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and

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SSMHealth St. Mary's Hospital

SSMHealth Cardinal Glennon

The Perinatal Outreach Program

The Perinatal Outreach Program is a collaborative effort between SSM Health St. Mary's Hospital - St. Louis, SSM Health Cardinal Glennon Children's Hospital, and Saint Louis University School of Medicine.

It is designed to improve outcomes for mothers and babies through educational programs and quality improvement activities for regional perinatal care providers in Eastern Missouri and Southern Illinois.

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The Perinatal Times welcomes comments on any of its articles and will consider such letters for publication. Suggestions for future topics of interest or announcements are encouraged.

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Inclusive language
The term "breastfeeding" is used to describe the act of feeding one's child one's own milk by any method. "Chest feeding" and "body feeding" may be preferred terms for people, including transgender and gender nonbinary individuals. Although the terms "woman," "women," and "mother" may be utilized throughout the content of this publication, we recognize the existence of diverse gender identities. To provide respectful and compassionate care, the health care provider should always ask individuals what words they use to describe themselves, their bodies, and their health care practices.

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Inside this issue:

NRP in the Know

Transferring of Care from the Community to a Neonatal Intensive Care Unit (NICU): A Collaborative Approach

By Amanda Cox, MSN, RN and Mackenzie Kimminau, BHS, RRT, RRT-NPS, CNPT

No provider ever wants to be in the position of performing a neonatal code. However, when this situation presents itself and the transport team has been called, who is in charge when they arrive, and what happens when they leave? As the team in the magic suits arrives, there can be confusion when trying to establish roles, collaborating with a new team, and subsequently, debriefing amongst different organizations. Regardless of the situation, collaboration is vital; we are in this together.

When the team arrives, there is often a natural instinct to drop and run; however, safe and timely transfer depends not only on the expertise of the transport team, but on the complete and accurate information received from the referring staff (Szary et al., 2010). We all have the same goal: to provide the highest level of patient care and deliver the best outcomes. Ideally, when the team arrives, there is an opportunity to get a concise patient report. Summarizing the necessary information, including a brief birth history and the events already taken place in the resuscitation are important points to share. This allows the transport team to step in and help with patient care without duplicating treatments, and potentially delaying further care.

Role delineation is challenging, though crucial, to providing optimal care. If a team leader has not been established, that is a good first step. The team leader serves as a point person for all team members, assigns roles, and deliver orders. The recognition of clear roles allows all staff, both hospital and transport team, a better of idea of what to do, and when to do it.

"A Joint Commission investigation found that poor teamwork and communication were the most common root causes for potentially preventable infant deaths in the delivery room" (Weiner, p. 9, 2022). Including role establishment, the Neonatal Resuscitation Program identifies 10 Key Behavioral Skills as building blocks for a successful resuscitation. These 10 skills are listed in Table 1. It can be beneficial for teams to review and deliberately practice these behavioral skills in simulations to help improve the team's performance. "Even though each individual may have the knowledge and skills to perform a successful resuscitation, each person's skills will not be used optimally without effective coordination." (Weiner, p. 9, 2022).

At the conclusion of an event, debriefing is an important way to identify any obstacles and successes for which to better the process and potential outcome for the patient (Gougoulis et al., 2020). This discussion should happen as soon as possible after the event with all, if not most participants. For scenarios that involve community hospitals and transport teams, this takes coordination but remains an important aspect in identifying strategies to improve teamwork. To improve the outcome of the debrief, those involved must feel empowered to speak, offer suggestions, and receive/give feedback in a non-punitive fashion with the understanding that patient care is a collaborative effort, and not the responsibility of one individual (Sawyer et al., 2016).

Ultimately, the transport team is there to support the referring staff where needed, and to the best interest of the patient and family. While each interaction will vary in approach and outcome, interdisciplinary communication must remain open. The magic suits may come with extra resources, but rarely a magic fix. Maintaining effective communication and collegial collaboration throughout the duration of care, as well as after, allows for best patient outcomes, team building, and education for all those involved in the event.

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Table 1.

Author Bios

Mackenzie Kimminau, BHS, RRT, RRT-NPS, CNPT is a Respiratory Therapist Team Lead on the SSM Health Cardinal Glennon Neonatal and Pediatric Transport Team. She has been a respiratory therapist for seven years, with the last two and a half being at SSM Health Cardinal Glennon. She loves the fast-paced, ever-changing environment of transport medicine; and strives to provide the best outcomes for all patients. She is active in several team and hospital committees that support her goal of optimizing team resources and improving patient care.

Amanda Cox, MSN, RN is the Clinical Nurse Manager of the Neonatal and Pediatric Transport Team. She has an extensive neonatal background and has spent the last 7 years at SSM Health Cardinal Glennon in both the Level IV NICU and on the Transport Team.

Diabetes in Pregnancy

By Jordan Lowe, MD

Diabetes Mellitus

One of the most common indications for subspecialty referral during pregnancy is diabetes. At SSM Health Saint Mary's Hospital - St. Louis, 50% of all visits are associated with a diagnosis of pregestational or gestational diabetes. Many institutions, including ours, create multidisciplinary teams for diabetic management. What is it about diabetes that so complicates pregnancy? This article will seek to address that question.

Fundamentally, diabetes mellitus is a condition of sustained high blood sugar that occurs with either no insulin, insufficient insulin, or in the setting of insulin resistance. In the context of pregnancy, we differentially categorize it as either pregestational or gestational diabetes. Pregestational diabetes, including Type 1, Type 2, maturity-onset diabetes of the young (MODY), and latent autoimmune diabetes of adults (LADA), traditionally predates the pregnancy. Gestational diabetes generally arises in the late second or third trimester. Similar to Type 2 diabetes, it is caused by insulin resistance, instigated by physiologic changes during pregnancy.

In the United States, 1-2% of all pregnancies will be complicated by pregestational diabetes. Gestational diabetes is more common, complicating 7.8% of live births.[1, 2] Among women of childbearing age, 6% have diabetes and that number is growing every year.[5]

Pre-Pregnancy and Early Pregnancy Concerns

Pregestational diabetes (particularly Type 1 diabetes) poses a number of challenges for women and their health care providers before pregnancy and early on in gestation. Poorly controlled hyperglycemia is associated with recurrent pregnancy loss, subfertility from ovarian dysfunction (such as in polycystic ovarian syndrome), and well known long-term medical risks of diabetes: diabetic retinopathy, nephropathy, neuropathy, vascular, or heart disease.

Less commonly, poor diabetic control can result in medical emergencies such as diabetic ketoacidosis or hyperosmolar hyperglycemic state. For these reasons, women with diabetes who wish to become pregnant are recommended to undergo preconception counseling and testing of vision, kidney function, and heart health. For women with diabetes still struggling to get pregnant, bringing diabetes under better control improves chances of a successful pregnancy.[3, 5]

Hyperglycemia also poses a direct risk to an early pregnancy. These risks include miscarriage, congenital malformations (birth defects), and growth restriction. In women with pregestational diabetes, early pregnancy loss is two to three times higher, and the overall risk of congenital malformations is two to four times higher than women without diabetes. The main driver of this risk is hyperglycemia.[4, 6]

In preconception and early pregnancy counseling, a hemoglobin A1c correlates with risk of miscarriage and congenital malformations. Most guidelines recommend a hemoglobin A1c goal of <7%. One such study, analyzing ~2000 pregnancies, found that a hemoglobin A1c of 5.5% was associated with a 2-3% risk of congenital malformation. The risk in otherwise healthy pregnancies is approximately 3-4% at baseline so this means there is no extra risk. When the hemoglobin A1c was 7.6% the risk was 4% and with hemoglobin A1c >14% the risk was 20%.7. Another study in the United Kingdom found that dropping your hemoglobin A1c by 1% could lower the risk of congenital malformations by as much as 30%.[8]

All women with pregestational diabetes are encouraged to immediately follow up with their primary physician, Endocrinologist, or seek referral to a Maternal-Fetal Medicine specialist to establish care early in pregnancy.

Diabetes During Pregnancy

Pregnant women without an anteceding diagnosis of diabetes are recommended to undergo routine screening for gestational diabetes (GDM). According to the CDC, GDM will affect 7.8% of live births in the USA.[1, 2] For this reason, all pregnant women are recommended to undergo a screening test between 24 to 28 weeks. In women with higher risk of GDM, it may be recommended to undergo testing even earlier. Women with increased risk include women >35 years of age, with BMI >30 or significant weight gain between the first 18-24 weeks of pregnancy, history of GDM in a previous pregnancy, or a previous birth of an infant over ~9 lbs (4000 g). Additionally, women of Hispanic, Native American, Alaskan, or Hawaiian native, South or East Asian ancestry are more likely to have GDM. The risk is lower in non-Hispanic white and black women.[9]

During pregnancy, screening takes the form of a glucose challenge test. This test involves a 50-gram oral glucose solution with serum glucose testing one hour after administration. At our institution, we use a cut off of ≥130 mg/dL. Patients who do not pass the screening test are scheduled for a diagnostic three hour 100-gram oral glucose tolerance test. A positive test is defined as elevated glucose concentrations at two or more for fasting (95 mg/dL), one hour (180 mg/ dL), two hours (155 mg/dL), and three hours (140 mg/dL) postprandial.[15]

For patients with pregestational diabetes, screening and surveillance targets the potential end organ effects of diabetes. This includes blood pressure monitoring, screening for preeclampsia, ophthalmology referral for retinopathy screening, baseline renal and liver function testing, and fetal echocardiogram.

With both gestational and pregestational diabetes, the focus of care is on bringing the hyperglycemia under control quickly with regular follow up. In our office, patients are seen initially by a Registered Dietician and Clinical Diabetic Educator (CDE) in addition to their primary health care provider. They then follow up every one to two weeks for the remainder of their pregnancy to review glucose logs with the CDE and provider. When patients are under more stable control, this can be done remotely.

For patients with gestational diabetes, the initial approach to treatment is counseling, lifestyle modification (specifically dietary modification) and follow up with fasting and postprandial glucose logs. If dietary modification alone is sufficient, then we classify this as diet-controlled gestational diabetes (A1-GDM per White's classification).

For women with pregestational diabetes or for whom dietary changes alone are not enough, insulin is the mainstay of treatment. Glucose crosses the placenta; however, insulin is too large to pass. Therefore, stable glycemic control indirectly lowers fetal insulin, mitigating its anabolic effects on fetal growth. Based on almost 100 years of experience of use in pregnancy, insulin is considered safe for the fetus and newborn and is endorsed by the American Diabetes Association.[10]

A routine fetal anatomy ultrasound is performed between 18-22 weeks after which regular ultrasounds are recommended for surveillance. Improved glycemic control mitigates risk of congenital anomalies such as cardiac malformations, however screening with fetal echocardiogram is still recommended. Serial ultrasound to assess fetal growth is recommended after the initial anatomic survey. We perform these every two to four weeks until delivery. Due to increased risk of stillbirth, we initiate antenatal testing at 32 weeks. This takes the form of twice weekly fetal non-stress testing and weekly fetal ultrasonography (a biophysical profile). The frequent office visits also provide a time to screen for any of the potential risks of diabetes such as high blood pressure/ preeclampsia, excessive amniotic fluid (polyhydramnios).[9]

Diabetic Ketoacidosis

While uncommon, if diabetic control cannot be established in the office, admission to the hospital is recommended. This can allow for more rapid control of hyperglycemia and is necessary for mothers with Type 1 diabetes who develop diabetic ketoacidosis (DKA). Normally, the body breaks down sugar for energy, however if there is no insulin to drive sugar into the cells, the body enters a period of starvation. Blood sugar levels rise, and the body burns fat for energy forming ketone bodies. The accumulation of ketones renders the blood acidic. In pregnancy, this can occur when there is significant nausea or vomiting and therefore poor oral intake. Other causes for DKA during pregnancy include infection or insulin pump malfunction. This is a medical emergency that requires inpatient management with IV insulin, fluids, and sometimes support in an Intensive Care Unit (ICU). It also represents a significant risk to the baby and extra fetal monitoring and surveillance is warranted.[11, 12]

Preparing for Delivery – The "When"

As a mother gets closer to the end of the third trimester, it is appropriate to start talking about delivery planning. In a pregnancy with gestational diabetes that can be controlled with diet alone, delivery is recommended during the 39-40 weeks.

In a pregnancy with pregestational diabetes or gestational diabetes that has required treatment with insulin, delivery is recommended during week 39.

In a pregnancy with poor diabetes control, care is individualized, however delivery is often recommended between 37-39 weeks. If there are complications to the mother's health or major fetal complications, preterm delivery may even be recommended up to 32 weeks in the most severe cases.[9]

If insulin treatment has been used throughout pregnancy, IV insulin will also be provided during labor. The rationale for strict glycemic control is to decrease the risk of neonatal hypoglycemia, which would require management in the Neonatal Intensive Care Unit (NICU). This occurs when

maternal hyperglycemia results in neonatal hyperglycemia and therefore neonatal hyperinsulinemia. When the cord is clamped and cut, the glucose source also stops. The high circulating fetal insulin quickly results in clinically significant hypoglycemia.

Preparing for Delivery – The "How"

Fetal growth is regularly assessed by ultrasound (every three to four weeks). Should the estimated fetal weight be >4500g (~10 lbs.) then cesarean delivery may be recommended. The rationale is to mitigate the risk of shoulder dystocia. Adipose deposition in diabetes is preferentially abdominal and thus, in diabetes, the fetus is more likely to become impacted (usually the anterior shoulder) on the maternal bony pelvis after delivery of the fetal head. This is a significant obstetric emergency. The longer a shoulder dystocia takes to resolve, the greater the risk of permanent neurologic injury to the baby. Rarely, injuries like fetal limb fracture or temporary paralysis of the impacted arm can result.

Much of the counseling and diabetic care in gestational diabetes is directed at preventing this kind of complicated birth experience and the trauma it may cause to the mother and explains why a cesarean delivery may be recommended by the Obstetrician (especially if the baby >4500g).[9]

After Delivery

Mothers with pregestational diabetes can expect to still have diabetes after pregnancy, however the amount of insulin required for good control will likely decrease significantly. Although, if the pregnancy was complicated by gestational diabetes, mothers requiring insulin during the pregnancy may no longer need insulin immediately postpartum. This occurs because the insulin resistance was primarily driven by placentally derived factors (such as human placental lactogen). With delivery of the baby and placenta, these factors are no longer present.

Breastfeeding is encouraged and several studies have reported a decrease in long-term risk of Type 2 diabetes when mothers breastfeed.[13]

Screening is still recommended to mothers with gestational diabetes at their six week follow up visit. This takes the form of a 75-gram, two-hour glucose tolerance test. According to the Center for Disease Control and Prevention (CDC), approximately 50% of women with gestational diabetes will go on to develop Type 2 diabetes later in life.[14]

Long-term risks to the baby include increased rates of childhood obesity, childhood diabetes and prediabetes, and heart disease later in life. Changes to lifestyle, diet, and follow up with a pediatrician are recommended.[5]

Closing Thoughts

We started with an initial question: "What is it about diabetes that makes for a 'high risk pregnancy'?"

Diabetes impacts every stage of pregnancy from preconception, early pregnancy, late pregnancy, and delivery. It poses risks to the mother and child including miscarriage, stillbirth, congenital malformations, preterm birth, and complicated deliveries, among others.

Management of diabetes takes a team and frequent visits (both in-person and remote/virtual) to get it right. Surveillance of the baby – both from ultrasound and fetal monitoring – only adds to the number of visits. Learning to take insulin for the first time can be a challenge to many patients.

For these reasons, diabetes can be difficult to manage during pregnancy and specialty follow up with Maternal-Fetal Medicine or Endocrinology is fairly standard.

With these concerns in mind, it remains manageable. As health care providers, our role includes outlining the risks and potential complications; however, it's equally important to be encouraging and underscore management strategies. With a multidisciplinary approach to care, many women with diabetes will go on to have normal pregnancy outcomes.

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Author Bio

Jordan Lowe, MD was born in Omaha, Nebraska and is a graduate of Abilene Christian University. He obtained his MS in Medical Sciences at the University of North Texas Health Science and his medical degree at Texas A&M University. He completed his training in Obstetrics and Gynecology with Michigan State University in Grand Rapids Michigan and is currently a third-year Fellow with St. Louis University at SSM Health St. Mary's Hospital in St. Louis, Missouri.

Congenital Heart Defects (Part I): Prenatal Evaluation and Ultrasound Detection of Congenital Heart Defects

By Megan Krupp, MSN, RNC-MNN

Background

Congenital Heart Disease (CHD) is the most common type of birth defect, affecting approximately one percent of births each year in the United States. Additionally, CHD remains the leading cause of infant morbidity, ranging from mild to critical. For example, a ventricular septal defect is considered mild, whereas hypoplastic left heart syndrome, with an intact or restrictive atrial septum, is considered critical. Prenatal diagnosis of CHD, as well as clinical management guided by the CHD's complexity, can improve patient outcomes. A fetus with mild CHD may deliver locally with their primary prenatal care provider. Such infants may only require outpatient follow up with cardiology. Patients with a more complex fetal diagnosis of CHD, however, require specialized coordination of care and multidisciplinary collaboration throughout pregnancy, with planned delivery at a tertiary care center. These infants generally require neonatal cardiac surgery and lifelong cardiology care. In the most severe CHD cases, heart transplantation may be recommended for survival (Sethi et al., 2022).

Importance of prenatal detection of CHD

Thorough prenatal evaluation and screening is essential for early identification of CHD and is beneficial to provide ample time for pregnant persons and their support systems to make decisions in partnership with their health care team. Another potential benefit includes improvement in neonatal morbidity and mortality. Knowledge of CHD in the prenatal period allows the health care team to provide specialized cardiac care and coordination of a delivery plan that sets the health care team up to deliver optimal care in the immediate postnatal period. There is also emerging evidence to support that prenatal diagnosis of CHD may help improve long-term neurodevelopmental outcomes. As patients with CHD are more likely to develop adverse long-term neurodevelopmental outcomes, a prenatal diagnosis is helpful in establishing a treatment plan to optimize neuroprotection in this vulnerable patient population (Sethi et al., 2022; Wong et al., 2022).

Routine screening with the second trimester anatomy ultrasound

Fetal echocardiography remains the gold standard for diagnosing CHD in the prenatal period and indications for its use have rapidly evolved over the past two decades. The performance of the routine fetal anatomic ultrasound in the second trimester, however, is an important test utilized in screening for the presence of CHD. Recent expansion of standard obstetric cardiac screening guidelines have moved from obtaining the four-chamber view to now also including imaging of the right and left ventricular outflow tracts (RVOT and LVOT) in addition to three-vessel view (3VV). The addition of these more detailed cardiac views increases the sensitivity of the second-trimester fetal anatomic ultrasound screening, with CHD detection rates ranging from 50% to 70%. Suspicion of abnormal cardiac anatomy detected on routine ultrasound screening automatically warrants referral for fetal echocardiography, which is performed by pediatric cardiology in collaboration with a specially trained fetal cardiac sonographer (Moon-Grady et al., 2023; Wong et al., 2022).

It is important to note, however, that there is great regional variability in the utilization of obstetric anatomic ultrasound scans to screen for the presence of CHD. Local practice patterns and practitioner expertise also contribute to decision-making regarding referral for fetal echocardiography. This poses a challenge to health care providers in the community as they make a decision regarding the indication to refer for fetal echocardiography to definitively diagnose CHD, especially in the presence of a normal obstetric anatomy ultrasound scan. The decision to refer a patient for fetal echocardiography is highly dependent on the rate of disease in the patient population being subjected to screening and on the quality of performance with the screening test (Moon-Grady et al., 2023).

Fetal echocardiogram for pregnancies with risk factors

Known risk factors for CHD in the prenatal period (maternal, fetal, or familial) also warrant referral to echocardiography. Fetal echocardiography may still be recommended in pregnancies with risk factors, even in the presence of a normal obstetric fetal anatomic scan. The level of known risk factors, local practice patterns, practitioner

expertise, cost- effectiveness, resource allocation, and many other contributing factors play an integral role in clinical decision-making for health care providers regarding referral for fetal echocardiogram with pediatric cardiology. There are many risk factors that prompt referral for fetal echocardiogram (Moon-Grady et al, 2023). Table 1 shows consensus recommendations for potential indications to refer for fetal echocardiography, outlined by the American Society of Echocardiography (ASE), in comparison with published guidelines from the American Institute of Ultrasound in Medicine and the American Heart Association (AHA). Weighing the aforementioned factors and using this table can help guide community providers when deciding whether to refer a patient for fetal echocardiography.

Table 1 Potential indications for fetal echocardiography

	ASE 2023 recommendation	AIUM 2020[4]	AHA 2014[2*]
Maternal factors (absolute risk)[†]			
Pre–gestational diabetes (3%-5%)	Is indicated	Is indicated	I (indicated)
Gestational diabetes diagnosed after second trimester (<1%)	Not indicated	Not indicated	III (no benefit)
Phenylketonuria (12%-14%)	Is indicated	Is indicated	I (indicated)
Autoimmune disease: SSA/SSB positive (1%-5%)[‡]	Is indicated	Is indicated	IIa (probably indicated)
In vitro fertilization (1.1%-3.3%)	May be considered[§]	Is indicated	IIa (Probably indicated)
Maternal infection: rubella (3%-4%)	Is indicated	Is indicated	I (indicated)
Family history of CHD: first-degree relative (3%-20%)[¶]	Is indicated	Is indicated	I (indicated)
Family history of CHD: second-degree or more distant relative (<2%)[‖]	Not indicated	May be indicated	IIb (may be indicated)
Obesity (BMI > 30 kg/m^2) (1-2%)	Not indicated	Not indicated	—
Retinoids (8%-20%)	Is indicated	Is indicated	I (indicated)
ACE inhibitors (3%)	May be considered[§]	May be indicated	IIa (probably indicated)
Paroxetine (3%)	May be considered[§]	May be indicated	IIb (may be indicated)
Other selective serotonin reuptake inhibitors (1%-2%)[6,7]	Not indicated	Not indicated	III (no benefit)
Anticonvulsants (1%-2%)	Not indicated	May be indicated	IIb (may be indicated)
Lithium (1%-2%)	Not indicated	May be indicated	IIb (may be indicated)
Warfarin (<1%)[8]	Not indicated	Not indicated	III (no benefit)
Fetal factors identified during screening (absolute risk)			
Fetal hydrops (15%-20%)[9]	Is indicated	Is indicated	I (indicated)
Extracardiac anomaly (20%-45%)[10,11]	Is indicated	Is indicated	I (indicated)
Chromosomal abnormalities (10%-90%)	Is indicated	Is indicated	I (indicated)
Monochorionic twinning (2%-10%)	Is indicated	Is indicated	I (indicated)
Nuchal translucency 3.0-3.4 mm (~3%)	May be considered[§]	May be indicated	IIa (probably indicated)
Nuchal translucency ≥3.5 mm (6%-60%)	Is indicated	Is indicated	I (indicated)
Single umbilical artery in isolation (1.2%-1.8%)[12]	Not indicated	Not indicated	IIb (may be indicated)

ACE, Angiotensin-converting enzyme; *BMI*, Body mass index.

Fetal echocardiography is indicated in the setting of abnormal results on screening ultrasound of the heart regardless of additional risk factors; below are recommended indications for fetal echocardiography on the basis of a priori risk from previously published guidelines and the current document. In the "ASE 2023" (present document) recommendations, a classification of "not indicated" assumes a normal cardiac screening result at second-trimester obstetric anatomy scan. Reference data reviewed in Donofrio *et al*.[2] unless otherwise noted.

*Using "classification of recommendations"[2]: I = procedure should be performed; IIa = it is reasonable to perform procedure; IIb = procedure may be considered; III = harm/no benefit.

[†]"Absolute risk": baseline CHD risk assessment independent of ultrasound findings.

[‡]Prior affected child with complete heart block, risk increases to 11% to 19%.

[§]Decision to refer for fetal echocardiography despite negative results on screening ultrasound should be based on the sensitivity and specificity of CHD detection in local community screening practices.

[¶]Can be up to 50% with genetic disorders with Mendelian inheritance.

[‖]Not indicated unless a genetic disorder with Mendelian inheritance.

Note. Reprinted from "Guidelines and Recommendations for Performance of the Fetal Echocardiogram: An Update From the American Society of Fetal Echocardiography," by A.J. Moon-Grady, M.T. Donofrio, S. Gelehrter, L. Hornberger, J. Kreeger, W. Lee, E. Michelfelder, S. A. Morris, S. Peyvandi, N.M. Pinto, J. Puetz, N. Sethi, J. Simpson, S. Srivastava, and Z. Tian, 2023, Journal of the American Society

Prenatal diagnostic confirmation of CHD

When a prenatal diagnosis of CHD is confirmed by fetal echocardiogram, with the expertise of pediatric cardiology, pregnant persons and their support systems are given the opportunity for more individualized counseling and support through referral to the SSM Health Cardinal Glennon Children's Hospital St. Louis Fetal Care Institute. A collaborative group of maternal fetal medicine (MFM), cardiology, cardio-thoracic surgery, and neonatology specialists, in addition to nurse navigators, social workers/psychotherapists certified in perinatal mental health, sonographers, and genetic counselors, helps families to navigate a plan of care in the presence of a fetal cardiac anomaly. The complexity of the fetal cardiac anomaly drives clinical decision-making and warrants specialized delivery planning. Most complex fetal cardiac patients require delivery at SSM Health St. Mary's Hospital - St. Louis with transfer of the neonate to SSM Health Cardinal Glennon after birth for a higher level of cardiac care and evaluation. The most critical fetal cardiac diagnoses require a Rapid Transport Pathway for postnatal transfer of the neonate to SSM Health Cardinal Glennon within 30 minutes of birth. In rare cases, an IMPACT (Immediate Postpartum Access to Cardiac Therapies) delivery via cesarean section at SSM Health Cardinal Glennon may be necessary. An IMPACT delivery is recommended in critical congenital heart disease when the newborn is at heightened risk of facing life-threatening cardiovascular or respiratory problems upon disconnection from the placenta. Decision to deliver at SSM Health Cardinal Glennon is multifactorial and takes coordinated effort by the multidisciplinary team to ensure safety of both mother and baby.

Patients and families are guided by the advocacy and care coordination of a designated Fetal Heart Nurse Navigator every step of the way at the St. Louis Fetal Care Institute. The Footprints Program is supportive to families facing the uncertainty that accompanies a complex fetal diagnosis, and Child Life Services are available, if desired and applicable to a family's individualized needs. Caring Connections is another avenue of support for patients that is unique to SSM Health Cardinal Glennon and is made up of trained volunteer mentors. Pairing caregivers with compassionate mentors who have been through similar lived experiences offers guidance, hope, and support. Referral to The St. Louis Fetal Care Institute is essential for patients and families as they walk through their pregnancy journey affected by CHD.

To find out more information about the SSM Health Cardinal Glennon Children's Hospital Fetal Heart Program at the St. Louis Fetal Care Institute, visit **cardinalglennon.com/fetalheart** or call **314-268-4037 option 2**.

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Author Bio

Megan Krupp, MSN, RNC-MNN has been a nurse for 11 years. Most of her career has been with SSM Health working as a bedside nurse on the high-risk mother/ baby unit at SSM Health St. Mary's Hospital - St. Louis. She currently works as a fetal heart nurse navigator and research nurse at SSM Health Cardinal Glennon's St. Louis Fetal Care Institute and strives to support patients along their pregnancy journey. Collaborating with the multidisciplinary team is an important part of her role, as they help families navigate a plan of care in the presence of a complex fetal diagnosis.

Congenital Heart Defects (Part II): Postnatal Evaluation, Decision Making, Transfer, and Treatment (of Critical Congenital Heart Disease)

By Angela Lewis, MD, FAAP and Renu Peterson, MD

Congenital heart disease (CHD) affects almost 1% of births (Khalil et al., 2019). There is a wide spectrum of severity of congenital heart disease from small ventricular septal defects that are likely to close spontaneously to critical CHD (CCHD) requiring surgery or catheter-based intervention in the first year of life. CCHD accounts for approximately 25% of all congenital heart defects (Oster, et al., 2013).

Prenatally, the combination of routine second trimester anatomy ultrasound and fetal echocardiography for infants with risk-factors detects more than 50% of all congenital heart disease (Oster, et al., 2013). Prenatal diagnosis allows for thorough counseling, close intrauterine monitoring, and detailed delivery, and post-natal care planning.

Postnatally, CCHD may present with rapid development of cyanosis, shock, or respiratory distress. Other CHD may present more subtly with failed pulse oximetry screening, abnormal findings on cardiac auscultation, poor feeding, diaphoresis, or failure to thrive.

Morbidity and mortality for infants affected by congenital heart disease increases when the diagnosis is delayed (Hill et al., 2015). For this reason, early recognition, emergency stabilization, and referral to a pediatric cardiac care center are essential steps to ensuring optimal outcomes for these newborns.

Management of prenatally diagnosed CHD

If CCHD is diagnosed prenatally, it is recommended that families meet with a multidisciplinary team to plan for delivery and postnatal care of the neonate. This team may include pediatric cardiology, pediatric cardiothoracic surgery, maternal fetal medicine, genetic counseling, palliative medicine, and neonatal-perinatal medicine.

Delivery at a hospital with 24 hour neonatal-perinatal medicine coverage near a pediatric cardiac care center is recommended. Respiratory support should be provided based on the infant's work of breathing or degree of hypercarbia. Oxygen will dilate the pulmonary vessels and can worsen symptoms in some lesions; therefore, oxygen should be used judiciously.

Many CCHD lesions require the patency of the ductus arteriosus vessel for pulmonary or systemic blood flow. For these ductal-dependent lesions, prostaglandin E1 (PGE1) infusion should be used to maintain ductal patency. When possible, PGE1 should be prepared and a plan for vascular access should be discussed prior to delivery to facilitate rapid initiation.

Finally, a plan for the infant's disposition following delivery should be in place. Neonates with CCHD are best served in a neonatal or pediatric ICU for close monitoring. Some lesions require an immediate catheter-based or surgical procedure for survival.

Postnatal Recognition of CHD

Even with optimal prenatal care, many cases of CHD go undetected prenatally (Hill et al., 2015). Conotruncal lesions, or those involving the vessels leaving the heart, are difficult to diagnose on routine second trimester ultrasound. Additionally, the majority of CHD occurs in infants without prenatal risk factors that would prompt a fetal echocardiogram (Khoo et al., 2008). CHD due to arrhythmias, valve abnormalities, tumors, or poor function can also develop after the second trimester screening period.

Mandated postnatal pulse oximetry screening or the "CCHD Screen"

Pulse oximetry screening can detect additional cases of CCHD that go undetected prenatally. As of 2018, all states and the District of Columbia have implemented policies mandating the routine use of pulse oximetry screening for CCHD (Glidewell et al., 2019).

This CCHD screen consists of simultaneous pulse oximetry on the right upper extremity (pre-ductal) and one of the lower extremities (post-ductal) between 24 and 36 hours of life. If either reading is <90%, it is a failed test. If either value is between 90-94% or there is a >3% difference in the readings, the test is considered borderline and should be repeated in an hour. Three consecutive borderline tests also indicate a failed test. (Kemper et al., 2011)

Table 1. Signs of Congenital Heart Disease in Infants

Hyperdynamic or displaced precordial activity
Abnormal heart sounds Presence of click or third heart sound (S3 gallop) Single second heart sound (loss of physiologic split of S2 upon inspiration)
Pathologic murmur Loud, harsh, or blowing Pansystolic or diastolic Loudest at upper left or right sternal border
Hepatomegaly (>3 cm below the right costal margin on palpation)
Decreased lower extremity blood flow Diminished or absent lower extremity pulses SBP[a] ≥10 mmHg higher in the arms than legs
Radiographic changes Cardiomegaly or abnormal heart shape Dextrocardia Increased pulmonary vascular markings Pulmonary edema
Failed CCHD[b] Screen or abnormal hyperoxia testing[c]

[a] Systolic blood pressure, [b] Critical congenital heart disease, [c] Should be considered only in special circumstances after consultation with Pediatric Cardiology. Table adapted from (Altman, 2022).

A failed screen should prompt evaluation for cardiac or respiratory etiology. This assessment often includes four limb blood pressures, electrocardiogram, and a chest X-ray (Kemper et al., 2011). When the etiology of a failed screen remains unclear or the infant has any of the signs of cardiac disease listed in Table 1, prompt consultation with a Pediatric Cardiologist and echocardiogram are warranted. Earlier diagnosis and referral to care due to this screening could save as many as 120 infant lives each year (Abouk et al., 2017).

Skilled clinical newborn examination: It is important for all newborn care providers to be vigilant for early signs of CHD. The three primary signs of CHD are cyanosis, shock, and respiratory distress, and the pattern of presentation can provide insight into the type of lesion (Khalil et al., 2019).

Critically obstructive right heart lesions and mixing lesions present with cyanosis. Pulmonary blood flow may be dependent on flow across the ductus arteriosus. Cyanotic heart lesions must be differentiated from other etiologies of cyanosis in the newborn period such as pulmonary causes, hypoglycemia, methemoglobinemia, polycythemia, or hypoventilation due to inborn errors or neurologic disorders.

Critically obstructive left heart lesions lead to decreased systemic blood flow and can present as shock. Like cyanosis, there are many other etiologies of shock in the newborn period including hypovolemic shock due to blood loss, distributive shock due to sepsis, and cardiogenic shock from severe birth asphyxia with myocardial dysfunction.

Signs of CCHD can present in the delivery room but are often more subtle in the first hours to days of life due to the persistence of fetal circulation through the patent foramen ovale and ductus arteriosus (Khalil et al., 2019). For this reason, some newborns with CCHD will be discharged from their initial newborn hospitalization without diagnosis (Khalil et al., 2019). Primary care providers must remain vigilant for emerging signs of CHD listed in Table 1 and symptoms including poor feeding, diaphoresis, and failure to thrive (Abouk et al., 2017).

Initial management of symptomatic newborns with likely critical CHD
When CCHD is suspected, early management is aimed at ensuring adequate tissue perfusion and oxygenation (Khalil et al., 2019). Prompt transfer to a cardiac care center will facilitate definitive diagnosis and care.

When clinical deterioration happens rapidly in the newborn period, it is often due to closure of the ductus arteriosus (Altman, 2022). If there is suspicion that a lesion is reliant on this communication of the fetal pulmonary and systemic blood flows, PGE1 infusion should be initiated empirically. This will maintain patency of the ductus arteriosus until definitive diagnosis can be made.

As with prenatally diagnosed CHD, respiratory support should be aimed at maintaining normocarbia and relieving respiratory distress. Oxygen should be used judiciously, especially when oxygen saturations do not respond to increasing oxygen delivery. When transportation between hospitals is required, a plan for escalation of respiratory support and possible intubation should be discussed due to the high risk of apnea with PGE1. If intubation or other painful procedures are required for stabilization, sedative, and analgesic drugs should be strongly considered to decrease cardiac strain with agitation.

Because bacterial sepsis can also present as poor perfusion or cyanosis, blood cultures and empiric broad-spectrum antibiotics should be considered. Some features that differentiate cardiogenic shock from septic shock include absence of early onset sepsis risk factors, cardiomegaly on chest radiograph, differential pulses, and lack of improvement or clinical deterioration in response to volume resuscitation.

All enteral feeding should be stopped as adequate perfusion and oxygenation to the gut cannot be ensured. Dextrose intravenous fluids should be started, and blood glucose levels should be monitored to maintain normoglycemia. Electrolytes, blood gases, and ionized calcium levels, should be normalized using respiratory support, fluid adjustments, and infusions to optimize cardiac contractility.

Given the increased association of CCHD with extracardiac and genetic abnormalities, head and renal ultrasounds, and genetic screening should be considered non-emergently after arrival and stabilization at a cardiac center (Baker et al. 2012).

Conclusions

Optimization of the second-trimester anatomy ultrasound, increased availability of fetal echocardiography, and mandatory pulse oximetry screening have improved early detection of CCHD in recent decades. When CCHD is diagnosed or suspected, prompt stabilization and referral to a pediatric cardiac care center are critical to optimal long-term outcomes.

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Author Bios

Angela Lewis, MD, FAAP is an Assistant Professor in the Division of Neonatology at SSM Health Cardinal Glennon and other SSM Health St. Louis Special Care Nurseries. She serves as the Co-Director of the SSM Health Cardinal Glennon Fetal Care Institute. She has a special interest in antenatal consultation with families and the care of infants requiring extracorporeal membrane oxygenation (ECMO) support.

Renu Peterson, MD is a Professor in the Division of Cardiology at SSM Health Cardinal Glennon and serves as the Director of the Fetal Cardiology program. Her research interests include echocardiographic predictors of outcome in prenatally diagnosed congenital heart disease.

Alprostadil (Prostin®)

By Laurie Niewoehner, PharmD

Background

- The ductus arteriosus is a blood vessel connection between the pulmonary artery and the aorta, allowing most of the blood ejected from the right ventricle to bypass the nonfunctioning lungs and transfer to the aorta and then to the placenta for oxygenation.[1]
- Endogenous prostaglandins, primarily prostaglandin E2 (PGE2) and prostaglandin I2 (PGI2) are produced within the lumen of the ductus to maintain patency.
- At birth, an increase in arterial oxygen saturation and decrease in the endogenous prostaglandins promote closure of the ductus.
- Infants with congenital heart disease dependent on the patency of the ductus arteriosus for survival can be categorized in 3 groups[1]:
    - Severe restriction of pulmonary blood flow-pulmonary atresia/tricuspid atresia/tetralogy of Fallot-pulmonary circulation is dependent on the ductus arteriosus and post-natal constriction of the ductus causes hypoxemia and cyanosis.
    - Severe restriction of systemic blood flow–aortic stenosis, coarctation of the aorta, interrupted aortic arch or left hypoplastic heart syndrome-where the systemic circulation is dependent on the ductus arteriosus and postnatal constriction of the ductus may cause systemic hypoperfusion, severe congestive heart failure, and death.
    - Cardiac anomalies where adequate mixing of pulmonary and systemic blood flow is necessary for maintaining circulation in series-transposition of the great arteries.

Alprostadil Indications

- Infants born with a known or suspected ductal dependent congenital cardiac lesion until surgery can be performed.
- Persistent Pulmonary Hypertension in the Neonate (PPHN) - to assist with right heart function for infant with inadequate blood pressure.

Preparation[2, 3]

- Mix 500 mcg (1 mL) with 49 mL of D5W/D10W/NS - total volume 50 mL - Concentration 10 mcg/mL
- Infuse through an umbilical or large peripheral vein.
- Initial infusion rate 0.025 - 0.1 mcg/kg/min. Once therapeutic response is achieved, reduce dose to lowest effective dosage for the shortest amount of time. Therapeutic response is indicated by an increase in systemic blood pressure and pH in those with restricted systemic blood flow and acidosis, or by an increase in oxygenation (pO2) in those with restricted pulmonary blood flow.

Mechanism of Action

- Promotes dilation of the ductus arteriosus (PDA) in infants with congenital heart disease dependent on ductal shunting for oxygenation and perfusion.
- 60-80% of PGE1 is metabolized on first pass through the lungs, it must be given by continuous infusion.[2]
- At a starting dose of 0.025 - 0.1 mcg/kg/min, the ductus usually reopens within 30 min to two hours of starting the PGE1. with the response being instant if the duct is vital for the infant's hemodynamic status.

Adverse Effects[1, 2, 3]

- Short term
    - Apnea - 10-12% - dose dependent, most often seen in neonates weighing less than 2 kg, and usually appears during the first hour of infusion. Infants receiving alprostadil may respond to low-or high-flow nasal cannula as a stimulant if apnea is associated with the medication. Monitor respiratory status throughout treatment and use alprostadil where ventilator assistance is immediately available.
    - Fever and hypotension - if this develops, the infusion rate should be slowed until resolution.
    - Cutaneous flushing - generally due to improper catheter placement and rapidly reverses with repositioning of the catheter.
    - Extravasation of concentrated solution may cause sloughing or necrosis.

- Long term
  - Use for greater than 120 hours (five days) is associated with cortical hyperostosis, brown fat necrosis, intimal mucosal damage, and gastric outlet obstruction.
  - Cortical proliferation of long bones has been associated with long-term infusions of alprostadil – most cases of bone changes occurred four to six weeks after starting alprostadil but has been as early as nine days.
  - In a study of 86 infants awaiting cardiac transplant, the incidence of hyperostosis:
    - <30 days of PGE infusion: 42%
    - 30-60 days of PGE infusion: 87%
    - >60 days of PGE infusion: 100%
    - *Normally, cortical hyperostosis resolves over 6-12 months.

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Author Bio

Laurie Niewoehner, PharmD is a Clinical Pharmacist, specializing in high-risk obstetrics and neonates at SSM Health St. Mary's Hospital – St Louis. She obtained a Pharm. D from the University of Minnesota and completed a pediatric pharmacy residency at Children's Mercy Hospital in Kansas City, Missouri. Laurie currently serves as a preceptor at the University of Health Sciences and Pharmacy in St. Louis.

Multidisciplinary Fetal Monitor Strip Review Process

By Elise Buchheit MSN, RNC-OB

Background

In 2004, The Joint Commission (TJC) brought the issue of safety to the perinatal community when they identified failure to communicate and function as a team as the root cause of infant injury and death during delivery. Eight years later, data from TJC showed that communication continued to rank among the top three contributing factors for maternal and neonatal sentinel events (The Joint Commission Sentinel Event Data: Root Causes by Type, 2012). Research has shown that increased collaboration and working jointly with others improves patient and provider satisfaction and patient outcomes (Horbar et al., 2001).

Effective communication between delivering providers and nurses is vital to patient safety in obstetrics (Lyndon et al., 2011). In our efforts to improve communication and collaboration among providers and nursing, we conduct monthly multidisciplinary fetal monitor strip reviews on the Labor and Delivery unit at SSM Health St. Mary's Hospital - St. Louis. Interdisciplinary strip review improves communication by building on an infrastructure of respect, attentiveness, collaboration, and competence (Lyndon et al., 2011).

Implementation of perinatal patient safety initiatives have resulted in improved outcomes, as evidenced by decreased incidence of obstetric adverse events and improvements in safety culture, as well as significant decreases in malpractice litigation (Clark et al., 2008; Pettker et al., 2009).

Team Composition

The multidisciplinary team at our tertiary care center consists of nursing staff from the Labor and Delivery and Antepartum units, nursing leadership, low-risk attending physicians, high-risk attending physicians, Maternal Fetal Medicine (MFM) Fellows, OBGYN resident physicians, medical students, and nursing students. It is important to include key stakeholders on your team, dependent on your practice setting.

Process of Identifying Strips to Review

The providers and staff identify strips in real time which they feel would be value-added to review. The Nursing Operations Manager reviews the record and prepares a brief synopsis for the team. We have developed a culture of safety on the unit. The goal of the fetal monitor strip reviews is to provide education, identify opportunities, and increase collaboration and communication, ultimately improving patient care and decreasing adverse events.

Strip Review Process

We hold our fetal monitor strip review once per month at 0730 on the Labor and Delivery Unit. The strip is displayed on a large television at the nurse's station so all participants can view while maintaining HIPAA compliance. The strip review is led by the Operations Manager and the Chief Resident of Labor and Delivery. We start the review by providing a brief background of the patient, chief complaint upon admission, pertinent medical history, initial vital signs, and then discuss the birthing person's labor course. As we review the tracing and review the labor course, we discuss when medications were administered, Pitocin titration, cervical exams performed, interventions performed, and other pertinent information. We prompt discussion by encouraging the participants to identify the strip, describe definitions and physiology of fetal monitor changes, and discuss interventions. Once the review is final, we discuss the outcome and any questions or opportunities that may have been identified.

Summary

It is crucial to recognize and acknowledge interpretation of intrapartum fetal monitoring is best performed by an interdisciplinary team involving nurses, midwives, and physicians with highly variable levels of experience and expertise. As a team endeavor, interdisciplinary team training is one way to achieve optimal outcomes for the birthing persons and infants in our care (Miller & Miller, 2013). Implementing multidisciplinary fetal monitor strip review as part of your quality improvement process builds collaboration and communication to create strong, cohesive teams.

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Author Bio

Elise Buchheit MSN, RNC-OB is the Operations Manager of SSM Health Women's Services and the Maternal Transport Team at SSM Health St. Mary's Hospital-St. Louis. In this role, she helps support the four Women and Infant Service's departments and oversees the Maternal Transport Team. Elise also serves as the St. Louis Chapter Chair for the Association of Women's Health, Obstetric, & Neonatal Nurses (AWHONN). She received her MSN with an emphasis in Nursing Education from Webster University in 2016 and her RNC-OB certification in 2018.

Continuing Education Opportunities

Many continuing education opportunities, including traditional lectures, hands-on skills sessions, as well as online presentations are available for perinatal professionals in eastern Missouri and Southern Illinois. Continuing education activities are offered through the Perinatal Outreach Program in conjunction with SSM Health St. Mary's Hospital - St. Louis, SSM Health Cardinal Glennon Children's Hospital, and Saint Louis University School of Medicine. Most educational offerings provide professional continuing education credits to participants upon completion.

For course calendars or more specific information on programs, please visit ssmhealth.com/perinataloutreach, call the Perinatal Outreach Program at 314-577-5317, or send an email to SSM-PerinatalOutreach@ssmhealth.com.

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