's National implemented a multidisciplinary Clinical Operations Readiness Team. This team was responsible for engaging all institutional stakeholders to ensure that the unit would be ready for opening. Everything, from the locations of linen carts and trash cans, nutritional delivery routes, and transport pathways were discussed. The committee met monthly up until three months prior to move. At that point the committee began to meet every other week and even weekly as we approached move date.



Dr. Billie Short and Linda Talley celebrate a successful move.



The Transition Team on move day.

Included in this committee were members from Family Services and Public Relations and Marketing. We engaged our Parent Advisory Council members once again to provide parent-to-parent support on move day. A week before the move we asked families to take personal belongings home, held parent orientation sessions on the new unit, and clearly explained the process. Each family who moved received a commemorative NICU blanket for their cooperation and support.

Our PR and Marketing team developed an integrated communications strategy that promoted our new facility to our internal

“Planning for the move to the NICU began several years ago, with physicians, nurses, staff, and families actively engaged in the design of the new unit.”



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audience, past and future consumers, and referring neonatologists, perinatologists, and nurseries. We held various events, including a NICU Family Reunion and a physician CME event with an invited professor lecture. One event, which was requested by our Parent Advisory Committee and was an incredibly powerful experience for families and staff, was a NICU closing ceremony. We invited bereaved parents who had been part of Children's family in the old unit to an event where we painted the old unit's walls, and left memorial tributes to the patients who once stayed there. While it was very emotional, it helped us gain closure and capture our last memories of our past home.



Lilly Pad theme.

The safe movement of patients on move day was an organizational and corporate goal and a Transition Team was chartered to ensure that we met this goal. Identified objectives included:

- Ensure a safe transition for all patients, families and staff.
- All professional, ancillary, and support functions facilitate continuity of care and a seamless transition process.
- All necessary equipment and supplies are available.
- All staff are trained based on roles and responsibilities.
- All technology tested and functioning.
- Staffing levels support patient care and transition requirements.
- Transition plan effectively communicated to all patients, families, staff, community, and all identified external stakeholders.

Transition planning began three months prior to the move. Chaired by the executive in charge of the move, the Executive Vice President for Patient Services, key stakeholders met monthly and then weekly leading up to the move to ensure move plans were ready and resources were in order. Meeting agendas covered security plans, materials management readiness, meeting the financial goals, completed staffing plans for all departments, environmental readiness, as well as the planning of key events, including the official ribbon cutting ceremony.

An extensive Move Manual was written by the staff. The manual covered the design of the move sequence including the identification of three move teams and sending and receiving teams to monitor patients. The Move Manual was used by the Command Center as a reference manual. Beginning at least 48 hours prior to the actual move, the

leadership team made preliminary room assignments and staffing assignments for the Move Day. These plans were reassessed on the day immediately prior to the move. The Move was scheduled to begin at 0800, and the rounding teams started as early as 0500 to make sure that orders had been written and that patients and families were ready. After a review of a "go/no go" checklist at the Command Center at 0700, the move was commissioned to begin on time at 0800. The move of 28 patients was accomplished uneventfully in just over three hours.

Three Months Later

Three months have gone by since our historic move into our new unit, and the value of careful planning and consideration of even the smallest design details is evident. Most visitors remark on the quiet sense of calm that pervades the space, thanks to aspects such as acoustic-backed flooring, a cheerful color palette, and the newest technology. Wireless phones, for example, have reduced the need for disruptive overhead pages. We also implemented a system of lights on the ceiling that direct care providers to any rooms where there is a code or assistance is needed. Making rounds on the morning after Move Day, the Leadership Team asked one bedside nurse how her night went. "It's amazing" she responded, gesturing to one of her tiny patients, "he slept for six hours straight!"

By cataloguing current equipment, as well as that which we planned to purchase for the new space, we were able to ensure that bedside nurses can spend their time where they need to be-- with their patients. The previous NICU had nurses walking long distances from a single dirty utility room to weigh each diaper. The new unit features a

diaper scale nook designed specifically to hold a scale, in the nurse's work area but without risking contamination of clean supplies. Previously, privacy at the bedside for lactating mothers was nearly impossible to achieve fully. Breast milk was pumped in a separate lactation room where moms sat knee-to-knee on small sofas and brought to a central storage location. When it was time for a feeding, nurses removed the milk from the fridge and thawed it using warm water in a wash basin. Now moms can pump in private rooms at baby's bedside (or in our new, comfortable lactation room with five private spaces and large flat-screen TV) and place their milk in baby's own breast milk storage refrigerator. Penguin nutritional warmers in every room take milk from frozen to body temperature in six minutes!

Parent comments on the design have been overwhelmingly positive. The value of including our Parent Advisory Council members on the NICU Design team cannot be overstated. As mentioned earlier, parent team members helped select our lily pad theme, chose much of our unit furniture and restructured some rooms. For example, one of our most popular areas is the "Quiet Family Waiting Area" at the south end of the building. This was a special request by our design team parents, who recognized early on that the main waiting area, with its sibling play zone and two large televisions situated near the main entry, could seem loud and overwhelming, especially to a parent in crisis. The quiet area has large comfortable rocker/recliners like those in patient rooms, reading materials, and a beautiful view of the Capitol Building and Washington Monument, as well as an occasional sighting of Marine One in the nearby skies. Moms on our design team even requested that the recliner mechanism on the chairs be reset to make the motion easier on tender postpartum abdomens. This request resulted in a custom-manufactured chair for our unit.

Since the move, our hand washing data has improved 54 percent. In addition, comments gathered through the Patient Interactive System showed an improvement in cleanliness of the environment and care, privacy and quiet for the patients and families.

We have had very minor issues to address, which were focused primarily on door adjustments, hardware adjustments for staff bathrooms, and minor adjustments to nurse call designed algorithms.



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Lessons Learned from the Move

The debriefing after the move, identified some items that we would consider doing differently and other things we did really well.

1. **Radio issues** – We used walkie-talkies during the move to communicate between all the teams. Since we were moving from one building to another, we incorporated dead zones where we didn't have service. We would recommend an assessment of future move areas for dead spots and a listing of all back up phone numbers to give to the sending and receiving teams.
2. **Move teams** – Our teams did a great job, and were well organized and trained. Leading up to the move we did three mock moves with significant debriefing sessions to ensure everyone was on the same page and we had considered all the necessary contingencies.
3. **Move equipment** – It was difficult to manage all of the equipment. We would recommend in the future to have a mover assist and secure IV poles.
4. **Breaks** – We were half way through the move and one of the move teams decided that they needed a bathroom break. This wasn't communicated well to the command center and there was already a baby on its way to the new unit. We think there should be no stoppages for breaks, but that there are phased and scheduled breaks added to team schedules during the planning process.
5. **Move route and education** – We walked the route numerous times and had back-up routes planned in case of elevator outages. Everyone was well prepared, especially Children's Security team, who ensured the route was secure and void of traffic.
6. **Security** – We had a great presence and sense of direction from the team. Our one area of improvement would be to have the security team on the same radio frequency as the move team, which would improve communications.
7. **Infection control** – Infection control was actively engaged in the move process. They did a great job and we had no issues.
8. **Ancillary teams** – Departments such as Respiratory, Pharmacy, Radiology, Family Support, etc., were all part of the move plan and had an active presence during the move day. The departments

were well coordinated and provided the appropriate level of support.

9. **Parent Support** – We had several parents come to visit the closed unit after the move. We hadn't anticipated this, and we needed family and/or social services there to provide psycho-social support. We expected our bereaved families to have strong emotions about the new unit, but were surprised at the emotion from other families and staff who had worked in the unit for so long.

The move to the new unit was a tremendous event in the history of Children's National. It underscores the importance of planning for all contingencies, with all necessary departments of the institution engaged in the move's success. We are proud of the new unit and the care it provides for the patients and families we serve. We are happy to discuss our move and unit with any interested institutions to further detail our recommendations and lessons learned.

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NEONATOLOGY TODAY

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ISSN: 1932-7129 (print); 1932-7137 (online).
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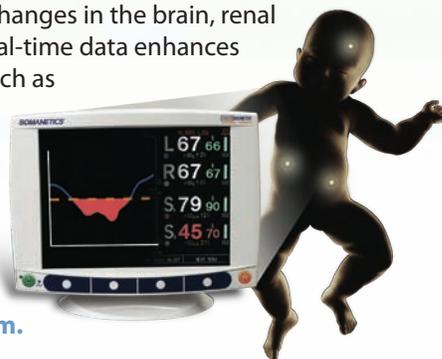
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