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acute flaccid myelitis: a case study in the pediatric intensive care unit

by Kristin Mikolajewski, MSN, CPNP-AC/PC

learning objectives

Following the completion of this article, the reader should be able to:

1. Discuss diagnostic criteria for acute flaccid myelitis.
2. Review management and treatment options for acute flaccid myelitis.
3. List complications associated with acute flaccid myelitis.

A previously healthy 13-year-old unimmunized male presented to the emergency department with a one-day history of right shoulder weakness and neck stiffness. Symptoms started approximately one week prior with fever (103°F), sore throat, nasal congestion and dizziness. He was initially evaluated by his primary care physician, diagnosed with sinusitis and prescribed a course of amoxicillin. Two days later, he developed left-sided facial droop and difficulty swallowing. He was taken to the local ED where he was diagnosed with Bell's palsy and prescribed a course of oral steroids. The following day he developed right shoulder weakness as well as neck stiffness. He returned to the local ED where he underwent MRI and CT scan of the head and cervical spine which were both normal. Due to the severity and rapid progression of symptoms, he was transported to the local children's hospital for further evaluation. Additional history was noncontributory. No recent travel. No insect bites. No vomiting. No diarrhea. No rash. No bowel or bladder dysfunction. No known ill exposures. Home medications included ibuprofen for fever as well as the prednisone and amoxicillin as previously prescribed.

The patient's admission exam was significant for a left-sided facial droop, asymmetric smile and inability to completely close left eyelid. Pupillary reflexes were normal. He was unable to shrug his right shoulder or lift his right arm against gravity. He had right upper extremity hyporeflexia and proximal weakness (shoulder strength 2/5, elbow strength 4/5, hand grip normal). All other extremities had normal strength and tone. He had no sensory deficits. He was able to ambulate and sit upright but required head support. He was alert and oriented with normal speech.

Initial lab workup was notable for a positive rhinovirus/enterovirus PCR (polymerase chain reaction) from respiratory secretions, a lumbar puncture showing cerebrospinal fluid (CSF) pleocytosis (WBC 18/mm^3) and a positive mycoplasma pneumoniae CSF antibody screen. His CBC and BMP were normal.

CSF Analysis: Colorless and clear, Glucose 61 mg/dL, Protein 52 mg/dL, WBC 18 cell/mm^3 (HIGH), RBC 28 cell/mm^3 (HIGH), Lymphocyte 76% (HIGH), Eosinophil 2%, Monocyte/ Macrophage 22%
CSF culture negative (including fungal)
CSF Enterovirus PCR negative
CSF HSV PCR negative
CSF mycoplasma pneumoniae IgM and IgG positive
CSF Borrelia burgdorferi antibody negative
CSF oligoclonal bands negative
CSF Aquaporin-4 antibody negative
CSF arbovirus panel negative
ANA negative
Double stranded DNA antibody negative
HSV PCR blood negative
Stool viral culture negative
Respiratory PCR panel POSITIVE for Rhinovirus/enterovirus *repeat 48 hours later was negative
Blood culture negative
Urine culture negative

table 1.
Laboratory data

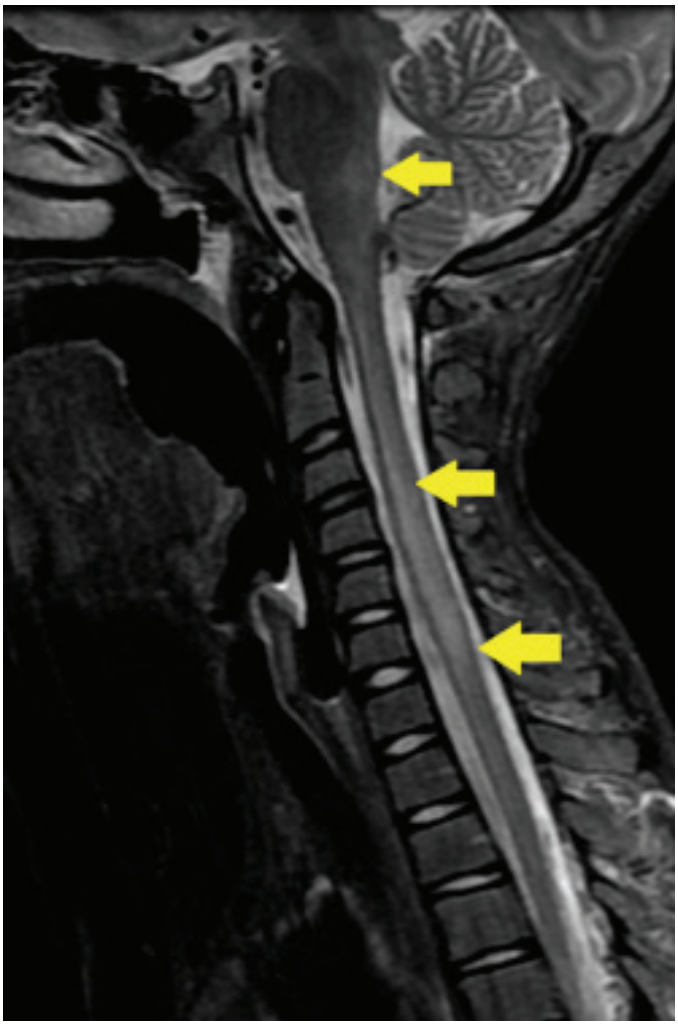

figure 1. MRI image demonstrating increased signal within the spine extending superiorly into the brainstem starting at the level of the middle cerebellar peduncle and extending downward into the medulla and cervical spinal cord to the level of C7.

Due to high risk for respiratory failure, the patient was admitted to the pediatric intensive care unit. He was started on empiric treatment for meningitis and transverse myelitis, which included methylprednisolone 30 mg/kg/day, ceftriaxone 100 mg/kg/day and acyclovir 30 mg/kg/day.

A nasogastric feeding tube was placed for nutrition due to cranial nerve dysfunction and aspiration risk. Physical therapy, occupational therapy and speech therapy were consulted for early rehabilitation treatment. NIFs (negative inspiratory force) and exhaled CO_2 via nasal cannula were monitored to assist with early identification of respiratory failure.

Despite 72 hours of aggressive steroid and antibiotic therapy, the patient's condition worsened with weakness spreading to his left upper extremity. He underwent repeat MRI which now showed concern for cervical myelitis with a spinal cord lesion extending from the level of the brainstem down to the level of C7 (figure 1).

A team of physicians from neurology, infectious disease, immunology, pediatric critical care, neurosurgery, pediatric surgery, physical medicine and rehabilitation, and nephrology reviewed the case. The team concluded that this patient's symptomatology and MRI findings were most consistent with acute flaccid myelitis (AFM), an acute neurologic disorder characterized by unilateral flaccid weakness. While there are no evidenced-based treatment guidelines for AFM, there are case studies documenting improved outcomes with steroids and plasma exchange. At this point, the medical team decided to proceed with plasma exchange. (Plasma exchange, or plasmapheresis, is a procedure in which inflammatory mediators are filtered from the blood. It is frequently used in the treatment of neurologic disorders with autoimmune etiology.)

The patient remained hospitalized for 13 days. He received a total of five days of high dose IV steroids, five plasma exchange transfusions and 14 days of doxycycline for the treatment of mycoplasma pneumoniae. The ceftriaxone and acyclovir were discontinued after 48 hours with negative CSF, blood and urine cultures. His respiratory status remained stable, requiring only a brief period of supplemental oxygen via nasal cannula. At time of discharge, the patient was able to support his own head, ambulate independently and tolerate a regular diet by mouth. He had minimal improvement in his extremity weakness or facial palsy. On six-month follow-up, the patient had completed extensive rehabilitation therapy consisting of two hours a day, five days a week. He had resolution of left upper extremity weakness. His right shoulder weakness and left facial palsy were present but improved. The probability of full recovery is unknown, but he continues with therapy in hopes of continued improvements.

defining characteristics	acute flaccid myelitis	transverse myelitis	Guillain-Barre syndrome	acute disseminated encephalomyelitis	spinal cord infarct
Encephalopathy	not present	not present	not present	present	not present
Cranial nerve dysfunction	may or may not be present	not present	may or may not be present	may or may not be present	not present
Muscle tone	decreased, often unilateral, UE > LE	initially decreased, increased in later stages, often bilateral, LE > UE	decreased, ascending in nature, often symmetric, LE > UE	variable	decreased
Sensory deficits	typically not present	present (clearly defined sensory level)	present	may or may not be present	present
Reflexes	decreased	acutely decreased, chronically increased	decreased	variable	decreased
CSF Pleocytosis	present	present	not present	present	not present

table 2. Differential diagnosis of acute flaccid myelitis

LE = lower extremities
UE = upper extremities

discussion

The definitive diagnosis for this case was challenging as the patient's symptomatology did not meet the classic criteria for a single disease process. This patient exhibited cranial nerve involvement, which is less likely with AFM. However, the unilaterality of his weakness and the gray matter findings on MRI were more characteristic of AFM. One could argue that this case meets the criteria for an atypical presentation of either acute transverse myelitis (ATM) or AFM (table 2). In fact, some experts argue that AFM is a subset of ATM. Nonetheless, this patient showed improvement with high dose steroids and plasma exchange. Both of these therapies have been associated with positive outcomes in ATM and AFM. Additionally, while the etiology of his illness was never defined, the labs suggested an infectious causality related to enterovirus or mycoplasma pneumoniae. Both of these pathogens have documented associations with AFM and ATM. The possibility of poliomyelitis was discussed given his unimmunized status, but was later ruled out with negative stool viral panel. The lack of data surrounding the treatment of AFM made this case challenging, and highlights the need for more robust research moving forward.

background

AFM is a rare, polio-like illness that is characterized by acute onset of flaccid weakness of one or more extremities with specific MRI findings of lesions within the anterior horns of the gray matter of the spinal cord[1]. The illness typically occurs in children (median age 6 years) and affects more males than females. The onset is usually rapid (within hours to days) and asymmetric. The upper extremities are more predominantly affected than the lower, and the proximal muscle groups are more predominantly affected than the distal[2]. Patients exhibit weakness consistent with a lower motor neuron process with clinical findings of hyporeflexia or arefelxia and hypotonia. Cranial nerve dysfunction occurs in 30 percent of cases[2]. Sensory deficits are rare, but if present are usually mild and transient. MRI findings are most common in the cervical spine. The gray matter lesions are initially diffuse but become more localized to the anterior horn cells over days to weeks. CSF pleocytosis is present in 80 percent of cases[3]. Many patients experience a prodrome of respiratory or gastrointestinal symptoms, which may include fever, approximately five days prior to onset of weakness[2,4]. Prognosis is not well understood. Aggressive rehabilitation therapy has shown improvement in

functional outcomes although complete recovery is rare. Residual deficits range from mild to severe with the most severe cases resulting in tracheostomy for long-term mechanical ventilation as well as gastrostomy tube for ongoing nutrition.[2] To date, no fatalities have been directly related to AFM.[5]

diagnosis

AFM is diagnosed through physical examination and MRI of the brain and spinal cord.[1] Lumbar puncture with CSF analysis is also helpful. Diagnosis can be challenging as AFM has a similar presentation to transverse myelitis and Guillain-Barre syndrome. The Centers for Disease Control and Prevention (CDC) defines AFM as an illness with acute onset of flaccid extremity weakness with either 1) an MRI with spinal cord lesion largely restricted to gray matter and spanning one or more vertebral segments (confirmed case), or 2) CSF white blood cell count > 5/mm^3 (probable case). Spinal cord lesions may not be present on initial MRI, thus a negative MRI within the first 72 hours of onset of limb weakness does not rule out AFM[1].

epidemiology

The first U.S. outbreak of AFM was reported by the CDC in 2014 with 120 confirmed cases in 34 states. Since that time, there has been an upsurge of biennial outbreaks in the summer and fall months. In 2016, there were 149 confirmed cases in 39 states. In 2018, there were at least 228 confirmed cases in 41 states (figure 2). So far in 2019, there are four confirmed cases in four states. This data is as of March 29, 2019[1]. The CDC is still working to confirm cases from 2018 and 2019.

The term AFM was identified in 2014 in response to the outbreaks. Prior to 2014, similar illnesses were classified under the umbrella term, acute flaccid paralysis (AFP), which includes Guillain-Barre syndrome, transverse myelitis and poliomyelitis[5]. Not all AFP cases demonstrate the distinctive MRI findings as seen with AFM. Thus, a formal case definition was created by the CDC for tracking and reporting purposes. Many patients that presented prior to 2014 were classified as transverse myelitis, but would have likely met the newly defined AFM criteria.

While a definitive etiology of AFM has not been identified, epidemiologists have discovered that the biennial outbreaks of AFM have coincided with spikes in enterovirus D-68 (EV-D68) cases. Additionally, EV-D68 was the most commonly identified pathogen in the respiratory specimens of AFM patients[1]. This suggests that EV-D68, primarily a respiratory illness, is the primary driver of the recent upsurges. Some experts have proposed that the increase of EV-D68-associated AFM may be attributed to the heightened neurotropism (affinity for nervous tissue) with modern strains of EV-D68, which increases the pathogen's ability to infect and kill neurons[2].

Aside from EV-D68, multiple pathogens have been detected in stool and respiratory specimens of AFM patients, including EV-70, EV-71, coxsackievirus A and B, echovirus, rhinovirus, West Nile virus, Japanese encephalitis, St. Louis encephalitis, cytomegalovirus and Epstein-Barr virus. All of the stool specimens have tested negative for poliovirus[1]. Detection of pathogens within the CSF is rare, as only four out of 551 confirmed cases reported to the CDC have isolated CSF pathogens[1].

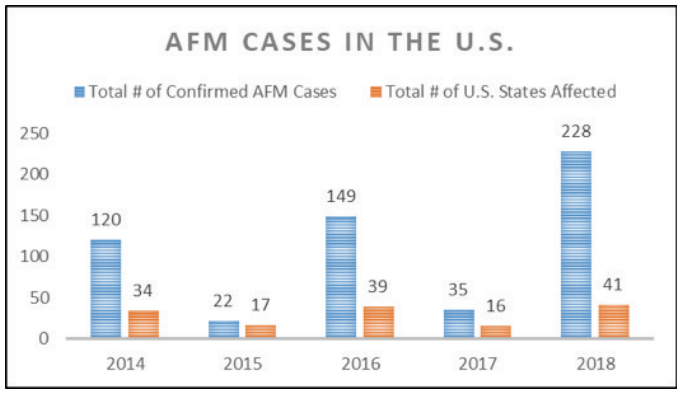

figure 2. This graph shows the number of AFM cases confirmed by the CDC as of March 29, 2019. The case counts are subject to change as the CDC continues to investigate and confirm all of the cases reported. The most current data is available at: https://www.cdc.gov/acute-flaccid-myelitis/afm-cases.html.

pathophysiology

The pathophysiology of AFM is not well understood, but is thought to be infectious or autoimmune in nature[6]. This leads to the theoretical assumption that spinal cord damage is either the result of a direct infection or a post-infectious or autoimmune inflammatory response. This is

an important discernment as the treatment for each is different. Incorrect treatment may result in worsening of the disease process, particularly in the setting of immune suppressants and active infection.

management

There are no evidence-based treatment guidelines for AFM, but there are an increasing number of case studies that have documented the potential benefits of immune-targeted therapies such as steroids, intravenous immunoglobulin (IVIG), and plasma exchange. However, these therapies remain controversial due to theoretical concerns for immunosuppression in the setting of acute infection. In 2018, the CDC released a Summary of Interim Considerations, which provides a discussion of potential treatment modalities for AFM[7]. The key points are summarized below:

• **Corticosteroids:** Corticosteroids have demonstrated improved outcomes in the setting of white matter, or upper motor neuron, involvement and spinal cord edema. Experts theorize that steroids may prevent further damage to spinal cord tissue in an ongoing immune or post-infectious inflammatory response. On the contrary, corticosteroids have been associated with poorer outcomes in EV-D68 and EV-71-associated neurological disease. After a 2012 outbreak in Cambodia, a commission within the World Health Organization concluded that corticosteroids were contraindicated in the management of EV-71-associated neurological disease. The CDC further noted that the incidence of EV-71-associated neurologic disease within the U.S. increased in 2018.

• **IVIG and plasma exchange:** Multiple case studies have documented improved outcomes with use of IVIG and plasma exchange. However, IVIG, plasma exchange and corticosteroids are often used in combination, making it difficult to discern the efficacy. While there is no supportive data, there is also no data to suggest that IVIG or plasma exchange is likely to be harmful to the patient (aside from known side effects and procedural risks).

• **Fluoxetine:** Fluoxetine, a selective serotonin reuptake inhibitor (SSRI), has shown in vitro activity against EV-D68 but has not been associated with improved outcomes in humans. A 2015-2016 multicenter study concluded that AFM patients treated with fluoxetine were more likely to have severe paralysis and poorer outcomes in setting of EV-D68.

• **Antivirals:** There is no data to support the use of antivirals in the treatment of AFM unless there is suspicion of herpes virus infection.

• **Interferon:** There is no data to support the use of interferon in the treatment of AFM.

prevention

Since AFM is suspected to involve an infectious causality, prevention strategies align with those of viral illnesses including effective hand hygiene and avoiding close contact with people who are ill. There is increasing concern surrounding the need for an EV-D68 vaccine as the AFM upsurges of 2014, 2016 and 2018 are similar to those of the poliomyelitis outbreaks that left thousands of children paralyzed. To date, there is no vaccine for preventative measures against AFM.

summary

Community education and awareness of AFM is crucial as it impacts the accurate and early identification of the disease. Late recognition not only delays treatment but also inhibits early specimen testing where shedding of the pathogen may be transient, such as with respiratory and stool samples. The delayed recognition of AFM has likely contributed to the underrecognition and underreporting of the disease process. The medical community, along with the CDC, must continue to work toward a better understanding of the pathogenesis, prevention and treatment strategies for AFM.

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CME questions

1. **AFM is characterized by flaccid weakness of all extremities.**

a. True

b. False

2. **Plasma exchange and high dose steroids have demonstrated improved outcomes in patients with AFM.**

a. True

b. False

3. **Enterovirus D68 outbreaks have coincided with recent outbreaks of AFM.**

a. True

b. False

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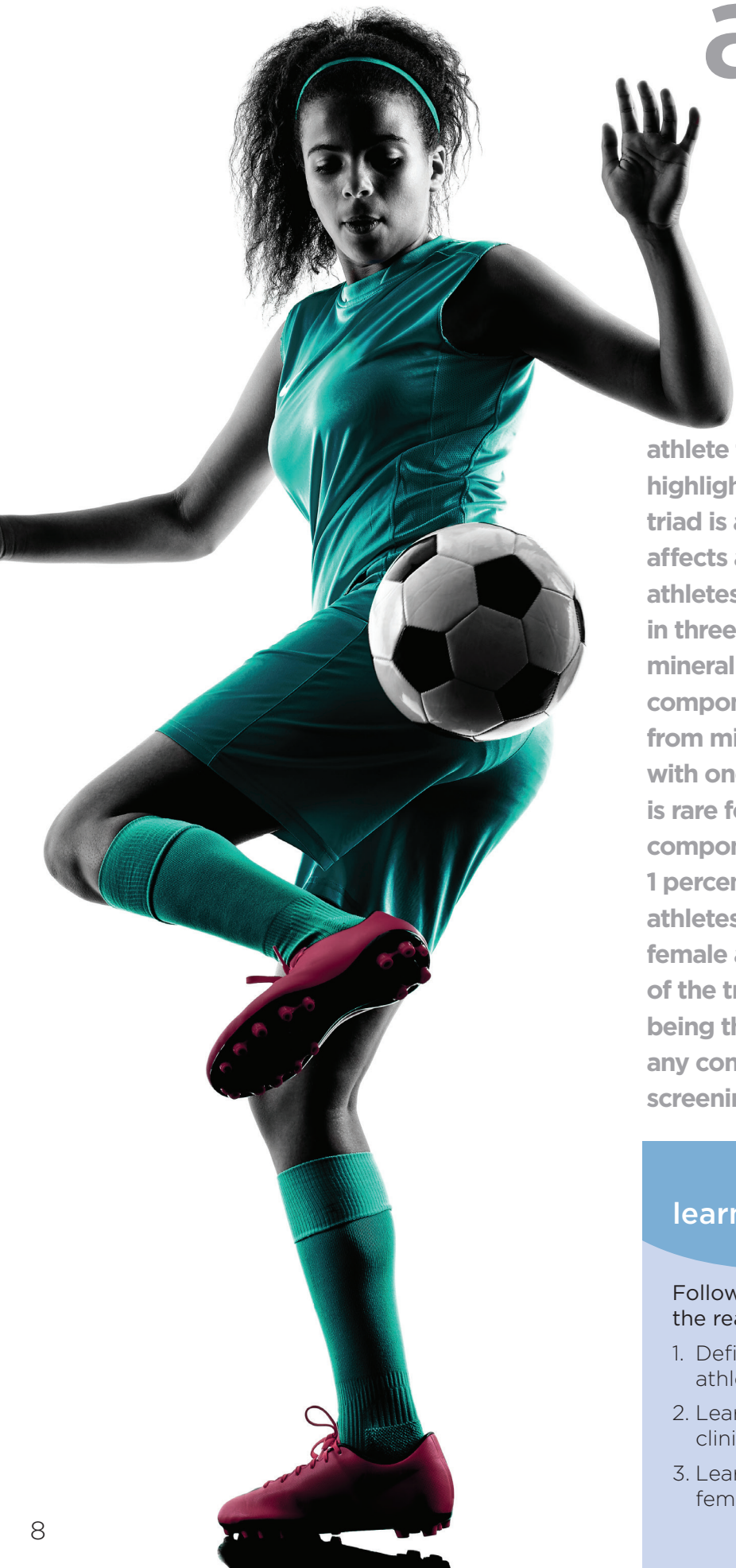


female athlete triad

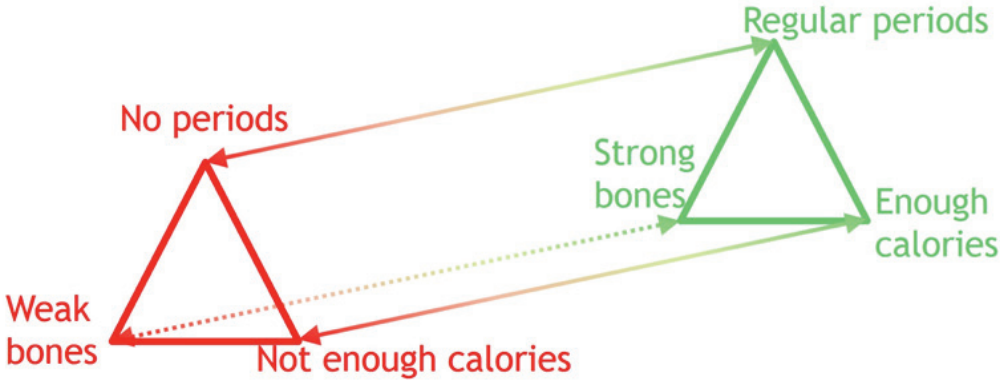
by Lora Scott, MD

In 2016, the AAP published its first policy statement on the female athlete triad. This article covers some of the highlights of that statement. Female athlete triad is an underdiagnosed condition that affects about half of female high school athletes. The triad consists of abnormalities in three areas: menstrual function, bone mineral density and energy availability. Each component occurs on a spectrum, ranging from mild to severe. Patients may present with one, two or all three components. It is rare for a female athlete to have all three components of the triad, representing around 1 percent of cases in high school female athletes. Up to 54 percent of high school female athletes have at least one component of the triad, with menstrual irregularities being the most common. If an athlete has any component of the triad, it should prompt screening for the other components.

learning objectives

Following the completion of this article, the reader should be able to:

1. Define the three components of the female athlete triad.
2. Learn available screening tools to use in clinic for the female athlete triad.
3. Learn basic treatment principles for the female athlete triad.



Sports at highest risk for developing female athlete triad include endurance sports, sports with an aesthetic component of their performance, and sports with weight classes. Particularly high-risk sports include cross country, swimming, cycling, cheer, gymnastics, dance and figure skating. Other risk factors include early sports specialization, family dysfunction, abuse and family dieting.

The condition is more difficult to diagnose in adolescent patients, where irregular menses or amenorrhea can be normal, depending on the patient's age. However, it is important to make a diagnosis and manage this condition when it occurs in adolescents, since this is a time of peak bone growth. The condition typically comes to attention from a screening questionnaire, or when the patient has a bone injury.

energy availability

The vast majority of adolescent females with female athlete triad do NOT have a true eating disorder or intentional weight loss. More often, they have difficulty eating enough to sustain their level of exercise. Athletes who eat 2,000 kcal per day, but need 3,000 kcal per day to fuel their exercise, will still have physiological problems due to their energy deficit. Low energy availability can lead to disruptions in menstrual function and bone mineralization. Athletes may initially present with vague symptoms, such as fatigue. There is limited evidence that athletes with menstrual irregularities have a measurable decrease in exercise performance.

menstrual function

Menstrual irregularities are extremely common in adolescent females, with an incidence of 21 percent in the sedentary female adolescent population. In contrast, menstrual irregularities occur at more than double the rate in adolescent female athletes, occurring in up to 54 percent.

Menstrual dysfunction due to female athlete triad is a diagnosis of exclusion in this population, after ruling out other potential causes of menstrual irregularities (such as pregnancy). Once other causes of amenorrhea are excluded, patients with amenorrhea and a history of low energy availability are diagnosed with functional hypothalamic amenorrhea. In this condition, the reproductive system functions normally, but is suppressed by lack of energy. The treatment is to improve energy availability until normal menstrual function resumes.

bone mineral density

Maximum formation of bone mass occurs during childhood and adolescence. Bone mass typically peaks during a person's 20s, then declines. Genetics, activity level and diet can all influence bone mass formation. Inadequate bone mass formation during adolescence will impact a patient's future risk of developing osteoporosis as an adult.

Types of menstrual irregularities

Primary amenorrhea

- No signs of puberty by age 14 OR
- No menarche by age 15 OR
- No menarche within 3 years of thelarche

Secondary amenorrhea

- No menses for 3 months

Oligomenorrhea

- Cycle longer than 35 days

Luteal phase deficiency

- Luteal phase shorter than 11 days OR
- Low progesterone levels

table 1. Types of menstrual irregularities

Bone mineral density (BMD) is typically measured using a DXA scan at a pediatric center, where results can be compared to age-based controls instead of adults. The American College of Sports Medicine has proposed more rigorous criteria for interpreting results in weight-bearing athletes, since they are expected to have increased bone-mass compared to their sedentary peers.[2]

It is outside the scope of this article to review how different types of sports can impact bone

health and density, or to review other medical conditions that can affect bone health. Developing healthy bones during adolescence is a multi-factorial process, of which energy availability plays a large—but not isolated—role. Menstrual irregularities and/or stress injuries in the bone often function as a "check engine" light on the dashboard, indicating there could be a larger problem with bone health or energy availability.

diagnosis

The American Academy of Pediatrics (AAP) recommends using a questionnaire to screen all adolescent female athletes for the triad during a well check-up or pre-participation physical.[1] Several versions of screening tools are available, and many centers will modify the tools to fit their clinic population. Table 2 outlines the screening tool that is built into the fourth-edition pre-participation physical evaluation consensus monograph. Similar questions appear on the Ohio pre-participation physical form for high school athletes. Unfortunately, these questions may not be an adequate screening tool for younger adolescents, where irregular menses or amenorrhea could be normal, or could be pathologic. Sometimes it is necessary to question a patient's mother about her early adolescent menstrual history as well.

Each screening tool has its own scoring system, allowing a physician to risk-stratify their athletes into low, moderate and high risk for having female athlete triad. This score will help guide additional work-up and return-to-play decisions. This can be reassessed as the athlete is treated for the condition.

Please keep in mind that this is only a brief screening tool, not a diagnosis. A "yes" answer to any question should prompt a more thorough evaluation. Full evaluation includes an extensive nutritional, menstrual, exercise, and injury history. Exam should include heart rate, orthostatic measurements, body weight percentile for age and height, percent of ideal body weight, and BMI. Other than abnormalities in vital signs, those with the triad tend to have a normal exam. Findings of lanugo, cold or discolored extremities, or parotid gland enlargement may signal that the athlete has a true eating disorder, such as anorexia nervosa[1].

Evaluation for female athlete triad should also include additional laboratory and/or radiological testing. Labs typically focus on other causes of irregular menses, such as screening for pregnancy, polycystic ovary syndrome (PCOS), and thyroid disorders. BMD testing indications are listed in table 3, and are consistent with the AAP policy statement for female athlete triad.[1]

1. Do you worry about your weight or body composition?
2. Do you limit or carefully control the foods that you eat?
3. Do you try to lose weight to meet weight or image/appearance requirements in your sport?
4. Do you currently or have you ever suffered from an eating disorder?
5. Do you ever eat in secret?
6. What age was your first menstrual period?
7. Do you have monthly menstrual cycles?
8. How many menstrual cycles have you had in the last year?
9. Have you ever had a stress fracture?

table 2. Screening tool

BMD/DXA testing for female athletes with

Any of the following:

- Current eating disorder
- Weight <85% ideal body weight
- Weight loss of > 10% body weight
- Menstrual dysfunction for over 6 months
- Low energy availability for over 6 months

or

Stress fracture PLUS one of the following:

- Low BMI (<18.5)
- More than 1 stress fracture
- Menstrual dysfunction <6 months
- History of prior eating disorder
- Chronic medical conditions or medication use associated with bone loss
- High risk stress fracture location
- Cyclists, swimmers

table 3. BMD testing indications

treatment

The primary treatment is to increase energy availability, either by increasing caloric intake

and/or decreasing exercise levels. This leads to subsequent increase in BMD and restoration of normal menstrual function. The first steps in treatment include increasing dietary intake by 200-600 kcal/day, and decreasing training volume by one day per week. Many adolescent athletes need a written contract that is signed by the athlete, parent and medical team that outlines the treatment plan and expectations for those involved. It can take one year or longer for restoration of normal menses after reaching appropriate energy availability.

Treatment often requires a team approach, which should include the treating physician, dietitian and the team's athletic trainer (if available) or school nurse. In some cases, an exercise physiologist and mental health specialist may be required as well. Athletes should be encouraged to address issues about weight and nutrition with medical professionals, rather than coaching staff or teammates.

medications

The use of oral contraceptive pills (OCPs) is not recommended unless it is needed for another reason, such as preventing pregnancy. Although the hormones in OCPs can restore a normal menstrual cycle, there are no studies that show they can improve BMD in the adolescent population with female athlete triad. Using OCPs to regulate menstruation can make it more difficult to determine when a patient truly meets her treatment goals.

Calcium and vitamin D are independently inadequate in treating the triad, but do have a positive effect on bone health. It is recommended that they are given as part of a larger treatment plan.

Bisphosphonates and other medications used in treating postmenopausal osteoporosis are not helpful in the adolescent female athlete triad.

male athletes

There is emerging research that suggests male athletes may have a similar condition, where low energy availability also impacts bone health and reproductive hormones. Without being able to monitor menstrual cycles, it is difficult to diagnose or study this population as easily. This is an area of future research.[1]

summary

Female athlete triad is a surprisingly common condition that can impact long-term bone health when left untreated. For more information, please read the AAP statement on the female athlete triad published in 2016.

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author

Lora Scott, MD

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CME questions

4. Approximately what percentage of high school female athletes have at least one component of the female athlete triad?

a. 5%

b. 20%

c. 50%

d. 80%

e. 95%

5. A 16-year-old female cross country runner with a BMI of 22, negative pregnancy test, and amenorrhea every year during her sports season does NOT need further evaluation.

a. True

b. False

6. What is the best treatment for irregular menses due to female athlete triad?

a. Increase calorie intake

b. Decrease exercise

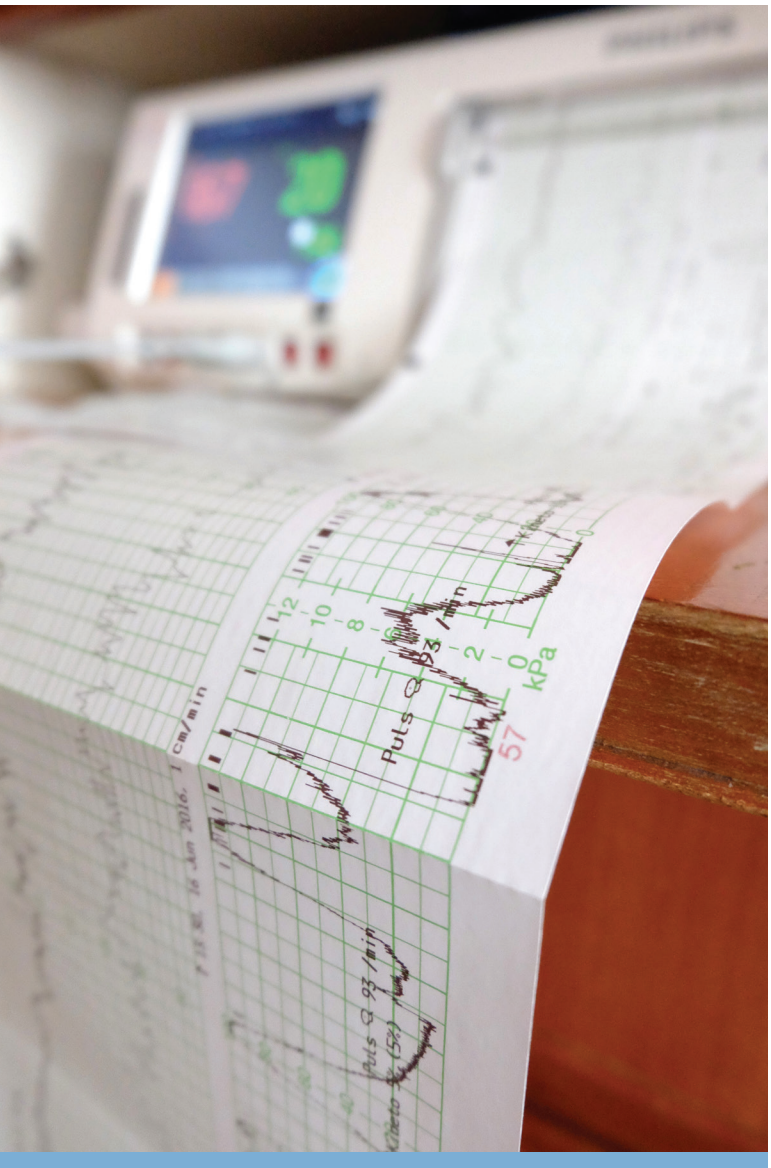
c. Oral contraceptives

d. A and B

e. A, B, and C

fetal cardiology now

by Lubabatu Abdurrahman, MD, and Joseph Ross, MD



learning objectives

Following the completion of this article, the reader should be able to:

1. Discuss what the field of fetal cardiology has to offer.
2. List the indications for referring a pregnant woman for fetal echocardiography.
3. Review the need for collaboration with maternal fetal medicine specialists and other specialists in caring for the fetus with congenital heart disease.

Congenital heart disease is a leading cause of infant morbidity and mortality. The overall incidence of congenital heart disease is estimated at six to 12 per 1,000 live births, and for moderate to severe congenital heart disease, six per 1,000 live births.[1] Accurate and timely diagnosis of fetal heart disease can improve postnatal outcomes especially in those cases likely to require prostaglandin infusion to maintain patency of the ductus arteriosus after birth.[2,3]

Comprehensive fetal cardiology is a team approach involving primarily the pediatric/fetal cardiologist, maternal fetal medicine specialists and neonatologists. Variably and depending on the presence of associated defects, the fetus may have additional practitioners involved: pediatric radiologist, geneticist and genetic counselors, pediatric pulmonologist, neurologist, urologist, surgeons and otolaryngologists. These specialties may be involved in providing care both prenatally and postnatally.

The cardiologist's primary tool in assessing the fetus is echocardiography. This allows single/serial and accurate assessment(s) of fetal cardiac structure, function and rhythm (figure 1). Ultrasound now permits precise and detailed diagnosis of structural and functional heart disease (figure 2 and 3).

The goal is to better understand the fetal patient taking into account the difference between the fetal and postnatal circulation. Fetal echocardiography is broadly defined as a detailed sonographic evaluation used to identify and characterize fetal heart anomalies prior to delivery. It is a specialized diagnostic procedure beyond the "basic" and "extended basic" fetal cardiac screening performed as part of routine obstetrical screening.

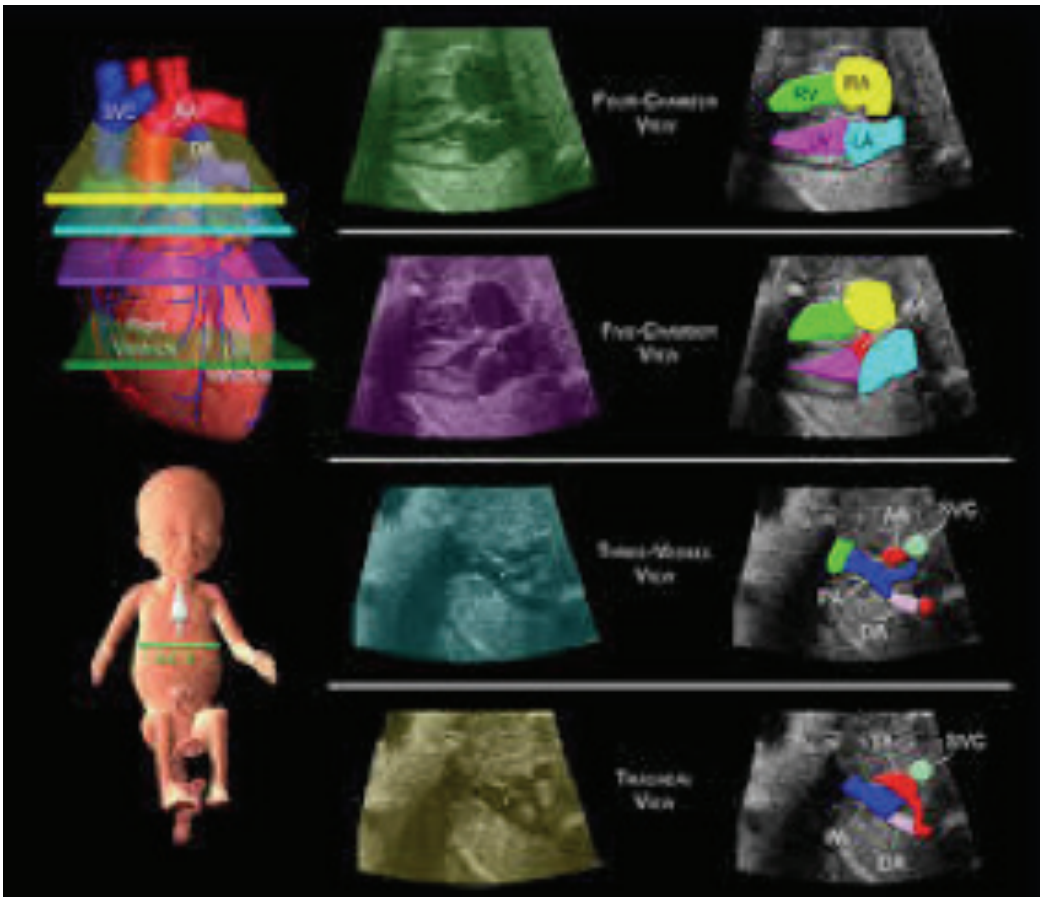


figure 1. Summary of fetal echo views: Four chamber, five chamber, three vessel and tracheal view.

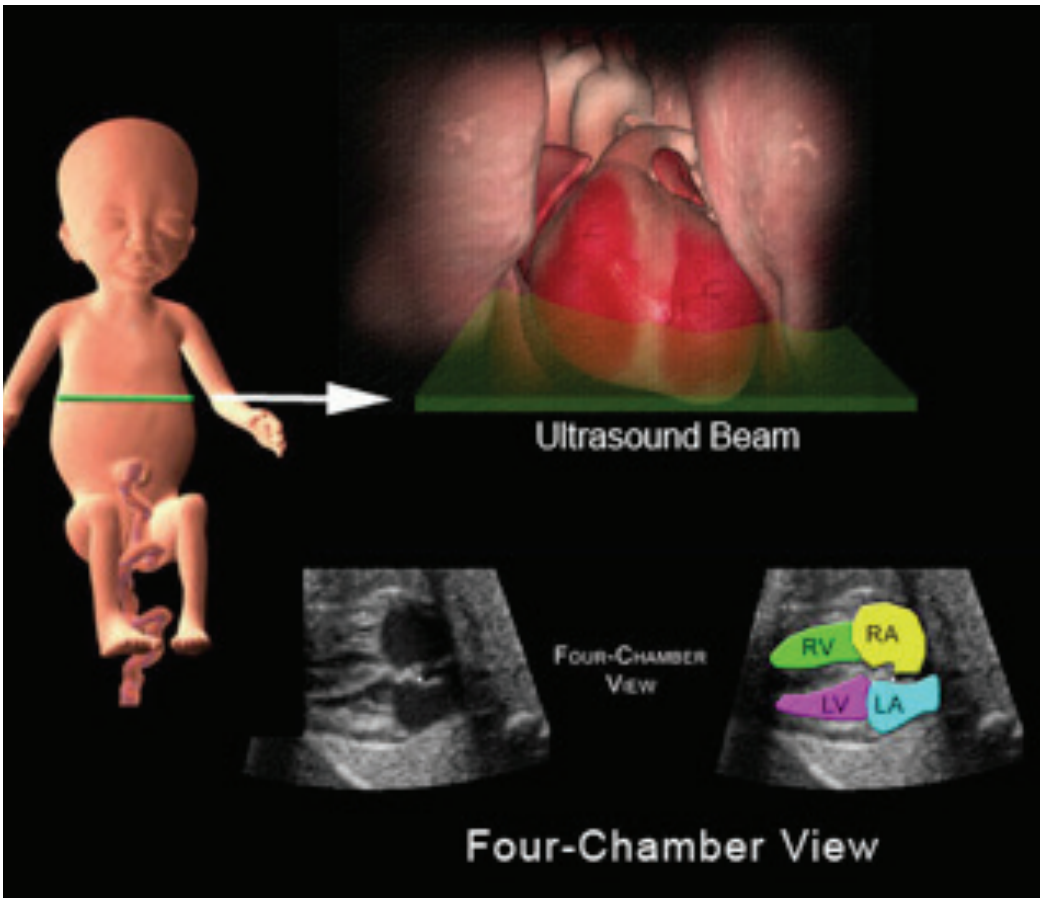


figure 2. Normal fetal echo: four chamber view

the fetal cardiac clinic at Dayton Children's

The typical patient is referred by a maternal fetal medicine specialist because of an abnormal/borderline fetal obstetrical ultrasound concerning for heart disease. Sometimes, the obstetrical ultrasound of the fetal heart is normal but mothers are referred for fetal echocardiography because of conditions predisposing the fetus to congenital heart disease. These conditions can include maternal heart disease, pregestational diabetes mellitus, conception by in vitro fertilization, and fetal aneuploidy.

Ultrasound scanning is performed by an ICAEL (Intersocietal Commission for the Accreditation of Echocardiography Laboratories) certified sonographer. The pediatric cardiologist reviews the images and consults with the family during the visit. The consultation includes a review of the findings of the study, implications for the health of the fetus/newborn and recommendations for delivery (mode and place). Further discussion addresses postnatal medical/surgical interventions that may be required.

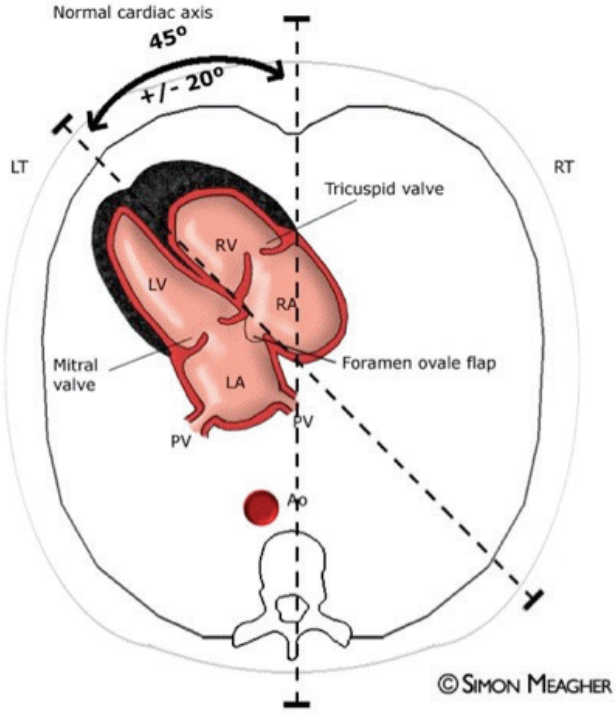


figure 3. Axial (transverse) plane through the fetal thorax: defines cardiac location, axis and size relative to the fetal chest. Provides four chamber view of the fetal heart.

When necessary, arrangements are made to introduce the family to the medical/surgical staff that will provide postnatal care to the baby. At times, serial studies are required for surveillance of fetal health.

indications for fetal echocardiography (maternal or fetal)

Maternal indications can include:

- Maternal/Paternal history of congenital heart disease
- Familial inherited disorders (e.g., 22q11.2 deletion syndrome)
- Metabolic disorders such as diabetes mellitus, phenylketonuria and thyroid disease
- Autoimmune diseases such as lupus erythematosus or Sjögren's syndrome only if antibodies anti-Ro/SSA and anti-La/SSB are present
- Teratogen exposure (e.g., retinoic acid, lithium, Vitamin K antagonists, NSAIDS, some anti-hypertensive medications and most anticonvulsant agents)
- Assisted reproductive technologies such as in vitro fertilization

Fetal indications can include:

- Abnormal cardiac screening examination
- First-degree relative of a fetus with congenital heart disease
- Abnormal fetal heart rate or rhythm
- Known or suspected fetal chromosomal abnormality: Approximately 15 percent of infants with congenital heart disease have recognizable chromosomal abnormalities[4]
- Extracardiac anomaly (cleft lip and palate, vertebral anomalies, tracheoesophageal anomalies, renal abnormalities)
- Hydrops
- Increased nuchal translucency
- Monochorionic twins (risk of twin-to-twin transfusion)

classification of fetal heart disease

1. Primary fetal heart disease: This is typically structural. Common abnormalities include defects as simple as small muscular ventricular septal defects (which will often cause no health problems, usually close spontaneously and require no surgical intervention), to a complex single ventricle anatomy often associated with heterotaxy syndromes (often life threatening and requiring careful management of delivery and with immediate medical and surgical postnatal critical care). These structural heart defects may be isolated or occur as manifestations of a chromosomal anomaly/syndrome such as Down syndrome and other trisomies, tuberous sclerosis or DiGeorge syndrome (22q11.2 deletion).

2. Secondary fetal heart disease: These fetal cardiac disorders are often functional and occur secondary to some other fetal condition. Examples include fetal cardiomyopathy secondary to twin-to-twin transfusion syndrome in monochorionic twins, malposition and compression of the fetal heart in congenital diaphragmatic hernia, dilated cardiomyopathy, and heart failure secondary to severe fetal anemia.

3. Fetal arrhythmias: Usually identified as an abnormal or irregular fetal heart rate, these arrhythmias account for approximately 12 percent of all referrals for fetal echocardiography. An abnormal fetal heart rate is found in one to three percent of all pregnancies.

- The most common arrhythmias are premature atrial contractions, which, in a heart with normal structure and function, are generally benign.
- Supraventricular tachycardia (SVT) which occurs typically at a rate of 220-280 beats per minute (bpm). When sustained, SVT can cause cardiac dysfunction and failure. It is rarely associated with structural heart defects but can be associated with Ebstein's anomaly.
- Atrial flutter that typically has a slightly higher ventricular rate of 220-240 bpm. It can occur either as an isolated event or secondary to cardiomegaly and hydrops.
- Premature ventricular contractions occur much less frequently than premature atrial contractions and are more likely to be associated with structural heart defects.
- Atrioventricular (AV) conduction delay/ block: Most physicians are familiar with the development of fetal third degree AV block when the mother has lupus erythematosus. More importantly, the fetus often has normal AV conduction in early pregnancy and then can develop AV conduction delay progressing (relatively) acutely to complete heart block. Close monitoring of the mechanical "PR" interval by fetal Doppler interrogation using serial echocardiograms is especially helpful in managing these fetuses.

It is important to note that certain sustained fetal arrhythmias can cause hydrops/ heart failure (primary arrhythmias). Vice versa, fetal arrhythmias can occur secondary to hydrops/ heart failure (secondary arrhythmias).

fetal therapy of congenital heart disease

This is a rapidly evolving area of fetal cardiology.

prenatal

The most established mode of fetal therapy is administration of medication (typically anti-arrhythmic agents or steroids) to the mother for transplacental transfer to the fetus. More recently maternal hyperoxia therapy is being explored for diagnostic and therapeutic purposes in certain obstructive fetal structural heart defects. Interventional fetal cardiac therapies range from minimally invasive fetoscopic-guided procedures (fetal transfusions, laser therapy for twin-to-twin transfusion, aortic valvuloplasty) to open uterine fetal surgery.

natal

Careful management of place, mode and time of the delivery of the fetus is a natural continuum of the care of the fetus with a congenital heart defect. Fetal and obstetrical risks are taken into consideration when planning for delivery.

conclusion

- The diagnosis of cardiac disease in the fetus is predominantly made with ultrasound.
- Newer technologies such as magnetic resonance imaging and magnetocardiography (fetal ECG), are available and are advancing fetal care.
- Medical and interventional treatments for certain fetal cardiac disease coupled with careful planning for delivery room care often results in improved fetal outcomes.
- Fetal cardiology is a highly specialized and rapidly advancing field.
- Ready access to fetal cardiology and maternal fetal specialists should, hopefully, allow prenatal diagnosis and care of most complex cardiac diseases in the future.
- Comprehensive fetal cardiology care is provided here at Dayton Children's in collaboration with our regional maternal fetal medicine specialists.

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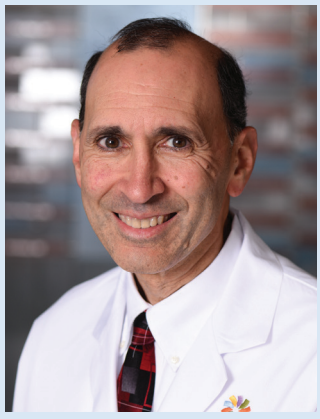

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CME questions

7. A 25-year-old woman with no family history of congenital heart disease and with controlled pregestational diabetes should have a fetal echocardiogram.

a. True

b. False

8. Isolated premature atrial contractions in a fetus with no structural heart disease and normal heart function are likely to be benign.

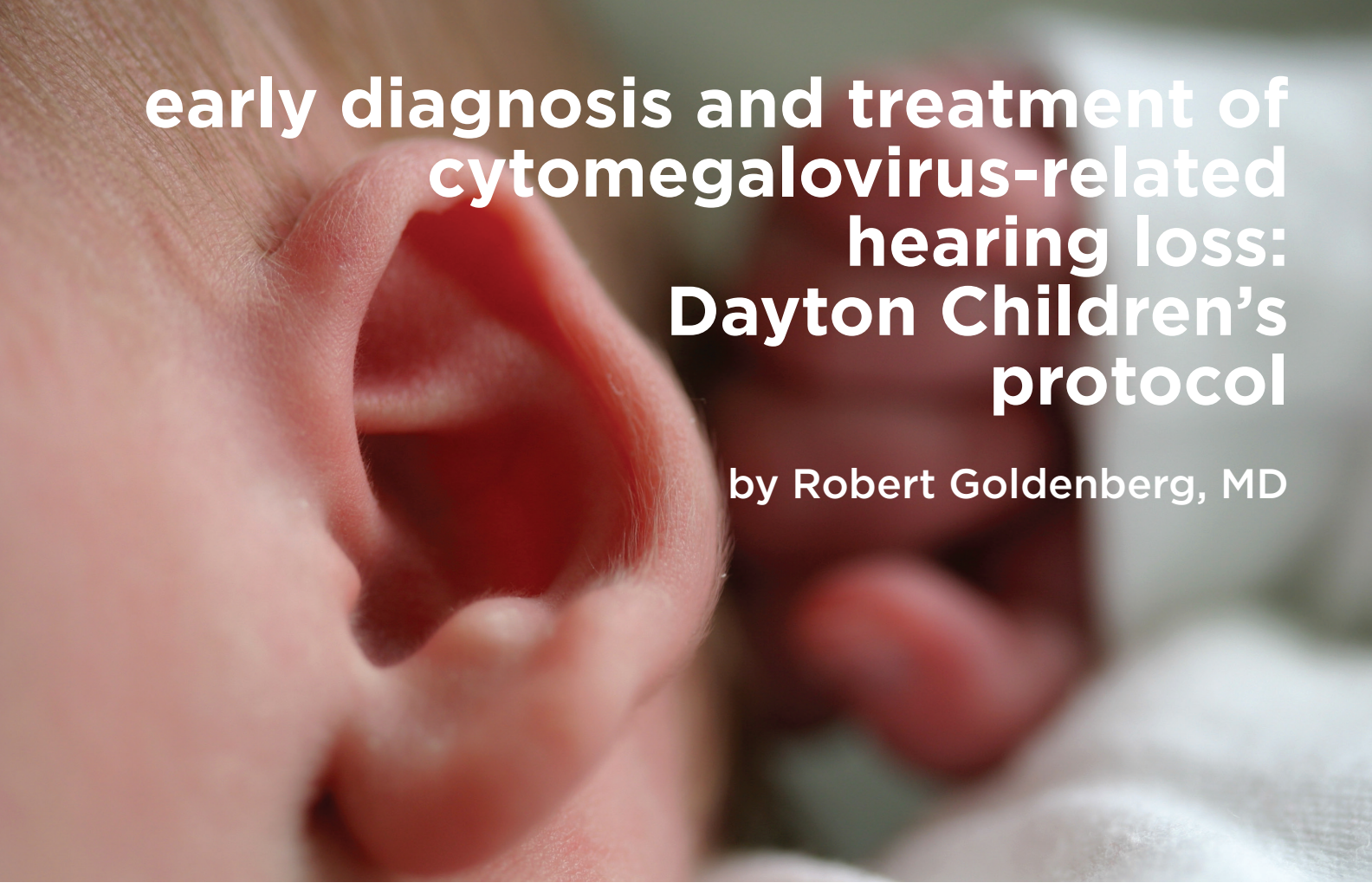
a. True

b. False

9. Dichorionic/dizygotic twin pregnancy is a risk factor for twin-to-twin transfusion syndrome and should be followed with serial fetal echocardiogram.

a. True

b. False



early diagnosis and treatment of cytomegalovirus-related hearing loss: Dayton Children's protocol

by Robert Goldenberg, MD

What if a type of congenital nerve deafness could be treated with medical management as well as with hearing aids?

Ankur Patel, DO, asked this question when he first joined the pediatric ENT department at Dayton Children's in 2017. He knew the answer from his fellowship in pediatric otolaryngology at the University of Pittsburgh Medical Center and several years on the staff of Children's Hospital Los Angeles. Hearing loss* in newborns caused by the cytomegalovirus (CMV) might be successfully treated with medication if detected in the first few weeks of life.

**In this article, the term "hearing loss" will be used exclusively to mean sensorineural hearing loss and not any form of conductive loss caused by fluid or other middle ear pathology.*

learning objectives

Following the completion of this article, the reader should be able to:

1. Review the current opinions regarding the management of congenital CMV.
2. Describe the present techniques of identifying newborn hearing loss.
3. Discuss the methods of early identification and treatment of CMV-related deafness.

background

Human CMV belongs to the family of herpes viruses (figure 1). The incidence of CMV in the general population of the United States increases with age leveling off at 80-90 percent by 80 years of age[1]. It is typically asymptomatic but viral latency remains throughout life and can be reactivated at any time, which most often occurs in immunocompromised individuals.[2]

CMV affects between 20-40,000 infants per year and is the most commonly transmitted virus to a fetus[3]. It is the most common congenital infection in newborns. Intrauterine infections can occur during any trimester of pregnancy. Transmission to a fetus during the first trimester,

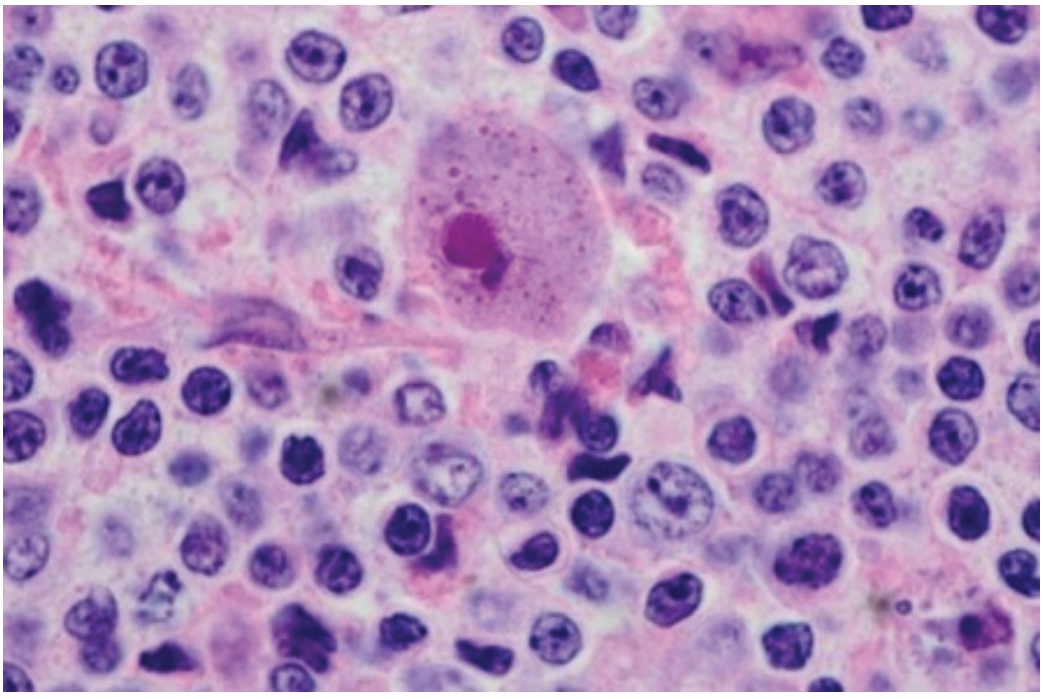


figure 1. Photomicrograph of the cytomegalovirus in a sample of human saliva

however, is associated with the greatest risk of severe fetal infection, organ involvement, and subsequent developmental sequelae[4]. Over one-half of symptomatic infants will have long-term sequelae. Lower rates of neurodevelopmental sequelae are reported in asymptomatic infants with sensorineural hearing loss being the most common manifestation.

Fetuses and neonates with congenital CMV infection show that the virus can infect a variety of cell types resulting in inflammatory infiltrates and organ disease with respect to the inner ear. Infected cells can include epithelial cells of the semi-circular canals, vestibulae, cochlea and other structures.

In developed countries, 50 percent of women of childbearing age have evidence of CMV infection (i.e., CMV seropositive). The incidence of congenital CMV infection parallels maternal CMV prevalence. Infection is most often asymptomatic 85-90 percent of the time and is symptomatic in 10-15 percent of infants[5]. The symptoms of fetal infections can include mental retardation, neurological defects, cerebral palsy, seizures, developmental delays and loss of vision. About 12 percent of CMV infected infants will experience some degree of hearing loss; 30 percent of these infants will have other symptoms and 10 percent will have no other symptoms[6]. Among the symptomatic infants, most will have a bilateral loss and asymptomatic infants will have a unilateral loss. In both groups the hearing loss is usually severe to profound. The hearing loss may be delayed for six to seven years and can be unstable, fluctuating or progressive.

Hearing loss due to CMV does not have a pathognomonic audiometric configuration and varies in the severity of the loss[7]. Complicating estimation of its incidence is the fact that less than half of the affected children are born with the loss and the other half do not develop it until the early elementary school years.

Congenital CMV infection can only be confirmed if the newborn is tested in the first three weeks of life. After three weeks the infant's inoculation may be due to a primary acquired virus and therefore not qualify as congenital. This has also made it difficult to estimate the proportion of hearing loss in children that is attributed to congenital CMV. One study estimates that congenital CMV infections account for 21 percent of all hearing loss at birth and 25 percent by 4 years of age. These numbers suggest that CMV is the leading non-genetic cause of hearing loss in children born in the United States[8].

Congenital CMV occurs only if the mother is infected with the virus during pregnancy. If the child is infected with the virus after delivery, he or she is not at increased risk of developing any of the sequelae (including hearing loss) of a CMV infection. These sequelae are more likely to develop in utero if the mother had a primary infection rather than a reactivation of a previous infection, and are more likely to occur if the infection is in the first half of the pregnancy. Infants born to seroimmune mothers are not completely protected from hearing loss, although it is often

milder than seen in infected infants following primary maternal infections[9]. About 30 percent of infected pregnancies result in infected fetuses.

Prevention of exposure to CMV during pregnancy is obviously a challenge[10]. Universal screening of pregnant women has been discussed but not routinely recommended. Obviously a seronegative pregnant woman should attempt to limit her exposure to the virus. Body fluids (saliva, urine) are probably the most common means of transmission, so awareness of this fact is quite significant; frequent hand washing is therefore very important. The use of CMV hyperimmune globulin infusion in pregnant women has not been shown to reduce the incidence of congenital CMV sequelae. Attempts to develop a vaccine for the prevention of developing a CMV infection have not proven successful as of now.

identifying hearing loss in newborns

Universal hearing screening programs for newborns have been used in the United States for several decades. It was mandated for the State of Ohio in 2004. Hearing loss is one of the most common anomalies present at birth. It is estimated to occur in one to three out of every 1,000 newborns[11].

Infants who are at risk for hearing loss should have frequency specific diagnostic auditory brainstem response (ABR) testing as soon as possible. Prior to universal screening programs, threshold ABR testing was performed only on infants identified as having high risk factors. These risk factors are still used today. The risk factors help identify infants requiring threshold ABR assessment instead of a hearing screening test. Threshold ABR testing provides hearing threshold data. Hearing screening is used to rule out more than a mild hearing loss.

High risk factors include:

- Family history of hearing loss
- History of congenital infections (CMV, rubella, herpes simplex virus, HIV, syphilis, toxoplasmosis)
- Low birth weight: <1.5 kg
- Low Apgar score: <5 at 1min, <7 at 5min
- Hypoxia
- Seizures
- Prenatal infections
- Craniofacial anomalies
- Hyperbilirubinemia
- Sepsis or meningitis
- Ventilator dependence
- Ototoxic drugs

The field of pediatric audiology has grown dramatically in the past several decades, and the ability to test hearing at increasingly younger ages has helped generate this growth. Nowhere is this more obvious than in the technological advances of objective hearing tests, which do not require any response or active participation from the child. In particular, the science of electrophysiology has enabled measurement of hearing in newborns with a high degree of accuracy and reliability.

Hearing screening of newborns can be performed in the newborn nursery or newborn intensive care unit within the first few days of life by trained technicians and does not require the participation of fully trained audiologists. The tests are automated; they use standardized response parameters and templates to generate a simple “pass/refer” result. Infant hearing screening can be performed by an OAE (otoacoustic emissions) or an AABR (automated auditory brainstem response) test.

The OAE test can assess the integrity of the cochlea and therefore infer that the cochlea is functional. An auditory stimulus (a tone or click) creates a response from the cochlea that is measured by a microphone; both stimulus and response are measured by a probe tip in the ear canal. The accuracy of the response can be affected by ambient noise, ear canal obstruction and middle ear pathology.

The AABR test assesses auditory function from the cochlea through the auditory brainstem. An auditory stimulus (usually a click set at 35dBHL) delivered through small disposable insert earphones generates a waveform. The waveform is recorded on a computer through surface electrodes placed on the infant’s forehead, shoulder and nape of the neck. The screening results are ear specific. If these tests indicate a “refer” response (unilateral or bilateral), the infant will require further evaluation.

A licensed audiologist performs this further evaluation (usually in an academic or children’s hospital setting). Tympanometry and repeat OAE testing are often performed, but the most important part of the follow-up evaluation is the threshold ABR. Threshold ABR testing is based upon the same electrophysiological principles as a screen-

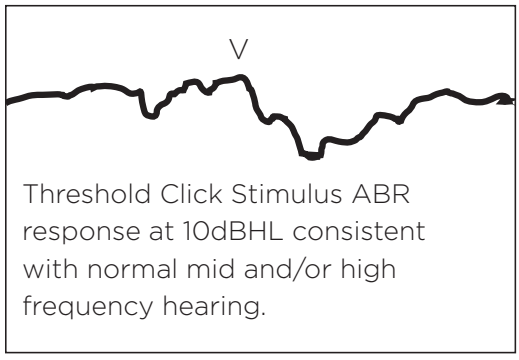
ing ABR. However, unlike a screening ABR, a threshold ABR can determine the presence or absence of hearing loss across the frequency spectrum; this is done by varying the frequency and intensity of the test stimuli (figures 2 and 3). If a hearing loss is present, the type and degree of loss can be determined. ABR testing provides an objective, not a behavioral, estimate of an infant's hearing level.

As with almost all hearing evaluations, a battery of tests provides an opinion that is validated by repeat testing over time. The audiologist can then recommend further testing, observation, treatment and follow-up.

identification of congenital CMV infection in the newborn

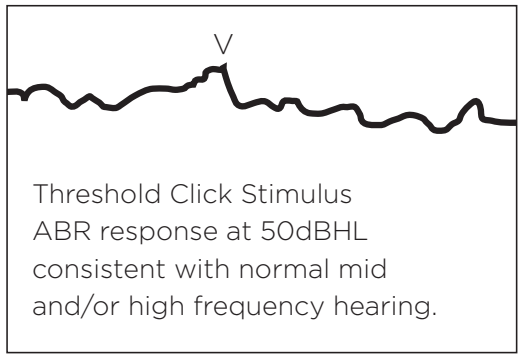
It is absolutely essential for the clinician to determine if an infant's CMV infection is acquired either congenitally or postnatally. The accepted standard for diagnosing congenital CMV infection in newborns is virus detection in the first three weeks of life. If a specimen for testing is obtained after this age, exposure to the virus may have occurred postpartum and this would not represent a congenital CMV infection.

2 ABR examples for the CMV project (normal and moderate loss)



Threshold Click Stimulus ABR response at 10dBHL consistent with normal mid and/or high frequency hearing.

figure 2. ABR demonstrating normal hearing in a newborn infant.



Threshold Click Stimulus ABR response at 50dBHL consistent with normal mid and/or high frequency hearing.

figure 3. ABR demonstrating severe hearing loss in a newborn infant.

In the past, CMV has been identified in cell culture from a urine specimen. Tissue culture isolation is slow and may take up to two to three weeks to have an answer. A shell viral assay is a modified tissue culture technique, which reduces the time considerably but still may take a week or so. Viral antigenemia assay has been commonly used for quantification in blood specimens. Polymerase chain reaction (PCR) is a widely available, rapid and sensitive method of CMV detection. PCR amplifies viral nucleic acids targeting CMV DNA. Immunochemistry can be performed on tissue or body fluid samples. Nucleic acid sequence is based upon an amplification technique (NASBA). Hybrid capture assay uses RNA probes to detect and quantify viral DNA. Serologic assays are generally not necessary for the diagnosis of congenital CMV infection.[12]

Since at times it can be difficult to obtain a urine sample from a newborn, PCR performed on salivary samples has been shown to be both sensitive and specific. Saliva is now considered to be the specimen choice and the PCR technique to be the technique of choice for CMV diagnosis.

medical management of CMV in the newborn

Antiviral agents specifically for the treatment of CMV were initially developed during the AIDS epidemic of the 1980s. Four antiviral drugs are licensed for the treatment of CMV infections: ganciclovir, valganciclovir, foscarnet and cidofovir. These agents began as medications to treat existing infections but have additionally evolved into medications to prevent infections primarily in transplant recipients. For almost a decade they have been used for the treatment of congenital CMV infections[13]. Antiviral therapy with either parenteral ganciclovir or oral valganciclovir does carry risks, especially the development of neutropenia. However, with diligent monitoring, antiviral treatment is currently recommended for symptomatic newborns with central nervous system (CNS) disease or severe focal organ disease.

Antiviral therapy has been studied in newborns with hearing loss. In a randomized and controlled clinical trial, hearing loss associated with CMV was treated with intravenous ganciclovir. Auditory brainstem responses were used to monitor hearing during treatment, which was determined to be stabilized at 6 months and one year of life[14].

A retrospective study of infants with isolated hearing loss associated with CMV who received 12 months of valganciclovir were reported. Of 80 ears assessed (38 infants with unilateral loss and 21 infants with bilateral loss), 55 ears (69 percent) showed improvement and two ears (3 percent) worsened[15].

Twenty-three infants with culture proven symptomatic CMV infection were treated with ganciclovir intravenously for six weeks followed by valganciclovir orally for 12 months. At age 1 year or greater, 76 percent of these infants' ears had normal hearing as compared to a baseline of 54 percent.[16]

Ongoing trials continue to investigate valganciclovir therapy in infants with congenital CMV infections and isolated sensorineural hearing loss.[17]

Dayton Children's protocol

Ravi Elluru, MD, PhD, division chief of pediatric ENT, strongly supported Dr. Patel's desire to develop a protocol for the early identification and treatment of CMV-related hearing loss in newborns. A task force was formed to create this protocol (table 1).

Ravi Elluru, MD, PhD
Chief, division of pediatric ENT

Ankur Patel, DO
Pediatric ENT

Linda McGinnis, MA, CCC-A
Audiology manager

Sherman Alter, MD
Chief, division of infectious disease

Pam Morgan, BSN, RN
Director, surgical services (pediatric ENT)

Robert Goldenberg, MD
Pediatric ENT

table 1. CMV task force

The task force worked together during 2018-2019 to create this protocol. They studied some of the programs already in existence nationally to learn from their experience. Many of the components of this protocol were already operational at Dayton Children's and it was simply a matter of putting the pieces together. However, this protocol is unique in its structure and may in turn stimulate other programs with innovative ideas. The task force would like to acknowledge and recognize the help of so many members of Dayton Children's staff who assisted with the establishment of this protocol.

Dayton Children's protocol is as follows:

1. Newborns who fail their screening test and are referred to Dayton Children's for a complete newborn hearing evaluation will receive an appointment in the first three weeks after birth.
2. Referral sources will be strongly encouraged and educated for the need to make this happen in a timely way.
3. At the appointment for the hearing evaluation a buccal swab to obtain a saliva specimen will be performed by the audiologist.
4. The saliva specimen will be analyzed in Dayton Children's lab by the PCR method in order to generate a report within one to two days.This report will result in one of the four recommendations made in table 2.
5. In addition to the above, a hearing aid may or may not be recommended depending upon the amount of hearing loss present.

hearing test	PCR	follow up hearing test	medical management	hearing aid
normal	negative	routine	no	no
normal	positive	frequent	recommend +/-	no
hearing loss	negative	frequent	no	yes
hearing loss	positive	frequent	recommend	yes

table 2. Recommendations following evaluation using the Dayton Children's protocol

While the above protocol seems very simple and straightforward, the execution of the protocol itself is anything but. Obtaining the initial order for the referral within the first three weeks of life is a challenge in itself. Obtaining the saliva specimen and PCR at the same time as the audiology referral appointment visit keeps the entire testing and reporting components within Dayton Children's; this avoids logistical problems and lost reports suffered by other protocols. Communication and education of parents, community physicians and their support staff as well as Dayton Children's staff is essential to the success of the protocol.

conclusion

The management of congenital CMV has been gradually evolving as more and more is understood about this ubiquitous disease. The recent recommendations from an informal consensus report developed by world experts in the field who attended the Fifth International Congenital Cytomegalovirus Conference in 2015[18] are an excellent summary of the current opinions on this topic. Their recommendations were:

1. Universal screening of pregnant women for CMV was not recommended.

2. Universal screening of newborns for hearing was recommended.

3. Screening of neonates who failed their newborn hearing test for CMV was recommended.

4. Universal CMV screening of all newborns was considered but not recommended.

5. Testing for CMV in newborns should use the PCR method with saliva as the preferred specimen.

6. Early treatment with antiviral agents showed significant benefit in management of any CMV-related hearing loss.

Because CMV is becoming increasingly recognized as a causal factor in a variety of newborn symptoms, there has been increasing interest in the universal screening of pregnant women for the virus. The consensus report did not recommend universal CMV screening of pregnant women this time but there seems to be interest in doing so in the future.

Universal screening for hearing loss in newborns was recommended. This appears to be a worldwide clinical validation of a program that was already in effect in the United States.

Screening for CMV in newborns who demonstrated a hearing loss was recommended. Because of this recommendation, more instances of congenital CMV should be identified, which should lead to earlier therapeutic intervention for CMV patients. It should also lead to clinical studies, which will better report evidence-based outcomes of treatment.

Universal screening of all newborns for CMV was considered but not recommended, but as in the decision not to recommend this for pregnant women, there also is considerable interest in revisiting this decision in the future.

There was universal agreement in the use of PCR to make a diagnosis of congenital CMV within the first four weeks of life. It will also allow early medical management of CMV if this therapy is indicated.

The medical management of CMV-related hearing loss has shown a great deal of promise since antiviral agents were first introduced in the 1980s. Drug selection, dosage, length of treatment and method of delivery (oral vs. IV) are still in a state of discovery. Many previous studies are anecdotal with relatively small numbers of patients. This of course could be corrected in the future with larger multicenter cooperative studies.

As further information from CMV screening programs become available, additional management strategies will better define the care of infants with asymptomatic congenital CMV infection with and without hearing loss. Early identification of children with hearing loss (whether or not CMV-infected) permits close monitoring of hearing function during the infant's critical stages of language development. The question of whether CMV-infected infants with hearing loss should routinely receive antiviral therapy will hopefully be clarified from findings in current investigations. Only through the analyses of data from targeted screening for CMV infection in infants who fail their newborn hearing screens can we better define the utility of such programs.[19] Hopefully, our protocol may further add to the knowledge base of appropriate management of these children.

Developing innovative programs in an area that is not yet mature presents an opportunity to make a significant contribution in that field. The simple question posed by Dr. Patel creates that opportunity here at Dayton Children's.

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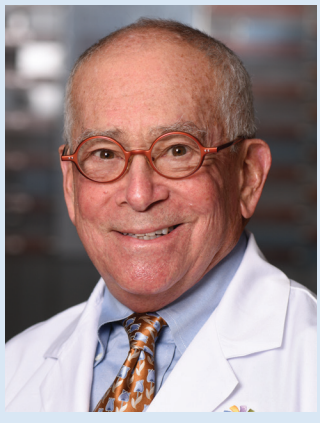
author



Robert Goldenberg, MD

Robert Goldenberg, MD, is with the division of pediatric ENT at Dayton Children's and professor emeritus, Wright State University. He is past chair of the division of otolaryngology at Wright State University Boonshoft School of Medicine and past chief of staff at Dayton Children's.

CME questions

10. CMV is the most common infection in newborns. It is estimated that 10-12 percent of children who contract congenital CMV will develop some degree of hearing loss by the time they are in elementary school.

a. True

b. False

11. A licensed audiologist must perform a hearing screening test in the newborn nursery in order for it to be certified.

a. True

b. False

12. The recommended laboratory test for the rapid identification of CMV in the neonate is:

a. cell culture

b. NASBA method

c. nucleic acid sequencing

d. PCR

e. shell viral assay

13. The preferred method of delivery for valganciclovir in the treatment of CMV-related hearing loss is:

a. intravenous

b. oral

c. either intravenous or oral

d. all of the above

e. none of the above

Dayton Children's updates

Dayton Children's officially opens The Child Health Pavilion

Dayton Children's officially opened The Child Health Pavilion on Monday, May 20, 2019, reinventing the path to children's health care for families in our region and beyond. This new space will support a truly unique, integrative model of pediatric primary care excellence unlike anything seen across the country.

The new and innovative care model integrates a primary care medical home, behavioral health and specialty clinical services for vulnerable populations (children in foster/kinship care, children with medical complexities, children with weight issues) alongside community-based programs to address the social determinants of health such as food insecurity, housing instability, durable goods and educational resources for children.

"We cannot achieve our mission of optimal health for every child without addressing the struggles they face every day, like lack of food, substandard housing or even having the right school supplies," says Deborah A. Feldman, president and CEO of Dayton Children's Hospital. "We envisioned The Child Health Pavilion as a place to not only elevate what happens in the doctor's office but to bridge the gap to accessing the social services that will help our children be healthier, today and into adulthood."

A few of the unique components built into The Child Health Pavilion in addition to the innovative primary care medical home include:

- A teaching kitchen where families can learn and practice preparing nutritious and tasty recipes.
- The Food Pharm where, in partnership with the Dayton Foodbank, families in need can get emergency boxes of nutritious food.

- The Family Resource Connection where advocates connect families with an identified social need to the appropriate community resources, including food, housing, transportation, after-school care or baby supplies.

None of the work at The Child Health Pavilion could be done without collaboration and partnership with local, state and even national organizations and agencies. No one group could bring about the level of change necessary to truly impact the course of our children's overall health. "We are incredibly fortunate to be blessed with a community that is rallying around our children and a Governor who has made children a key priority of his agenda," says Feldman.

new options for faster, easier care for broken bones and sports injuries

Injuries are never convenient but Dayton Children's Hospital is making sure that treating those injuries is as painless as possible. There are now more options than ever before to better care for kids with broken bones or sports injuries.

after-hours ortho

A parent's first stop may be the emergency department if they suspect their teen or child has a broken bone but Dayton Children's after-hours ortho will save them time and money. At the south campus in Springboro, orthopaedic specialists will be available evenings and weekends to diagnose and then cast, splint or brace the injury, as needed.

Not only does this save a family the expense of an emergency department co-pay, but it combines what is normally two visits into one. X-rays are also conveniently available onsite. To avoid a wait, parents can save their spot by checking in online.

open scheduling

During the day, parents or referring doctor's offices can get an appointment quickly with convenient online scheduling. Simply log on and find an open time slot, selecting from multiple days, times, providers and locations.

hours

Monday – Thursday
5:00 pm - 9:00 pm

Saturday
7:00 am – 11:00 am

location

Specialty care center

Dayton Children's — south campus

3333 West Tech Road
Miamisburg, Ohio

Dayton Children's Hospital named one of U.S. News & World Report 2019-20 Best Children's Hospitals

U.S. News & World Report, the global authority in hospital rankings and consumer advice, has ranked Dayton Children's Hospital in pulmonology in the new 2019-20 Best Children's Hospitals rankings published online.

"We are proud to be recognized by U.S. News and World Report Best Children's Hospital for the expert specialty pediatric care in pulmonology we provide," says Daniel Evans, MD, chief, division of pulmonology at Dayton Children's. "Our team works hard to go above and beyond for each child, ensuring they and their families have the very best care in a personalized plan that works for their unique needs."

Dayton Children's pulmonology department is a Cystic Fibrosis Center, one of just 120 Cystic Fibrosis Foundation-accredited care centers providing expert care and specialized disease management across the country. The network combines clinical research with medical care best practices, and has been cited by the National Institutes of Health as a model of effective and efficient health care delivery for a chronic disease.

"This center has honestly changed our lives," says Holly Williams. Her daughter, Caroline was diagnosed within days of her birth with cystic fibrosis. Excess mucus in her lungs and intestines makes it hard for her to breath, digest food and leaves her very susceptible to infections and illness. She takes a variety of medications and does breathing treatments several times a day to shake the mucus from her lungs.

"Without centers like this one, trained and accredited in CF care, the life expectancy of a child with CF was around elementary school age. Now people with CF are thriving into adulthood and have hope for a healthy future. That we have one of these centers right HERE in Dayton is bigger than I can say. Caroline will go to a center like this for a check-up every three months for the rest of her life."

Dayton Children's also created the Dayton Asthma Alliance, a group of more than 20 community agencies working in partnership in a global strategy to address asthma triggers in a child's entire environment—where they live, learn and play.

"The number one reason that children are admitted to Dayton Children's Hospital is for respiratory issues," says Deborah Feldman, president and CEO of Dayton Children's Hospital. "While we know it is just one measure that a family should use in choosing the right care for their child, it's another symbol parents can use to show them that Dayton Children's provides expert care."

"The Best Children's Hospitals rankings were designed to help provide families seeking the best medical care for their sick child with access to the most comprehensive data available," said Ben Harder, managing editor and chief of health analysis at U.S. News. "The rankings, coupled with guidance from pediatricians, help families make better-informed decisions about where to find high-quality, compassionate care for their children when they need it most."

program evaluation

1. The material presented in this publication met the mission to enhance health care delivery in our region through education based on the essentials and policies of the Accreditation Council for Continuing Medical Education.
   ☐ Strongly agree ☐ Agree ☐ Neutral
   ☐ Disagree ☐ Strongly disagree

2. Did the material presented in this publication meet the educational objectives stated?
   ☐ Yes ☐ No

3. Did the material presented in this publication have a commercial bias?
   ☐ Yes ☐ No

4. Please rate the contents of this issue using the following scale:
   1 = Poor, 2 = Fair, 3 = Good, 4 = Very good, 5 = Excellent *(Circle one response for each.)*

	Poor				Excellent
Timely, up-to-date?	1	2	3	4	5
Practical?	1	2	3	4	5
Relevant to your practice?	1	2	3	4	5

5. Please describe any changes you plan to make in your clinical practice based on the information presented in this program.

   _____

6. Are there any other topics you would like to have addressed in this publication or future educational programs for health care providers?
   ☐ Yes ☐ No If yes, please describe:

   _____

7. Please describe how you will incorporate information obtained from this publication into your practice.

   _____

8. Letter to the editor — Letter to the editor may be emailed to alters@childrensdayton.org or attached to this evaluation and may be published in the next issue.

physician accreditation statement and credit designation

This activity has been planned and implemented in accordance with the Essential Areas and Policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of Wright State University (WSU) and Dayton Children's Hospital.

WSU designates this Journal-based CME Activity for a maximum of 4 AMA PRA Category 1 Credit(s)™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

program test

to obtain CME credit you must:

Read and reflect on each article.

Answer the questions from each article and complete this test. 70 percent correct answers are needed to obtain the full 4.0 AMA PRA Category 1 Credits™.

Complete the program evaluation.

Return your completed test and program evaluation by email, mail or fax to: Sue Strader, coordinator
Department of Continuing Medical Education
Dayton Children's Hospital, One Children's Plaza,
Dayton, Ohio 45404-1815
Fax: 937-641-5931

E-mail: straders@childrensdayton.org

Take test online: childrensdayton.org/providers

This test must be received by December 31, 2019 for the credit to be awarded

pediatric forum | volume 33, issue 2

your answers to CME questions
(Please circle the BEST answer.)

1.	true	false			
2.	true	false			
3.	true	false			
4.	a	b	c	d	e
5.	true	false			
6.	a	b	c	d	e
7.	true	false			
8.	true	false			
9.	true	false			
10.	true	false			
11.	true	false			
12.	a	b	c	d	e
13.	a	b	c	d	e

please type or print clearly

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practice name _____

street address _____

city _____

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office telephone _____

office fax _____

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pediatric forum

summer 2019

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Pediatric Forum is produced for the professional staff and referring physicians of Dayton Children's by the marketing communications department.

The purpose of Pediatric Forum is to provide information and news about pediatric health care issues and to provide information about clinical services and management issues of Dayton Children's.

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obtaining CME credit

To obtain CME credit, read, reflect on articles, complete the evaluation and answer at least 70 percent of the quiz correctly. Send the answer sheet and program evaluation to:

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One Children's Plaza
Dayton, OH 45404-1815
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target audience

This education activity is designed for pediatricians, family physicians and related child health care providers.

educational objectives

- Identify the four pediatric issues covered in this journal and develop appropriate intervention.
- Appropriately use the resources of Dayton Children's Hospital to improve patient care.

dayton children's

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