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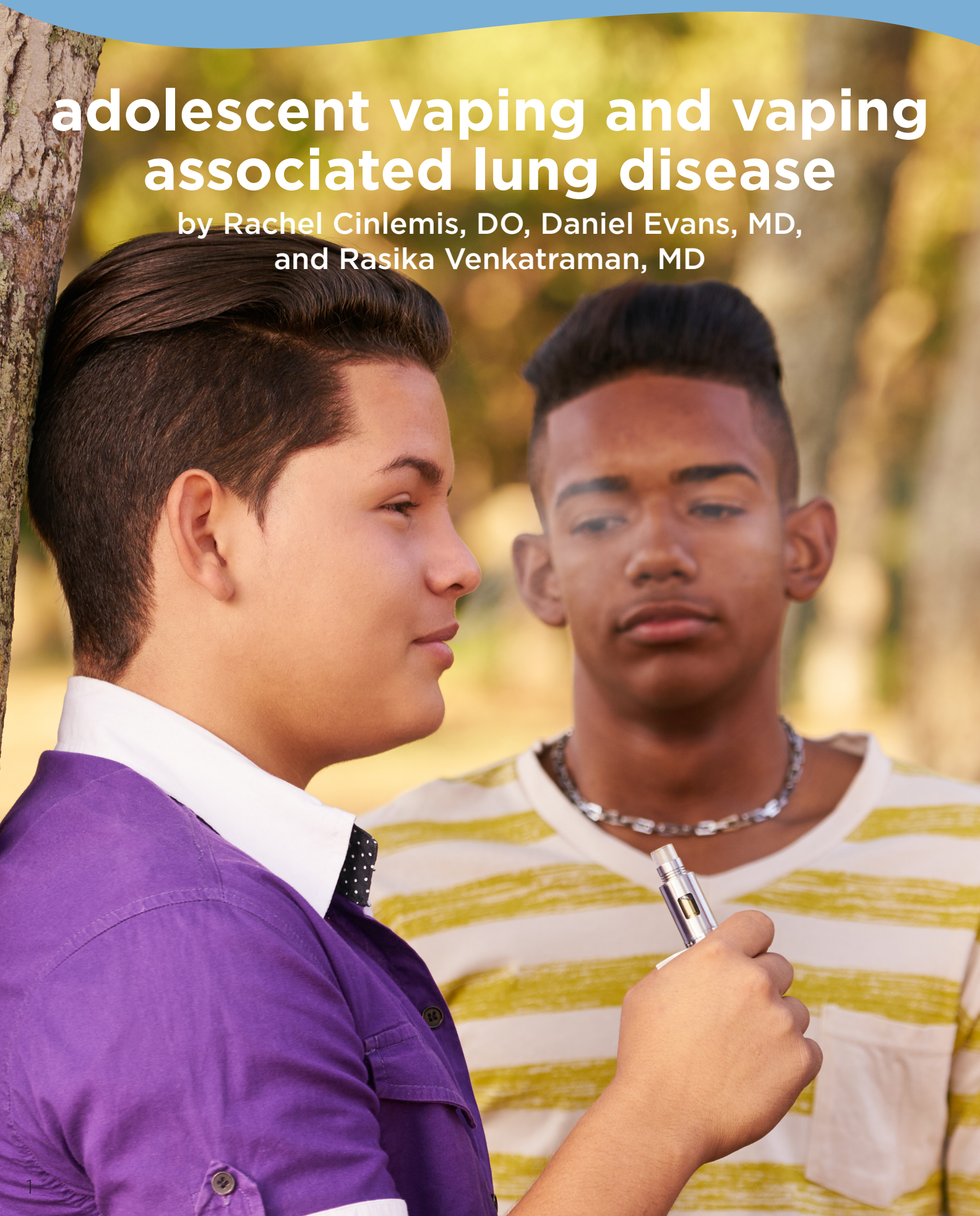
adolescent vaping and vaping associated lung disease

by Rachel Cinlemis, DO, Daniel Evans, MD, and Rasika Venkatraman, MD



learning objectives

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

1. Understand adolescent attitudes and views on electronic cigarette devices and vaping.
2. Identify electronic vaping lung associated injury in outpatient and hospital settings.
3. Learn to treat nicotine addiction and provide resources to patients and families promoting smoking cessation.

The use of electronic cigarette devices is rising at an alarming rate in youth compared to prior years and the problem is serious. E-cigarettes were first introduced to U.S. markets in the mid-2000s.[1] The design of these products has rapidly evolved, first resembling traditional cigarettes with pre-filled liquid cartridges to now, easily concealed systems with refillable reservoirs.[1] The Centers for Disease Control and Prevention (CDC) report that e-cigarettes are the most prevalent vehicle for tobacco use in our adolescents,[2] with nearly one in 20 middle school students and one in five high school students admitting to using e-cigarettes within the last 30 days.[2] Most teens chose nicotine, marijuana and flavored products. The National Institutes of Health report that 17.6% of eighth graders and 37.3% of 12th graders report vaping within the past year (figure 1).[3] A recent case within our institution highlighted the danger of e-cigarettes and brought to the forefront adolescent attitudes.

teens using vaping devices in record numbers

Nearly 2 in 5 students in 12th grade report past-year vaping, raising concerns about the impact on brain health and potential for addiction.

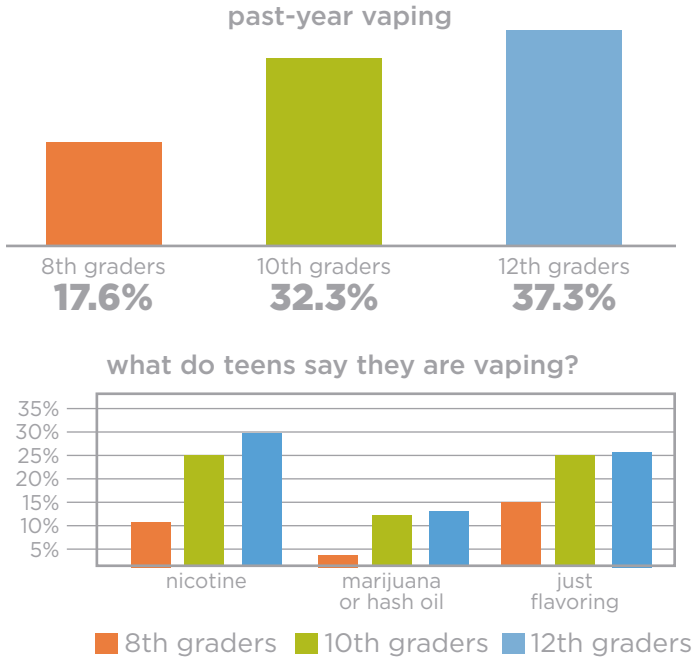


figure 1. Middle and high schoolers are using vaping products at record numbers. They are primarily vaping nicotine, marijuana and flavorings.[3]

case

A previously healthy 17-year-old female presented to the emergency department (ED) with a two-day history of progressively worsening dyspnea. She had already been diagnosed with a pneumonia for which she was on an antibiotic. She admitted to intermittent marijuana and frequent vaping. The patient started vaping nicotine and flavored juices approximately three years prior to presentation. Three months prior to presentation, she had switched to THC cartridges. In the ED, she required non-invasive ventilation (NIV) for acute hypoxemic respiratory failure. Lab values were significant for a mild leukocytosis with neutrophil predominance and elevated inflammatory markers. Imaging showed diffuse alveolar airspace disease on chest X-ray (figure 2) and chest CT angiogram showed diffuse ground glass opacities present bilaterally sparing the periphery (figure 3). An infectious workup was completed and only positive for rhinovirus/enterovirus on viral panel. She was started on high dose systemic steroids that were slowly tapered over a two-week course. She was eventually weaned from NIV to room air and discharged home to follow up with pulmonology after eight days in the hospital. Lung function was slowly returning to normal.

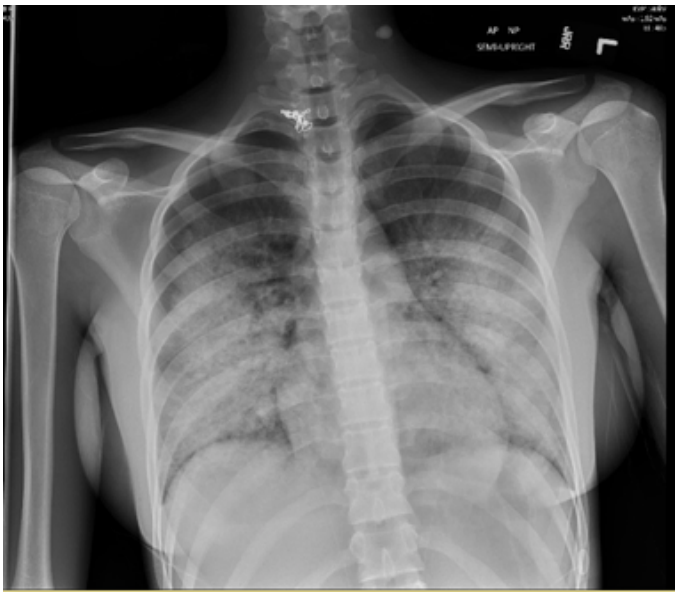


figure 2. Chest X-ray showing diffuse alveolar airspace disease consistent with acute respiratory distress syndrome (ARDS). No evidence of heart failure.

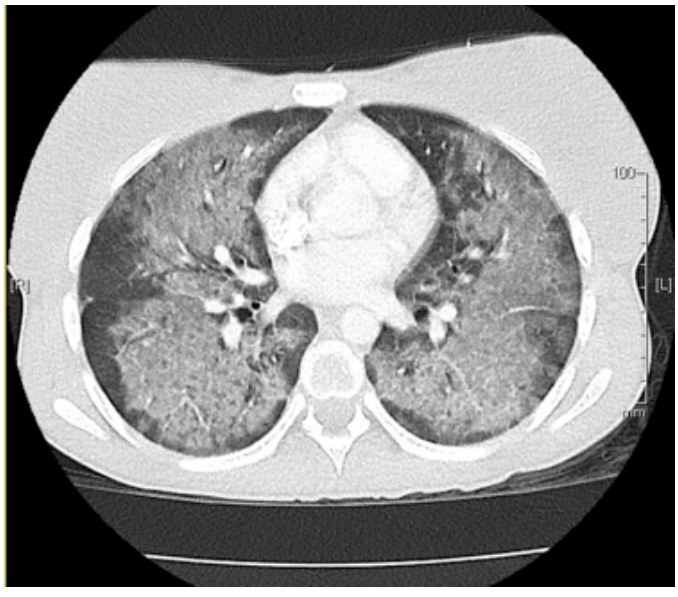


figure 3. Chest CT angiogram shows diffuse presence of ground glass opacities bilaterally that spare the peripheral pleura. No evidence of thrombus. Pattern is consistent with ARDS.

figure 4. Common and popular brand of vaping pen, JUUL, resembles a USB drive. (image source: Google)

figure 5. Common and popular brand of vaping pen, Blu, resembles a pen making it compact and easy to conceal. (image source: Google)

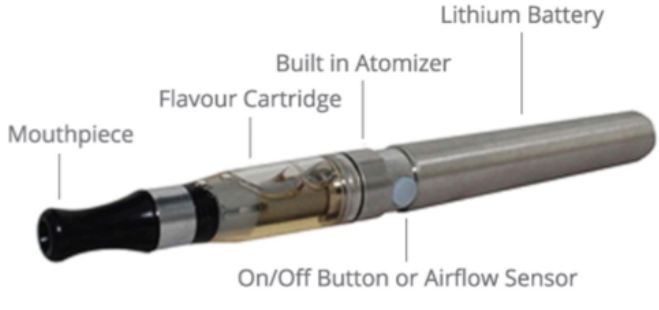


figure 6. Parts of an e-cigarette. (image source: Google)

vaping stats/ adolescent attitude

In a 2016 National Youth Tobacco Survey, teens reported numerous reasons for using e-cigarettes. Common reasons included:

1. Because a friend or family member also uses;
2. Availability of multitude of flavors;
3. Thought process that e-cigarettes are safer than other forms of tobacco.[4]

Vape pens are also more accessible to adolescents and are often able to be used in areas where traditional cigarettes are banned.[4] Others report the use of vaping as a means to quit other nicotine products.[4] Unfortunately, advertisement for these products is designed to attract younger populations, boasting various flavors such as mint, candy, fruit and chocolate.[4] Many companies market e-cigarettes as a safer alternative to traditional cigarettes.[4]

Vaping products come disguised in a number of day-to-day objects. One popular brand of e-cigarette, JUUL®, strongly resembles a USB drive (figure 4). Other popular brands, such as Blu® (figure 5), are compact and easy to conceal. Tank systems are another device that do not resemble classic tobacco products. They are medium-to-large size devices that come in disposable and re-buildable systems that allow the user to fill the system with any e-liquid of their choosing. All these products have aforementioned refillable flavor cartridges. E-liquids, also called e-juices, are the substances that are added to a cartridge or pod and subsequently vaped. These products are commercially available at smoke shops and gas stations. JUUL vape pens and their products are easily located by area code on their main website: https://www.juul.com/locator. Their mission statement is to "Improve the lives of the world's one billion adult smokers by eliminating cigarettes."[8]

E-cigarettes are electronic battery-operated devices that produce an aerosol by heating a liquid (figure 6). A lithium battery heats a metallic coil and aerosolizes whatever e-liquid the user decides to fill the device.[5] These liquids can contain nicotine, flavorings and THC in addition to a multitude of additives. Some of these additives include distilled water, propylene glycol and glycerin.[5]

A number of these additives are known to be harmful chemicals associated with adverse health effects (table 1). Additionally, e-cigarettes and their flavorings typically do not provide full ingredients lists. Smoke shops and businesses offering e-cigarettes and their products and even drug dealers will supply e-liquids. Empty flavor cartridges are refilled with these often illegal and unknown substances.[2] Many of these ingredients have roles in promoting cytotoxicity by upregulating IL-8 and TNF-alpha.[6] Many ingredients used for popular flavors can lead to significant damage of the epithelial barrier in the lung.[7]

EVALI description/ pathology

E-cigarette vaping associated lung injury (EVALI) has been reported to the CDC from all 50 U.S. states and the numbers are climbing.[2] The issue is a pediatric one as well. Fifteen percent of patients reported with acute lung injury are under 18 years of age.[2] At the time of publication, there have been 2,668 hospitalized cases of EVALI reported from all 50 states, the District of Columbia, and Puerto Rico and the U.S. Virgin Islands.[2] A total of 55 deaths have been confirmed and more are under investigation in patients ranging in age from 13 to 85.[2] Of reported cases, 82% of patients admit to using THC-containing products and 57% admit to use of nicotine-containing products.[2]

At this time, EVALI is a diagnosis of exclusion lacking definitive diagnostic criteria, and patients often present with vague symptoms.[2] EVALI should be suspected in patients presenting with respiratory distress or hypoxemia and who have been vaping e-cigarette products or THC within the past 90 days of symptom onset.[9] To date, the CDC has

ingredient	purpose	adverse effect
Diacetyl	Adds buttery/creamy flavor	Cause of bronchiolitis obliterans or "popcorn lung" when inhaled
Benzaldehyde	Fruit flavoring, especially in cherry products	Cause of irritation of airways
Cinnamaldehyde	Adds cinnamon flavoring	Cytotoxicity and loss of epithelial barrier function
2-MOCA	Adds cinnamon flavoring	Cytotoxicity
Acetoin	Adds buttery flavor	Loss of epithelial barrier function
Maltol	Adds flavoring	Cytotoxity and loss of epithelial barrier function

table 1. Common ingredients for flavorings in electronic cigarettes.[6, 7]

detailed vaping history to obtain

Substances used

Source of substances (commercially available or homemade)

Devices used (manufacturer, brand name, model, etc.)

Where the products were purchased

Method of substance use (aerosol, dabbing, etc.)

Whether devices were shared with others

box 1. CDC-recommended questioning in cases of severe lung disease thought to be attributed to e-cigarette use.[2]

not identified any single cause among cases of EVALI reported to them; however, one commonality among patients is use of THC products obtained from questionable sources such as friends/family or illicit drug dealers.[10]

The exact mechanism of injury causing lung injury associated with e-cigarette use is largely unknown at this time. There are a few proposed mechanisms. One theory proposes lipoid pneumonia as cause of injury.[12] Some studies suggest inhalation of aerosolized vegetable glycerin in nicotine e-liquids is the cause of injury based on presence of lipid-laden macrophages in bronchoalveolar (BAL) specimens.[12] Others theorize lipid-laden macrophages are rather a marker of vaping-related lung injury and not cause of injury.[13] Another proposed mechanism is a theory EVALI is a form of airway centered chemical pneumonitis.[14] Injury is due to direct tissue damage caused by toxic chemical fumes.[15] This leaves the role of lipid-laden macrophages unknown.[15]

Recent reports also indicate vitamin E acetate as a potential source of injury.[11] Product testing from patients diagnosed with and treated for EVALI show vitamin E acetate is a common additive to THC containing products.[11] However, while vitamin E acetate has been identified as a potential cause, there is likely more than one etiology as those using nicotine products exclusively are also affected.[2]

CDC recommendations for providers

The CDC recommends all cases of severe pulmonary disease of unclear etiology be reported if the patient has a history of e-cigarette or THC product use within the last 90 days. Providers should screen all patients with a history of vaping for commons signs and symptoms of pulmonary disease.[2] If a patient's history revealed e-cigarette use, then a detailed vaping history should be obtained as detailed in box 1. Once a provider has suspicion for EVALI, other etiologies should be evaluated. Box 2 summarizes common symptoms, exam findings, workup

common characteristics

Reported uses of an e-cigarette or dabbing within the last 90 days (Layden et al)

Reported THC use

Symptoms on presentation

Respiratory
- Shortness of breath
- Chest pain
- Cough

Gastrointestinal
- Nausea
- Vomiting
- Abdominal pain
- Diarrhea

Constitutional
- Subjective fevers
- Fatigue

Physical exam findings
- Tachycardia
- Tachypnea
- O2 desaturation <95%

Laboratory testing
- Respiratory Viral Panel
- Rapid influenza testing (depending on season)
- Streptococcus pneumonia, Legionella pneumophilia, Mycoplasma pneumoniae testing
- CBC, CMP, ESR/CRP
- Urine toxicology

Imaging
- Chest X-ray
- Consider chest CT for worsening disease

Inpatient management
- Admission for patients with SpO2 <95% or respiratory distress
- Initiate corticosteroids with/without antibiotic coverage for community acquired pneumonia
- Follow up following hospitalization with pulse-oximetry testing and repeat chest X-ray
- Pulmonology referral/consult to follow long-term lung function
- Consider Endocrinology referral if long-term corticosteroid use required

box 2. Common history, symptoms, and recommended workup and management in cases of EVALI.[10]

Outpatient Management
- Return to clinic for follow-up within 24-48 hours to assess for worsening injury
- Refer for admission if SpO2 <95% or exhibiting worsening respiratory distress
- Consider antibiotic and antiviral treatment

Post-Discharge Follow-Up
- Clinic follow-up appointment no later than 1-2 weeks after discharge
- Initial follow-up visit should include pulse oximetry and repeat chest radiograph with another chest radiograph 1-2 months after diagnosis
- Consider spirometry and diffusion capacity testing if not already followed by a pulmonologist
- Consult to Endocrinology for those on high-dose corticosteroids to assist with taper

Cessation and Preventative Care
- Stress importance of discontinuing vaping products
- Prescribe cessation assistance and provide education for patient with nicotine addiction
- Refer for treatment in patients with marijuana-use-disorder
- Recommend routine influenza vaccination and consider pneumococcal vaccine in high risk groups

High-risk groups at risk for more severe outcomes
- Older age (>50 years-of-age)
- Pregnant
- History of cardiac or prior lung disease

box 3. Outpatient management and discharge follow-up for patients diagnosed with EVALI and high-risk groups at risk for worse outcomes.[10]

and admission criteria for EVALI. Specific outpatient care and discharge follow-up for patients diagnosed with EVALI are found in box 3.

Patients should be strongly counseled against the use of all e-cigarette products. If patients are unwilling to quit, discourage them from buying additives and THC from unknown sources or on the street.[2] Never modify any vaping substances.[2] Vaping products should not be used in youth or pregnant women.[2] It is important to stress vaping is not means to quit or prevent smoking.[2] If patients are unwilling to quit, then instruct them to monitor for signs of EVALI reminding patients there are no safe tobacco products.[10] The CDC advises that all vaping products utilized by patients diagnosed with EVALI be submitted to their state health department for testing.[2] The CDC posts all updates regarding EVALI at https://www.cdc.gov/lunginjury.

Dayton Children's offers teen nicotine cessation programs and includes those patients addicted to vaping/e-cigarettes. The STAND (stop tobacco and nicotine dependency) Program aims to help teens in stopping tobacco and nicotine use and in choosing healthy behaviors and coping mechanisms. The program consists of five 90-minute sessions, one session a week for five weeks. To register, clinicians or parents can call 937-641-4068. Learn more at childrensdayton.org and search "nicotine cessation program" in the search bar.

conclusion

In summary, adolescents as young as 13 have reported use of vaping products. Many young people turn to vaping as a method to prevent addiction to traditional cigarettes. Electronic cigarette companies employ sleek marketing techniques as a safe and healthy alternative to smoking cigarettes. The CDC has requested all cases of EVALI to be reported, with all substances used by the patient to be sent in for further testing. Those patients who admit to vaping should be encouraged to stop and offered resources to facilitate smoking cessation. Those who refuse to stop should be monitored for signs and symptoms of EVALI and told not to make any modification to substances smoked or buy from unreliable sources.

references

1. Jenssen BP, Walley SC, AAP Section on Tobacco Control. E-cigarettes and similar devices. *Pediatrics*. 2019; 143(2):e20183652.

2. Centers for Disease Control and Prevention. Severe pulmonary disease associated with using e-cigarette products. August 30, 2019. https://emergency.cdc.gov/han/HAN00421.asp.

3. National Institute on Drug Abuse. Tobacco/nicotine and vaping. https://www.drugabuse.gov/drugs-abuse/tobacconicotine-vaping.

4. Truth Initiative. The 3 main reasons youth use e-cigarettes. March 19, 2018. https://truthinitiative.org/research-resources/emerging-tobacco-products/3-main-reasons-youth-use-e-cigarettes.

5. Khan MS, Khateeb F, Akhtar J, et al. Organizing pneumonia related to electronic cigarette use: A case report and review of literature. *Clin Respir J.* 2018;12:1295-1299. https://doi.org/10.1111/crj.12775

6. Barrington-Trimis JL, et.al. Flavorings in electronic cigarettes: An unrecognized respiratory health hazard? *JAMA.* 2014;312 (23):2493-4.

7. Gerloff J, Sundar IK, Freter R, et al. Inflammatory response and barrier dysfunction by different e-cigarette flavoring chemicals identified by gas chromatography-mass spectrometry in e-liquids and e-vapors on human lung epithelial cells and fibroblasts. *Applied in vitro Toxicology.* 2017;3:28-40

8. JUUL. https://www.juul.com.

9. Layden et al. Pulmonary illness related to e-cigarette use in Illinois and Wisconsin – Preliminary report. *N Engl J Med.* 2019 Sep 6. doi:10.1056/NEJMoa1911614. [Epub ahead of print].

10. Siegel, DS, Jatlaoui TC, Koumans EH, et al. Update: Interim guidance for health care providers evaluating and caring for patients with suspected e-cigarette, or vaping, product use-associated lung injury. *MMWR.* 2019;68:919-926.

11. Taylor J, Wiens T, Peterson J, et al. Characteristics of e-cigarette, or vaping, products used by patients with associated lung injury and products seized by law enforcement — Minnesota, 2018 and 2019. *MMWR Morb Mortal Wkly Rep.* 2019;68:1096-1100. doi:http://dx.doi.org/10.15585/mmwr.mm6847e1external icon.

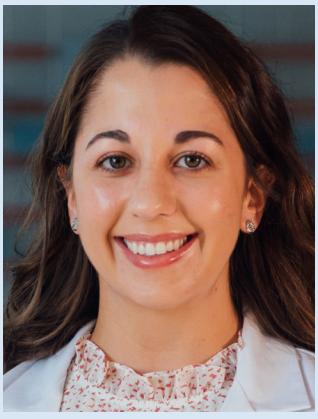
12. McCauley L, Markin C, Hosmer D. An unexpected consequence of electronic cigarette use. *Chest.* 2012;141(4):1110–1113.

13. Maddock SD, et al. Pulmonary lipid laden macrophages and vaping. *N Engl J Med.* doi:10.1056/NEJMc1912038.

14. Butt YM, Smith ML, Tazelaar HD, et al. Pathology of vaping-associated lung injury. *N Engl J Med.* 2019;381:1780-1781. doi:10.1056/NEJMc1913069. [Epub ahead of print].

15. Brown T. 'Chemical burns' seen as possible cause of vaping lung damage. *Medscape.* October 03, 2019. https://www.medscape.com/viewarticle/919361.

authors

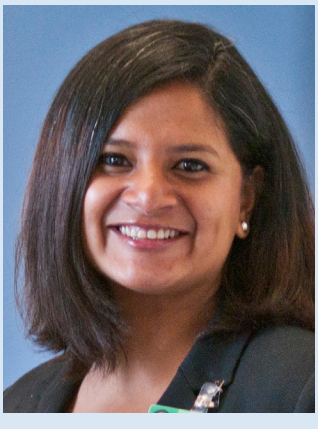


Rachel Cinlemis, DO

Rachel Cinlemis, DO is currently a third year resident in the Wright State University Integrated Pediatric Residency Program and Captain in the U. S. Air Force. She received her undergraduate degree from Wittenberg University in Springfield, Ohio and medical degree from Western University of Health Sciences in Pomona, California. Rachel grew up in Colorado Springs, Colorado and enjoys spending time outside.

Daniel Evans, MD

Daniel Evans, MD is a pediatric pulmonologist and division chief of pulmonology at Dayton Children's Hospital. Dr. Evans treats children with all varieties of respiratory disease as well as serving as the medical director of the Department of Respiratory Therapy and the Pulmonary Diagnostics Laboratory. Dr. Evans was born and raised in the greater Dayton area. He completed his medical school education at Wright State University School of Medicine in Dayton, Ohio. Following college, he spent his internship and residency at Dayton Children's Hospital. He completed his fellowship at Cincinnat Children's Hospital Medical Center in Cincinnati, Ohio. Dr. Evans is board certified in both pediatric pulmonology and general pediatrics.



Rasika Venkatraman, MD

Rasika Venkatraman, MD, is a pediatric intensivist in the Wallace Critical Care Complex at Dayton Children's Hospital, and an Assistant Professor of Pediatrics at Wright State University Boonshoft School of Medicine. She works in both the pediatric intensive care unit (PICU) and the intermediate care unit (IMCU) with a team of intensivists, nurses, residents, respiratory therapists, social workers and dietitians to heal the most critically ill or injured children.

CME questions

1. Adolescents have admitted to vaping which of the following products?

a. Nicotine

b. Marijuana

c. Flavorings

d. All of the above

2. An increasing number of adolescents have admitted to past-year vaping according to CDC studies.

a. True

b. False

3. Providers should do which of the following when patients admit to e-cigarette use?

a. Prescribe evidence-based means of tobacco cessation

b. Advise against buying e-liquid additives and THC from unknown sources

c. Inform vaping is not a means to quit or prevent smoking

d. All of the above

bowel management for severe functional constipation in children

by Oliver S. Soldes, MD, FACS, FAAP

learning objectives

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

1. Describe the clinical features and diagnosis of functional constipation.
2. Discuss the difference between true incontinence and pseudoincontinence.
3. Discuss the conduct of a bowel management program.

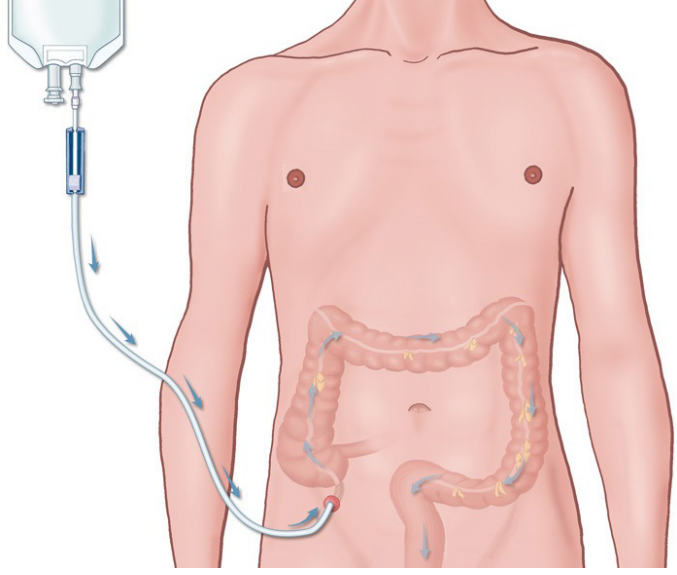


figure 1. Malone appendicostomy.

Constipation is a common condition encountered in pediatric practice. Idiopathic, or functional constipation without identifiable cause is most common, representing greater than 90% of cases.[1] Functional constipation often develops in early childhood with a median age of onset of 2-3 years.[2] The mean prevalence of functional constipation in a systematic review was 14%.[3] There is a wide range of severity from mild to severe. Severe cases are characterized by abdominal pain, painful stooling, fissures, repeated hospitalizations for fecal impactions and overflow incontinence (encopresis). Chronic soiling and the need for diapers in school-age children are particularly distressing for children and families as the child ages. When chronic and severe, constipation is a common cause of referral to pediatric gastroenterologists.

An important distinction in the child with soiling is whether the child has true incontinence or pseudoincontinence. Patients with true incontinence do not have the capacity for voluntary bowel movements and voluntary control, as may occur with severe anorectal malformations, injury to the anal continence mechanism, spina bifida or spinal cord injuries. Patients with pseudoincontinence have the capability for voluntary bowel movements and control, but constipation and fecal loading leads to overflow incontinence of stool.[4] Patients with functional constipation and soiling have pseudoincontinence. Management is different in these groups and this article will focus on patients with severe functional constipation, who may sometimes have overflow pseudoincontinence.

Functional constipation is usually managed with dietary modification, fiber and osmotic laxatives (polyethylene glycol). When chronic constipation is deemed medically refractory, referral for surgical management may occur. A wide variety of surgical procedures have been utilized including anal and pelvic floor procedures, antegrade continence enema (ACE) procedures (Malone appendicostomy, figure 1), colorectal resections and ostomies.[5] The definition of failed medical management is not standardized.[1] What constitutes medical failure may simply represent a failure to take a structured step up approach that includes stimulant laxatives and mechanical adjuncts (enemas) to bowel management.

In patients with anorectal malformations, Hirschsprung's disease and neurogenic bowel, a structured bowel management program—developed by Alberta Peña, MD, and Marc Levitt, MD, that includes with diet, senna-based laxatives and enemas —may be highly effective for management of constipation and fecal incontinence.[6,7] This bowel management program has been modified and extended to patients with severe functional constipation with excellent results.[8] Such a program should be attempted prior to more invasive surgical interventions.[1]

diagnosis

The symptoms of functional constipation are hard stools, decreased stool frequency and abdominal pain. Complications include painful defecation, anal fissures, fecal impaction and pseudoincontinence. Functional constipation is a clinical diagnosis based on the Rome IV criteria.[9]

ROME IV diagnostic criteria for functional constipation

Must include two or more of the following occurring at least once per week for a minimum of one month with insufficient criteria for a diagnosis of irritable bowel syndrome:

1. Two or fewer defecations in the toilet per week in a child of a developmental age of at least 4 years
2. At least one episode of fecal incontinence per week
3. History of retentive posturing or excessive volitional stool retention
4. History of painful or hard bowel movements
5. Presence of a large fecal mass in the rectum
6. History of large diameter stools that can obstruct the toilet

After appropriate evaluation, the symptoms cannot be fully explained by another medical condition.

bowel management program

Patients referred for intensive bowel management have generally failed conventional constipation management. The program developed at Primary Children's Hospital in Salt Lake City demonstrated an 82% reduction in admission for constipation (figure 2). Fully adherent patients experienced a 100% reduction in admissions.[8] The aim of the program is for the patients to empty the contents of the colon daily and be clean and free of fecal soiling. It is a patient specific intervention, usually

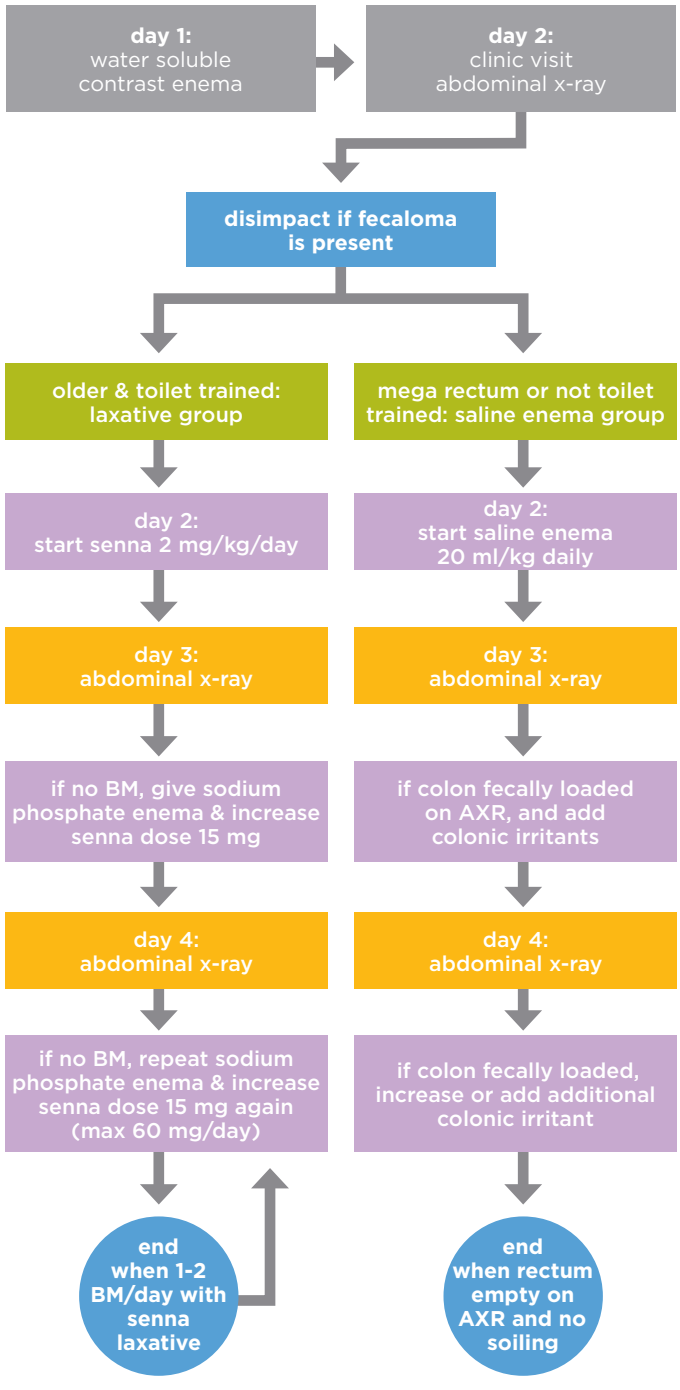


figure 2. bowel management

Russell KW, Barnhart DC, Zobell S, et al. Effectiveness of an organized bowel management program in the management of severe chronic constipation in children. J Pediatr Surg.2015;50:444-447.

one week in length. The management program has two arms: high-dose senna-based laxatives or retrograde enemas. Both require active daily review and titration of the intervention. The program begins with a water-soluble contrast enema to assess the colonic anatomy, size and fecal burden, and to evacuate the stool. A clinic visit and a baseline abdominal X-ray occur the day after the enema to assess motility by the degree of contrast retention. Patients require fecal disimpaction when a large rectal fecaloma is present on the abdominal X-ray or on physical examination, prior to beginning the intervention. A daily abdominal X-ray is obtained, and the clinical response (bowel movements) to the interventions is assessed and the caregivers contacted daily to discuss the results during the program. The treatment plan is adjusted based on X-rays and the clinical response (bowel movements).

Older and toilet trained patients with functional constipation are started on senna-based laxatives (laxative group). The senna is started at a dose of 2 mg/kg. An abdominal X-ray is obtained the next day. If there is no bowel movement within 24 hours, a sodium phosphate enema is given to evacuate the stool and the laxative dose is increased by 15 mg. This cycle is repeated daily until one to two bowel movements per day occur. High doses of senna are well tolerated and are often significantly higher than are typically prescribed. However, at higher doses some patients may develop skin blistering (median dose of 60 mg/day).[10] Pectin is administered (2 gm PO BID) if the stool is loose, to bulk the stool. Patients who do not tolerate the laxative, usually because of abdominal cramping, are switched to enema.

Patients with megarectum on contrast enema, or who have never been toilet trained and are soiling, are started on the enema program. Large volume saline enema are administered at a volume of 20 ml/kg once daily. An abdominal X-ray is obtained the next day and the results are reviewed with the caregiver. If the enema is not adequately effective, colonic irritants are added to the solution: glycerine (10-30 ml), Castile soap (9-27 ml) or sodium phosphate enema (30-120 ml), in that order. Each enema is retained for 10 minutes and the patient sits on the toilet for 30-45 minutes. When phosphate is added to the saline enemas, they are limited to a maximum of three times per week to prevent phosphate overload.

The treatment plan is considered successful when the rectum is empty on abdominal X-ray and the child has no soiling. A daily bowel movement is ideal. The program can be tailored in length to accommodate the patient and family's needs and abilities. Some children (i.e. with developmental disabilities or other factors) will not tolerate rectal enemas or laxatives and can undergo an antegrade continence enema (ACE) procedure (Malone appendicostomy or a cecostomy tube) initially.

Follow-up after the initial program is with a monthly telephone call and an office visit at six-month intervals. For children on the enema program with good results for three to six months, a weeklong laxative trial is performed and the enemas can be weaned. If repeated attempts at laxative trials are unsuccessful, patients are offered the option of continuing enemas and attempting laxatives again in six to 12 months or an ACE procedure. After an ACE procedure, patients are still encouraged to try periodic laxative trials. When laxative or enema needs are very high, a sigmoidectomy may be offered to reduce the dose or volume.

summary

Functional constipation is a common problem that often manifests by 2-3 years of age. It is generally managed medically with diet, fiber and osmotic laxatives and has a wide range of severity. Severe cases manifest with abdominal pain, painful stooling, anal fissures, and repeated hospitalizations for fecal impactions and soiling. These severe cases may be well managed with a structured bowel management program utilizing high-dose senna-based laxatives and large-volume enemas. Pediatric surgeons are familiar with and can coordinate these bowel management programs because of their experience with them in the course of caring for patients with anorectal malformations, Hirschsprung's disease, spina bifida and neurogenic bowel. These programs can obviate the need for more extensive surgical procedures such as ostomies and colonic resections.

references

1. Wood RJ, Yacob D, Levitt MA. Surgical options for the management of severe functional constipation in children. *Curr Opin Pediatr.* 2016;28(3):370-339.

2. Malowitz S, Geen M, Karpinski A, Rosenberg A, Hyman PE. Age of onset of functional constipation. *J Pediatr Gastroenterol Nutr.* 2016;62(4):600-602.

3. Mugie SM, Benninga MA, Di Lorenzo C. Epidemiology of constipation in children and adults: A systematic review. *Best Pract Res Clin Gastroenterology.* 2011;25:3-18.

4. Levitt MA, Peña A. Pediatric fecal incontinence: A surgeon's perspective. *Pediatr Rev.* 2010;31:91-101.

5. Siminas S, Losty PD. Current surgical management of pediatric idiopathic constipation. Ann Surg. 2015;262(6): 925-933.

6. Bischoff A, Levitt MA, Bauer C, Jackson L, Holder M, Peña A. Treatment of fecal incontinence with a comprehensive bowel management program. *J Pediatr Surg.* 2009;44:1278-1284.

7. Bischoff A, Levitt MA, Peña A. Bowel management for the treatment of pediatric fecal incontinence. *Pediatr Surg Int.* 2009;25:1027-1042.

8. Russell KW, Barnhart DC, Zobell S, et al. Effectiveness of an organized bowel management program in the management of severe chronic constipation in children. *J Pediatr Surg.* 2015;50:444-447.

9. Hyams JS, Di Lorenzo C, Spas M, Shulman RJ, Staiano A, van Tilburg M. Childhood functional gastrointestinal disorders: child/adolescent. *Gastroenterology.* 2016;150:1456-1468.

10. Vilanova-Sanchez A, Gasior AC, Toocheck N, et al. Are senna based laxatives safe when used as long term treatment for constipation in children? *J Pediatr Surg.* 2018;53: 722-727.

author

Oliver S. Soldes, MD, FACS, FAAP

Oliver S. Soldes, MD, FACS, FAAP is a graduate of the Warren Alpert Medical School of Brown University. He completed his general surgery residency, surgical critical care/ECMO and pediatric surgery fellowship training at The University of Michigan Hospitals in Ann Arbor, Michigan. He has been a staff surgeon at the University of Michigan Mott Children's Hospital, the Cleveland Clinic and Akron Children's Hospital. Dr. Soldes is board certified in pediatric surgery, general surgery and surgical critical care by the American Board of Surgery. In July 2018 he joined the department of pediatric surgery at Dayton Children's.

CME questions

4. Pseudoincontinence occurs in patients with the potential for voluntary control of bowel movements as a result of fecal loading and overflow.

a. True

b. False

5. High doses of senna-based laxatives are generally well tolerated but may cause skin blistering.

a. True

b. False

6. Antegrade continence enema procedures (appendicostomy) are offered to patients who cannot tolerate retrograde enemas or high-dose laxatives, or fail to wean from enemas to senna-based laxatives.

a. True

b. False

a primer on pre-exposure prophylaxis (PrEP): prevention of HIV in the pediatrician's office

by Amanda Smith, MD, Capt, USAF

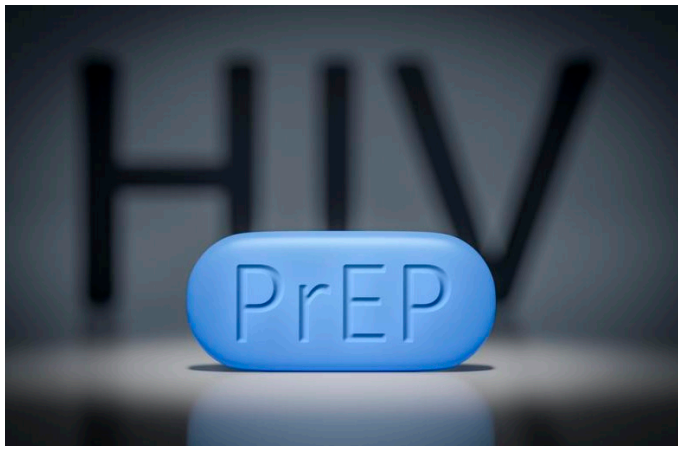
learning objectives

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

1. Perform appropriate evaluation and counseling prior to prescribing PrEP.
2. Discuss appropriate prescription of PrEP and its limitations.
3. Review appropriate follow-up evaluation while prescribing PrEP.

case study

A 17-year-old female presents to the infectious disease clinic following a positive human immunodeficiency virus (HIV) blood p24 antigen, but negative for HIV 1/2 antibody obtained in the emergency department. Follow-up blood polymerase chain reaction (PCR) testing for HIV was negative and the initial test was deemed a false positive result. The patient has a history of having a spontaneous abortion at 13 years of age. She was treated for chlamydia cervicitis 15 months ago, and both chlamydia and trichomonas infections 13 months ago. She was treated for pelvic inflammatory disease seven months prior to this visit. A week ago, she was again treated for trichomonal infection. She has a Nexplanon birth control implant in place in her right arm. Now that her HIV PCR is negative, you inform her of the good news emphasizing that she is not HIV-infected. Relieved, she then asks how she can best prevent HIV infection in the future. Her history of an unplanned pregnancy and multiple recent sexually transmitted infections (STIs) indicate inconsistent condom use.
You are concerned that counseling on condom use alone may not prove effective at preventing HIV in this patient.



Despite accounting for only 23% of the U.S. population, young people age 13-29 account for nearly 40% of new HIV diagnoses.[1] The risk of contracting HIV does increase as patients age through this age group. However, HIV infection is estimated to precede diagnosis by 2.7 years in young people, and patients are generally beginning to explore their sexual identity during late adolescence.[1] The primary care pediatrician is in a unique position to educate high-risk patients in their options for preventing HIV infection. Providers should screen all adolescents and young adults for at-risk sexual practices and provide appropriate counseling to at-risk patients. History should include eliciting information about condom use both directly and indirectly by reviewing recent bacterial STIs and unplanned pregnancies. Patients should be reminded that consistent condom use has been associated with 80% reduction in HIV acquisition among heterosexual persons and 70% reduction among men who have sex with men (MSM).[2,3] While effective and important for its role in preventing STIs and pregnancy, regular condom use has been shown to be infrequent. It is quite infrequent with increasing numbers of sexual partners.[4] Thus with most patients, particularly those with a history of several recent STIs and multiple sexual partners, condom use alone may not be sufficient to prevent HIV infection.

HIV PrEP with the medication Truvada was approved for adults >35kg in 2012 and for adolescents in May 2018.[5] Truvada consists of a fixed combination of tenofovir disoproxil fumarate (TDF) 300mg and emtricitabine (FTC) 200mg (both HIV nucleoside analog reverse transcriptase inhibitors – NRTIs). Truvada is taken orally once daily for as long as an increased risk of infection exists.
A second medication, Descovy, a fixed combination of two NRTIs, (tenofovir alafenamide 25mg and emtricitabine 200mg) was approved for PrEP in October 2019 for adults and adolescents >35kg.[6] Importantly, it is not indicated for individuals at risk for HIV infection from receptive vaginal sex because its effectiveness in this population has not been evaluated.[6] The CDC recommends PrEP for MSM and for heterosexual men and women who have had (a) at least one sexual partner in the last six months and, (b) report inconsistent condom use with individuals of unknown HIV status and/or patients who have had a bacterial STI in the last six months.[7] Another unique group consists of individuals in a monogamous relationship with an HIV seropositive partner. Patients abusing IV drugs are also approved indications for PrEP,[7]; however, this is less common in the pediatric age group and thus will not be the focus of this article.

Truvada has been shown to be highly effective when taken regularly. Studies have shown that when taken daily, it is as much as 99% effective at preventing HIV transmission through

sexual transmission.[7,8] Truvada's effectiveness also varies by tissue concentration of the medication and accumulates fastest in rectal tissue. Truvada reaches peak levels in rectal tissue at approximately seven days and peak levels in blood and cervicovaginal tissues at approximately 20 days.[7] It therefore confers quicker and perhaps more effective protection from anal transmission of HIV. It has been suggested that taking at least four days per week confers 90-96% protection from HIV acquisition through anal sex, while strict adherence of at least six days per week was required to achieve similar protection in vaginal tissues.[7,9] All patients prescribed PrEP should be counseled on the importance of taking the medication regularly. There is an alternative option, called "event driven" PrEP. This mode of administration is only recommended for MSM who report infrequent sexual intercourse and are able to predict when a sexual encounter will occur. In this model, two pills are taken two to 24 hours prior to anal sexual intercourse, continued daily while the individual is having sexual intercourse, and then for two days after sexual intercourse.[10] Adolescents, for whom

an overview of Pre-Exposure Prophylaxis[6]

Who should be considered for PrEP?	• Weight must be >35kg AND • Men who have sex with men OR heterosexual men and women • WITH ANY of the following risk factors:	Risk factors to consider: • Bacterial STI in last 6 months • High number of sexual partners • Inconsistent or no condom use • Commercial sex work • HIV positive sexual partner • High local HIV prevalence
What medications are approved for PrEP?	Truvada (TDF/FTC 300/200mg), OR Descovy (TAF/FTC 25/200 mg) take 1 tab daily** 90 day supply to coincide with follow-up schedule	** If miss a dose, it is not advised to double next dose
Requirements to be clinically eligible for PrEP:	• Document negative HIV status with serum antibody/antigen or serum antibody test alone. POC finger stick testing is acceptable. • Screen for signs/symptoms of acute HIV in last 4 weeks** • Serum creatinine with eCrCl >60ml/min • Document Hepatitis B infection and vaccination status • Evaluate need for HBV vaccination	**Note: If patient with positive signs/symptoms, prefer antibody/antigen test over antibody test alone for improved sensitivity
Follow-up visits every 3 months while taking PrEP:	• HIV testing every 3 months • Pregnancy testing every 3 months for women • Serum creatinine at 3 months and every 6 months after • Bacterial STI testing, every 3-6 months depending on risk and symptoms • HCV testing for anyone with any injection drug use and MSM, recommended annually if ongoing exposure	At each visit discuss: • Strict adherence • Further risk reduction including condom use, birth control • Screening for side effects • Screening for STI symptoms

table 1.

compliance has been shown to be a particularly strong barrier to effective PrEP, are unlikely to be a good candidate for event driven PrEP and in most cases will benefit most from daily PrEP.[11]

Before prescribing PrEP, patients should be screened to determine if Truvada is safe to prescribe and side effects should be discussed. Common side effects include headaches, nausea and increased flatulence.[7] Most commonly observed when just starting Truvada, these symptoms typically resolve within one month of taking the medication. Long-term safety concerns include renal disease and decreased bone mineral density, although these are more prevalent in HIV positive patients taking tenofovir (TDF) as part of their combination antiretroviral regimen (HAART).[7] Renal function should be measured by a serum creatinine with calculation of estimated creatinine clearance (eCrCl) performed. Only patients with eCrCl >60 ml/min should be prescribed PrEP. Routine bone densitometry (DEXA scanning) is not currently recommended in otherwise healthy patients. Preliminary studies have failed to demonstrate the same effect of TDF used in PrEP as in HIV positive patients receiving TDF as part of their HAART regimen.[7] It should be noted that the effect of TDF on bone health in actively growing adolescents has not yet been fully elucidated.

Other required screening includes serum HIV and HBV screening as infection with these viruses can have impact on treatment decisions. Acquiring HIV while on PrEP could cause resistance to develop to either component of Truvada.[7] It is important that patients who seroconvert to HIV positive while on PrEP be urgently referred to a provider experienced in treating HIV and started on an antiretroviral regimen. Patients should likewise be counseled to return for evaluation if they start having signs of acute HIV infection. These most commonly include nonspecific viral symptoms such as fever, fatigue, myalgias and headache.[7] Truvada is active against hepatitis B virus (HBV). While not a contraindication to PrEP, patients who are HBV-infected and are receiving Truvada either as treatment for PrEP or HBV infection should be counseled that stopping Truvada could result in reactivation of their HBV infection.[7]

In addition to the above screening, patients should be evaluated for evidence of other STIs both at initiation of PrEP and subsequently every three to six months.[7] This includes screening for syphilis (RPR or VDRL), as well as screening for gonorrhea and chlamydia infection at all sites of sexual contact including urine, vaginal, rectal and pharyngeal specimens. Patients who screen HBV negative at the initial visit should receive hepatitis B vaccine. For both MSM and injection drug users, hepatitis C virus (HCV) screening should also be performed at initiation of PrEP and then considered annually depending on local HCV risk factors. Women who do not wish to become pregnant should also be provided effective contraception and tested for pregnancy every three months.

Important resources for clinicians interested in providing PrEP include

- CDC Clinical Practice Guidelines for providing PrEP, updated 2017: https://www.cdc.gov/hiv/pdf/risk/prep/cdc-hiv-prep-guidelines-2017.pdf
- Clinical Providers' Supplement for the above CPG, updated 2017: This supplement contains a provider checklist for initiating PrEP, as well as several useful patient information sheets, and screening questionnaires to identify patients who are most at risk for HIV acquisition.

  https://www.cdc.gov/hiv/pdf/risk/prep/cdc-hiv-prep-provider-supplement-2017.pdf
- HIV Prevention: Using HIV Medication to Reduce Risk: Pre-Exposure Prophylaxis: Information from the United States Department of Health & Human Services on PrEP utilization as one step towards ending the HIV epidemic in the U.S. https://www.hiv.gov/hiv-basics/hiv-prevention/using-hiv-medication-to-reduce-risk/pre-exposure-prophylaxis
- Truvada medication assistance program for patients whose insurance will not cover PrEP: https://start.truvada.com
- Several calculators for calculating estimated creatinine clearance (Cockcroft-Gault calculation) are available online.

resources

1. Ocfemia MC, Dunville R, Zhang T, Barrior LC, Oster AM. HIV diagnoses among persons aged 13-29 Years – United States, 2010-2014. *MMWR Morb Mortal Wkly Rep.* 2018;67(7):212-215.

2. Weller S, Davis K. Condom effectiveness in reducing heterosexual HIV transmission. *Cochrane Database Syst Rev.* 2002;(1):CD003255.

3. Smith DK, Herbst JH, Zhang X, Rose CE. Condom effectiveness for HIV prevention by consistency of use among men who have sex with men in the United States. *J Acquir Immune Defic Syndr.* 2015;68(3):337-44.

4. Peterman TA, Tian LH, Warner L, et al. Condom use in the year following a sexually transmitted disease clinic visit. *International Journal of STD & AIDS.* 2009;20(1):9-13.

5. HIV-1 PrEP drug can be part of strategy to prevent infection in at-risk adolescents. *AAP News.* https://www.fda.gov/files/science%20&%20research/published/HIV-PrEP-drug-can-be-part-of-strategy-to-prevent-infection-in-at-risk-adolescents.pdf. Published June 28, 2018. Accessed January 2, 2020.

6. Hunt A. FDA approves second drug to prevent HIV infection as part of ongoing efforts to end the HIV epidemic. *FDA News Release.* https://www.fda.gov/news-events/press-announcements/fda-approves-second-drug-prevent-hiv-infection-part-ongoing-efforts-end-hiv-epidemic. Published October 3, 2019. Accessed January 2, 2020.

7. Centers for Disease Control and Prevention. US Public Health Service: Preexposure prophylaxis for the prevention of HIV infection in the United States—2017 Update: A clinical practice guideline. https://www.cdc.gov/hiv/pdf/risk/prep/cdc-hiv-prep-guidelines-2017.pdf. Published March 2018. Accessed January 2, 2020.

8. Abbas UL, Glaubius R, Mubayi A, Hood G, Mellors JW. Antiretroviral therapy and preexposure prophylaxis: Combined impact on HIV transmission and drug resistance in South Africa. *J Infect Dis.* 2013;208(2):224-234.

9. Cottrell ML, Yang KH, Prince HMA, et al. A translational pharmacology approach to predicting outcomes of preexposure prophylaxis against HIV in men and women using tenofovir disoproxil fumarate with or without emtricitabine. *J Infect Dis.* 2016;214(1):55-64.

10. World Health Organization. What's the 2+1+1? Event-driven oral pre-exposure prophylaxis to prevent HIV for men who have sex with men: Update to WHO's recommendation on oral PrEP. https://www.who.int/hiv/pub/prep/211/en/. Updated July 23, 2019. Accessed January 9, 2020.

11. Allen EB, Gordon, A, Krakower D, Hsu K. HIV pre-exposure prophylaxis for adolescents and young adults. *Curr Opin Pediatr.* 2017; 29(4): 399-406.

author

Amanda Smith, MD, Capt, USAF

Amanda Smith, MD is a third year pediatric resident at Dayton Children's Hospital and she is a captain in the U.S. Air Force. She completed medical school at Indiana University School of Medicine. She is interested in topics affecting the outpatient pediatric clinic as she intends to be a general pediatrician following residency.

CME questions

7. Prior to initiation of PrEP, which of the following is an acceptable test to document an HIV negative status?

a. Finger stick HIV antibody test in a patient with seven days of fever and malaise

b. HIV antibody/antigen venous blood draw in a patient with seven days of fever and malaise

c. Oral HIV antibody testing in a patient who has been asymptomatic for the last four weeks

d. Venous HIV antibody test in a patient with seven days of fever and malaise three weeks ago

8. Truvada is most effective at preventing which mode of HIV transmission when taken daily:

a. Receptive anal intercourse

b. Penile-Vaginal intercourse

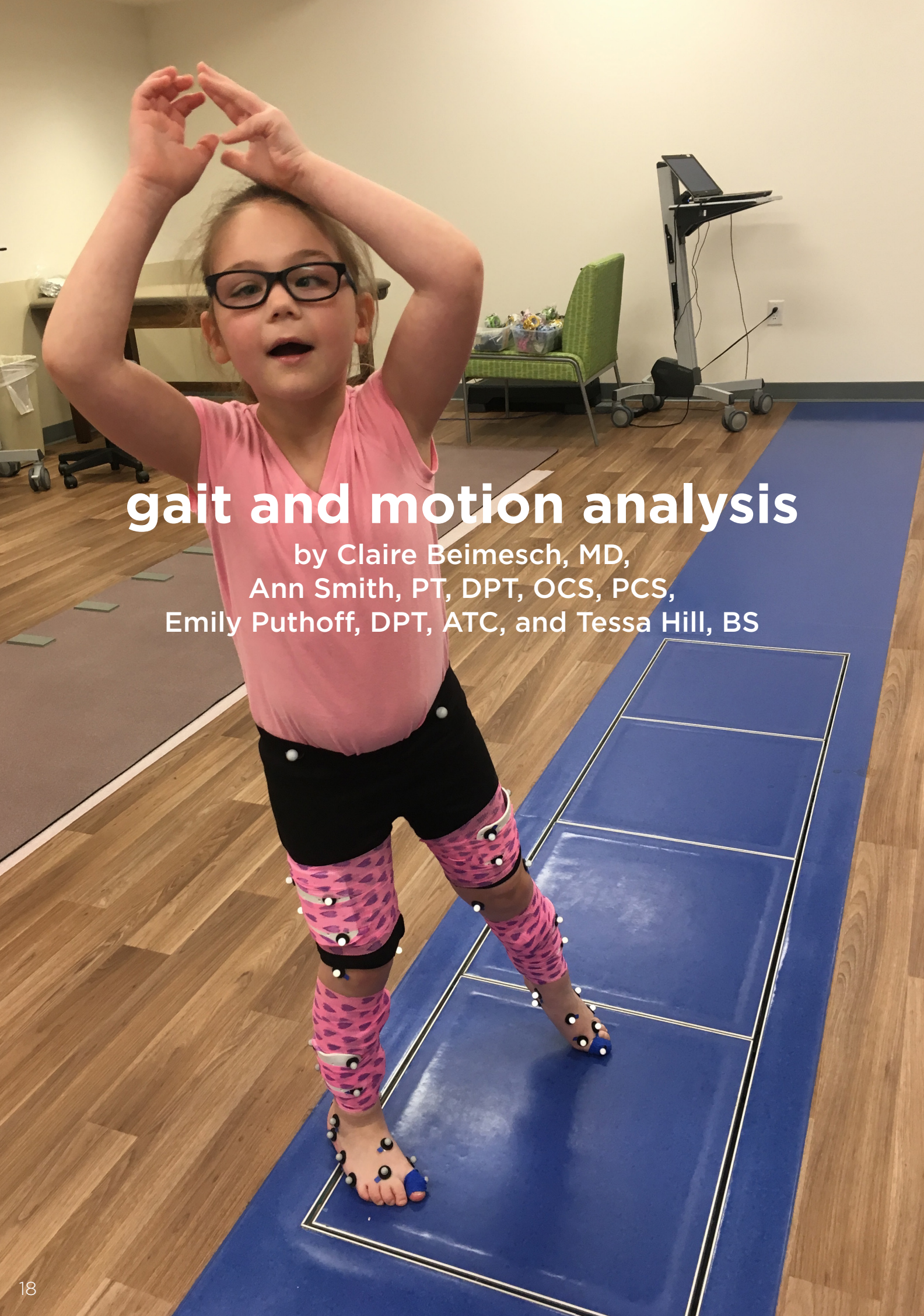
c. IV drug use

d. It protects against all methods of transmission equally

9. A female patient is using PrEP to prevent sexual transmission of HIV. As long as she takes Truvada at least four days per week, she does not need to use condoms during penile-vaginal intercourse.

a. True

b. False



gait and motion analysis

by Claire Beimesch, MD,
Ann Smith, PT, DPT, OCS, PCS,
Emily Puthoff, DPT, ATC, and Tessa Hill, BS

learning objectives

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

1. Identify the purpose of a gait lab assessment.
2. Recognize which diagnoses might be appropriate for referral to a gait lab.
3. Distinguish between 2-D and 3-D assessments.

How people walk—or why they appear to walk differently than "normal" — has been a constant question since the ancient Greek philosopher Aristotle (384-322 BCE) keenly observed varying patterns associated with walking. In the modern world, gait and motion analysis are highly dependent not only on observation, but also on mathematics. Richard Baker, in his extensive paper about the history of gait analysis, notes it was not until the time of the Renaissance in Europe that science and mathematics began to develop in a mutually beneficial way to allow for the basis of what is now known as gait analysis.[1] Scientists and medical professionals who have analyzed gait include many renowned scholars such as Galileo, Descartes, Borelli, Duchenne and Trendelenberg. The acceleration of gait and motion analysis over the past 30 years is based on the extensive work of orthopedists Jacquelin Perry, David Sutherland and James Gage (figure 1).

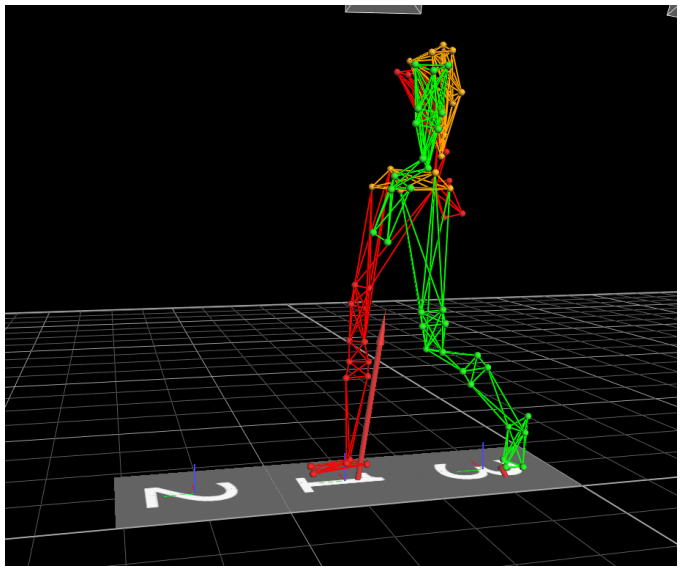


figure 1. Force plate and joint kinematics using Vicon® system

Dr. Perry was one of the first female orthopedic surgeons and a leading authority on gait analysis. Dr. Perry joined the U.S. Army prior to WWII and trained as a physical therapist at Walter Reed before receiving her medical degree in 1950 and becoming board certified in orthopedics in 1955. She joined the staff at Rancho Los Amigos where she was chief of the pathokinesiology service for 30 years. Her interest in polio and post-polio syndrome was the driving force behind designing a device known as a "halo" to stabilize the neck and spine of patients with polio who lacked muscle strength in addition to becoming a leading expert on gait analysis.[2]

Dr. Perry was a colleague of Dr. David Sutherland; they were mentored by Dr. Vern Inman during their orthopedic residency in San Francisco, who was instrumental in developing a lifelong interest in quantitative and qualitative analysis of the biomechanics of human locomotion, specifically with children who had either cerebral palsy or spina bifida. Dr. Sutherland worked closely with engineers from the Vanguard Missile Corporation to develop computerized 3-D motion analysis and founded one of the world's first comprehensive motion analysis laboratories at San Diego Children's Hospital in 1976.[3]

The James R. Gage Center for Gait and Motion Analysis is located at Gillette Children's Specialty Healthcare Center in Minneapolis and is routinely recognized as the leading center for clinical research and evaluation. Gage began practicing medicine in the 1970s at Newington Children's Hospital. He was dismayed by the fact that many children

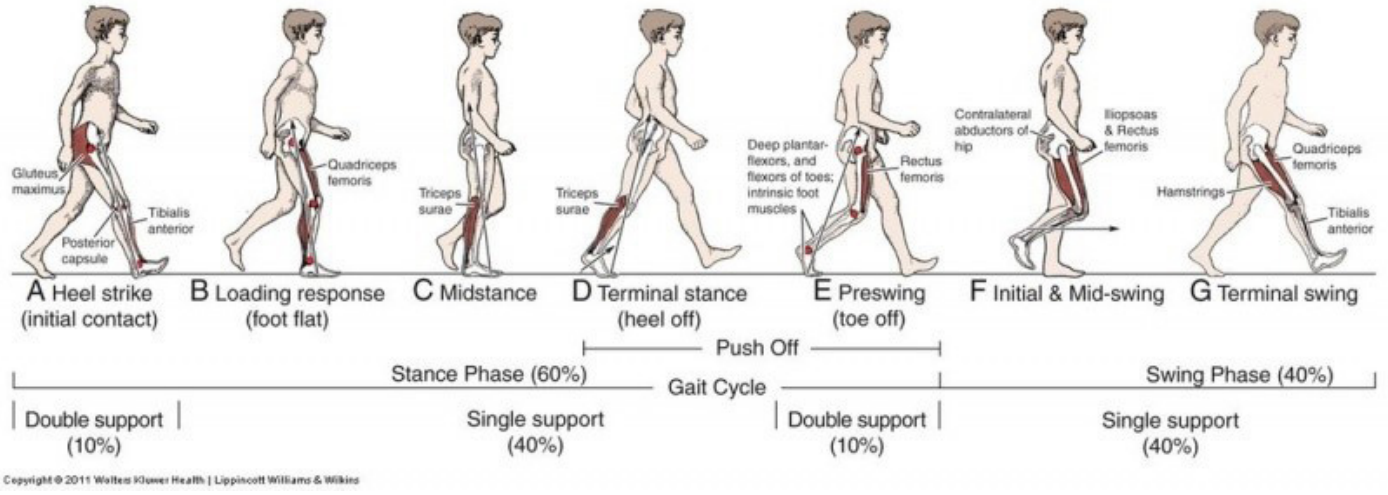


figure 2. Normal gait cycle

who had cerebral palsy underwent multiple surgeries, lengthy hospital stays and countless hours of physical therapy but had very disappointing outcomes, often losing the ability to ambulate as they entered their teen years. Gage held a strong belief that the answer to this dilemma lay in the evaluation of complex movement disorders, and he led the way to take motion analysis out of the research paradigm and incorporate gait analysis into clinical practice.[4]

Gait is a complex activity that requires (1) a control system, (2) an energy source, (3) levers providing movement, and (4) forces to move the levers.[5] Dr. Perry noted that normal gait has five prerequisites that are frequently altered or absent in pathological gait. They include (1) stability in stance, (2) sufficient foot clearance during swing, (3) correct swing phase pre-positioning of the foot, (4) adequate step length and (5) energy conservation.[6] (figure 2)

Quadruped animals have a distinct advantage in gait as they are inherently fast and stable, with their center of gravity located inside their base of support. The core muscles of the trunk are utilized to propel the animal forward increasing both power and stride length. Humans are at a disadvantage: In a bipedal position, the center of mass is located precariously above the base of support (anterior to the S2 vertebra), affecting not only balance, but also power.[5] The human body when walking or running is a complex 3-dimensional linkage that defies understanding through traditional tools such as visual inspection with the naked eye or joint range of motion measurement. The gait lab allows us to examine human movement from a 3-D perspective with the use of high-speed cameras, force plates and surface electrodes that provide detailed information regarding joint kinematics in addition to muscle innervation and power (figure 3).

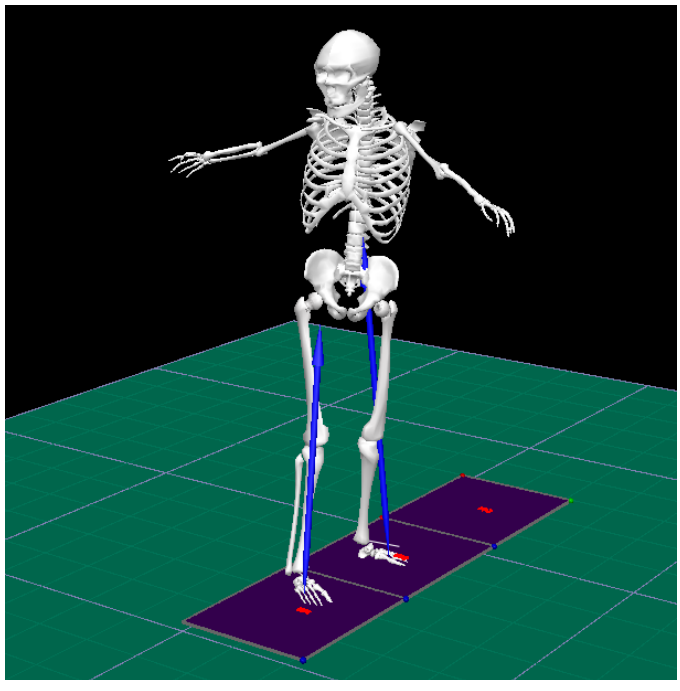


figure 3. Scoliosis patient performing rotation — note asymmetrical force plate readings.

The gait lab staff is comprised of a multidisciplinary team led by Claire Beimesch, MD. Dr. Beimesch is a pediatric orthopedic surgeon specializing in cerebral palsy and gait analysis. She is a native of Covington, Kentucky, and graduate of Xavier University and University of Kentucky College of Medicine. She did her orthopedic residency at West Virginia University and fellowship at Gillette Children's Specialty Healthcare, where she first became interested in gait and motion analysis. Dr. Beimesch was the head of the Gait Lab at Shriners Hospital in Shreveport, Louisiana, prior to accepting her position at Dayton Children's in 2018. Ann Smith, DPT, is the director of OT/PT services and has a particular interest in cerebral

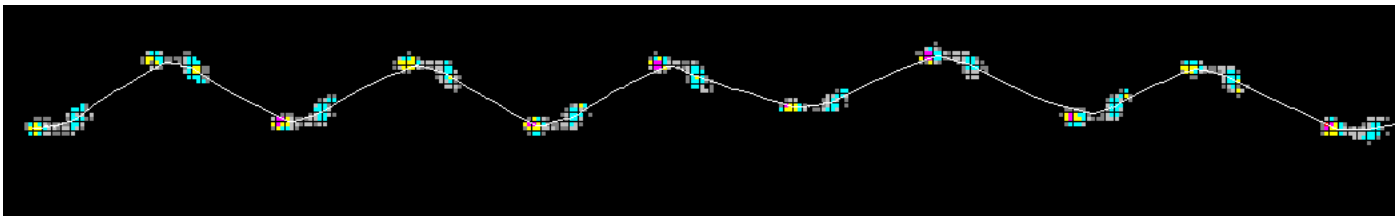


figure 4. Foot pressure mapping and alignment (GAITRite®)

palsy. Emily Puthoff, DPT, is a recent graduate of the University of Dayton with a strong background in physiology and human movement. Tessa Hill is also a recent graduate of the University of Dayton, where she was able to pursue her interest in gait lab studies and graduate with a degree in biomechanical engineering.

The gait lab is located at the Springboro location in the orthopedic department. Patients are usually referred from specialty services within the hospital (orthopedics, neurology, neurosurgery, physical medicine and rehabilitation); information from the gait lab is utilized to assist providers in clinical decision making regarding appropriate bracing, spasticity management, contracture management and (where indicated) surgical intervention.

An evaluation in the gait lab usually takes 1.5–2.0 hours and includes a comprehensive physical examination with one of our physical therapists, detailing range of motion, strength, spasticity or increased tone at each joint. We capture 2-D spatiotemporal information, including pressure mapping of the feet, by having the patient walk across a specialized mat system (GAITRite®) (figure 4).

The patients are then "suited up" in reflective markers that are precisely placed on bony landmarks including the trunk, hips, knees and ankles that allow multiple cameras to capture the marker location as the child walks across force plates. Surface electrodes are placed on key muscle groups to measure the strength and timing of muscle activation. Force plates are built into the floor of the gait lab in a sequential fashion. The force plates measure ground reaction forces generated by the patient, in either a standing position or when walking.

The data is then synthesized into a comprehensive report that allows providers to better understand movement and gait patterns, leading to informed decision making and optimal treatment recommendations for patients. The report looks at each patient from the frontal, sagittal and coronal planes and then compares the child's gait and movement patterns with data from a typical cohort of patients (figure 5 and 6).

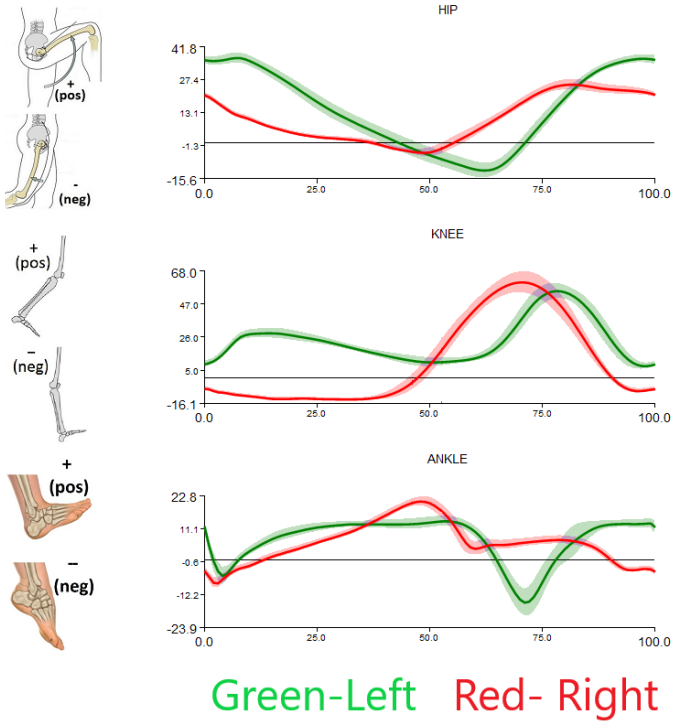


figure 5. Barefoot sagittal joint angles of a patient

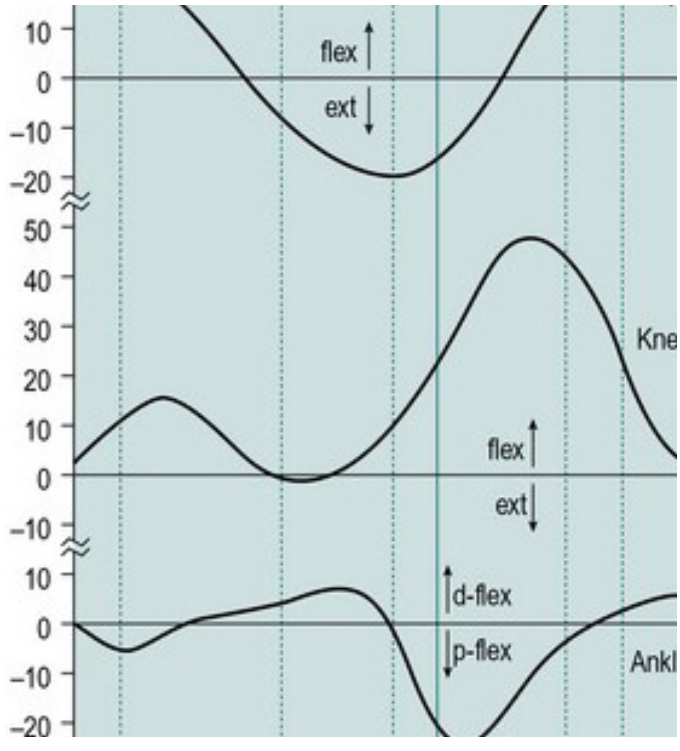


figure 6. Normative data of barefoot sagittal joint angles of a patient

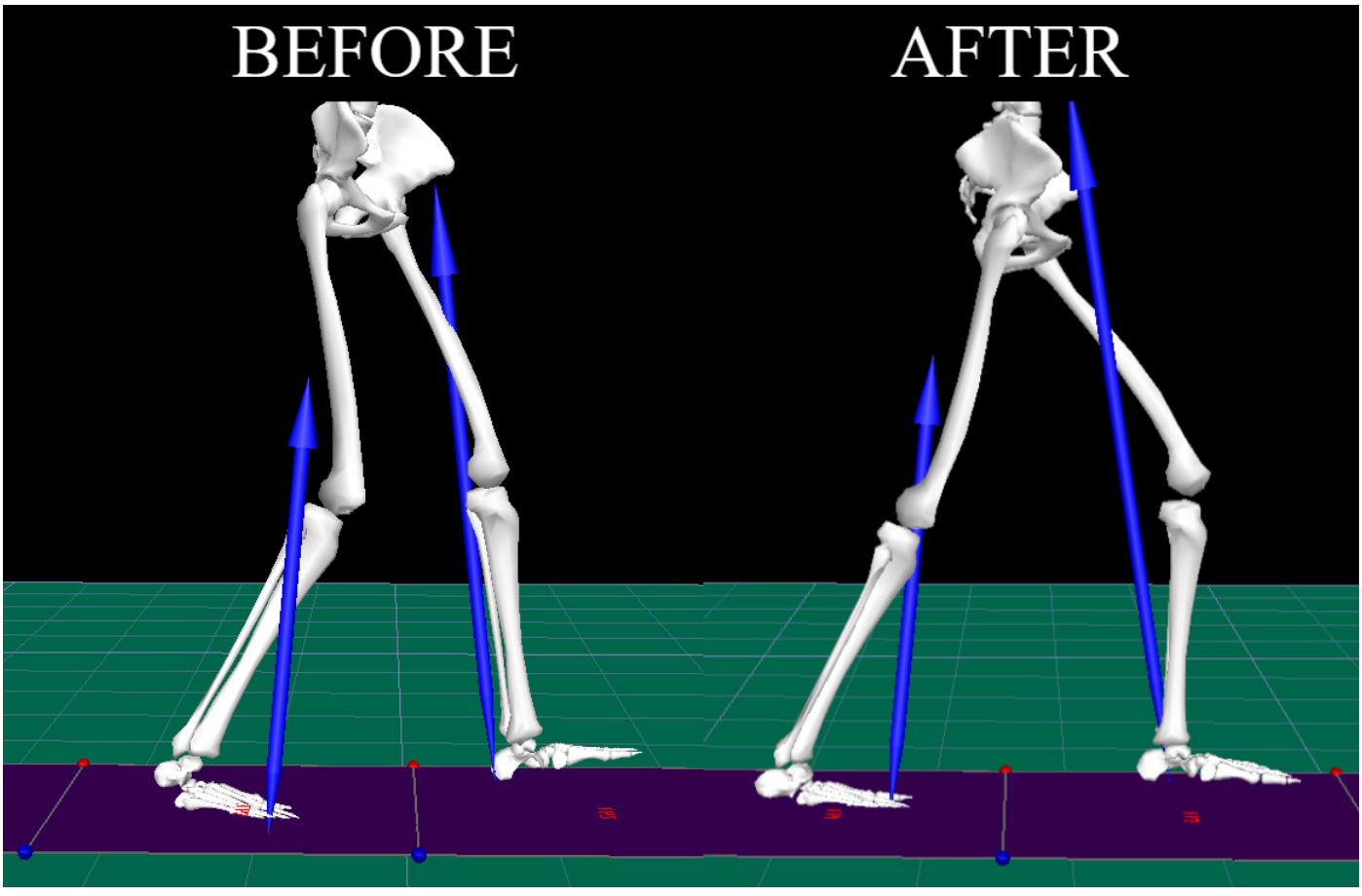


figure 7. Visual 3-D representation of hemiplegic patient before surgery and 12 months later

Highly technical computer programs also allow us to develop a skeletal profile for patients that helps to not only guide surgical decisions, but also allows us to compare physiological outcomes from before and after surgery (figure 7).

We have performed approximately 100 gait lab evaluations for clinical and research purposes to date. Referrals are frequently made for patients with cerebral palsy (spastic diplegia or hemiplegia). We have increased our scope of patients to include pre and post-operative scoliosis patients in addition to patients referred by neurology/neurosurgery for gait deviations.

Several of our providers also have a strong interest and background in the treatment of idiopathic toe walking. The gait lab has provided novel information and cutting edge technology for our patients, families and providers that was not previously available for our pediatric population in the Miami Valley. The gait lab enables us to live our mission of the relentless pursuit of optimal health for every child within our reach.

references

1. Baker R. The history of gait analysis before the advent of modern computers. *Gait & Posture.* 2007;26:331-342.

2. Watts G. Jacquelin Perry. *The Lancet.* 2013;381(9876):1454. doi:https://doi.org/10.1016/S0140-6736(13)60916-2.

3. Clinical Gait Analysis. History of the study of locomotion. Clinical Gait Analysis. http://www.clinicalgaitanalysis.com/history/modern.html. Accessed June 2020.

4. Pardo C. "Simply a hero": Jim Gage's legacy of improving patients' outcomes. Gillette Children's Specialty Healthcare. https://www.gillettechildrens.org/khm/simply-a-hero-jim-gages-legacy-of-improving-patients-outcomes. Published October 2, 2017. Accessed June 2020.

5. Gage JR, Schwarts MH, Koop SE, Novacheck TF. *The Identification and Treatment of Gait Problems in Cerebral Palsy.* London: Mac Keith Press; 2009.

6. Perry J. Normal and pathological gait. In: Bunch WH, ed. Atlas of Orthotics. St. Louis: C.V. Mosby; 1985:76-111.

Claire Beimesch, MD

Claire Beimesch, MD, is a pediatric orthopedic surgeon at Dayton Children's specializing in cerebral palsy and gait analysis. Dr. Beimesch is a native of Covington, Kentucky. She is a graduate of Xavier University and University of Kentucky College of Medicine. She did her orthopedic residency at West Virginia University and fellowship at Gillette Children's Specialty Healthcare, where she first became interested in gait and motion analysis.

Ann Smith, PT, DPT, OCS, PCS

Ann Smith is director of OT/PT services at Dayton Children's Hospital. She received her physical therapy degree from Northwestern University and completed a fellowship in developmental medicine at Georgetown University. Ann completed her doctorate in physical therapy from Rocky Mountain University of Health Professions and holds board certifications in pediatrics and orthopedics. She is presently involved in two research projects examining scoliosis and ACL surgery-rehabilitation utilizing the unique properties of the gait lab to gather data on joint kinematics and muscle activation. Ann is a retired USAF officer and is active in the APTA, with whom she recently published a monograph on articular cartilage and tissue tolerances.

Emily Puthoff, DPT, ATC

Emily Puthoff, DPT, ATC received her athletic training degree from Eastern Kentucky University and her doctorate in physical therapy from University of Dayton. Emily has a strong background and interest in sports injury assessment/treatment in addition to advanced training in scoliosis assessment/exercises. She is currently pursuing board certification in sports medicine and is an investigator on two research studies examining scoliosis and ACL surgery/rehabilitation.

Tessa Hill, BS

Tessa Hill, B.S. studied mechanical engineering at the University of Dayton where she specialized in biomechanics. After college, Tessa joined the multidisciplinary gait lab team at Dayton Children's Hospital. Her responsibilities during gait lab collections include placing muscle sensors/reflective markers on the patients and operating all technical equipment. Outside of collections, Tessa completes post processing, engineering analysis, and report generation for each patient.

CME questions

10. Gait Lab assessments are performed only in research settings.

a. True
b. False

11. Orthopedic surgeons who have contributed to the advancement of gait and motion analysis include all of the following except:

a. Gage
b. Albert
c. Perry
d. Sutherland

12. Gait and motion analysis includes:

a. Force vectors
b. Surface EMG
c. Joint kinematics
d. All of the above

Dayton Children's updates

Dayton Children's named one of U.S. News & World Report 2020-21 Best Children's Hospitals in two specialties

U.S. News & World Report, the global authority in hospital rankings and consumer advice, has ranked Dayton Children's Hospital in two specialties in the new 2020-21 Best Children's Hospitals rankings.

- **Pulmonology**
- **Orthopedics**

The 14th annual Best Children's Hospitals rankings recognize the top 50 pediatric facilities across the U.S. in 10 pediatric specialties.

"We are honored to earn a top spot in U.S. News and World Report Best Children's Hospitals this year," says Michael Albert, MD, chief, division of orthopedics at Dayton Children's. "We continuously strive to be on the cutting edge of the latest innovations in orthopedics for children, including options you will find nowhere else in the country. This allows us to strengthen children today, as well as protect their future growth and development."

This is the first year in the rankings for Dayton Children's Orthopedics Division. It's part of a Level I Trauma Center, and a member of the Setting Scoliosis Straight collaborative to improve spinal surgery outcomes. The division offers innovative techniques such as magnetic limb lengthening, BandLoc spinal surgery, gait and motion analysis, scolio-pilates® and are currently involved in a national study involving a new device for fusionless spine surgery.

It's the third year that Dayton Children's pulmonology division ranked in the magazine's annual survey of children's hospitals. It is a Cystic Fibrosis Center, one of 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. Dayton Children's also formed 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.

"We are proud to once again 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."

"Even in the midst of a pandemic, children have health care needs ranging from routine vaccinations to life-saving surgery and chemotherapy," said Ben Harder, Managing Editor and Chief of Health Analysis at U.S. News. "The Best Children's Hospitals rankings are designed to help parents find quality medical care for a sick child and inform families' conversations with pediatricians."

Dayton Children's is accredited as a Level 4 Epilepsy Center

Dayton Children's neurology department is now accredited by the National Association of Epilepsy Centers as a level 4 epilepsy center. This means that our providers have the professional expertise and facilities to provide the highest level of medical and surgical evaluation, and treatment for patients with complex epilepsy.

"The division of neurology is very pleased to have attained the certification of a Level IV epilepsy center by the National Association of Epilepsy centers. We are the only Level IV center in this region including the adult hospitals," says Dr. Gogi Kumar, division chief of neurology.

"In the last two years our division has doubled in size, and our new EMU has shown an exponential growth in volume. We have a first seizure clinic to provide easy access and comprehensive care to children who are presenting with a first time seizure as well as a multidisciplinary intractable epilepsy clinic for ketogenic diet, vagus nerve stimulation (VNS) and epilepsy surgery evaluation." In addition, we have a tuberous sclerosis (TS) clinic accredited by the TS Alliance.

Our center is well known for its impact on our community. Neurology nurses visit schools and day care centers to provide education about rescue medication and VNS therapy. Our epilepsy team has advanced imaging with 3T MRI, and three pediatric neurosurgeons equipped with robotic stereotactic EEG. We are participating in drug research trials and providing cutting edge comprehensive epilepsy care.

We feel that Level IV accreditation will ensure that our community is confident in our competence and expertise, and and families can receive compassionate and comprehensive care close to home.

We are fotunate to have an amazing team of physicians, nurses and EEG techs who have worked extremely hard to achieve this milestone. I am especially grateful to Dr. Goenka, Dr. Agarwal, Dr. Vacchrajani, Dr. Lober and Dr. Ey as well as Samantha Mescher, RN for their exemplary efforts in getting the epilepsy surgery program off the ground," says Dr. Kumar.

coronavirus (SARS-CoV-2/COVID-19) update updated as of August 10

by Sherman Alter, MD

COVID-19 background

The 2019 novel coronavirus (SARS-CoV-2 that causes COVID-19) pandemic first was recognized in December 2019 in Wuhan, Hubei Province, China. It has spread to more than 180 countries, including the United States. There have been more than 20,000,000 confirmed cases and over 730,000 deaths reported worldwide since December 2019. Since the beginning of the pandemic, there have been over 5,000,000 confirmed and presumptive positive cases in the U.S., including over 162,000 deaths. All U.S. states are reporting community spread of COVID-19. Different parts of the country are seeing different levels of COVID-19 activity.

pediatric COVID-19

Most reported cases of COVID-19 in children aged <18 years appear to be asymptomatic or mild. The American Academy of Pediatrics (AAP) and the Children's Hospital Association recently reported that more than 338,000 children have tested positive for COVID-19 since the onset of the U.S. epidemic, with 97,078 new cases reported in the July 16-30 period. Children <18 years of age account for < 2% of laboratory-confirmed cases. The AAP noted "severe illness due to COVID-19 appears to be rare among children."[1]

However, while uncommon, some children can develop severe COVID-19 illness. From March 1–July 25, 2020, 576 pediatric COVID-19 cases were reported to the COVID-19–Associated Hospitalization Surveillance Network (COVID-NET), a population-based surveillance system that collects data on laboratory-confirmed COVID-19–associated hospitalizations in 14 states.[2] The cumulative COVID-19-associated hospitalization rate among children aged <18 years during was 8.0 per 100,000 population, with the highest rate among children

aged <2 years (24.8). Hispanic and non-Hispanic black children had higher cumulative rates of COVID-19–associated hospitalizations (16.4 and 10.5 per 100,000, respectively) than did non-Hispanic white children (2.1). Forty-two percent of children had one or more underlying medical conditions. One-third of children were admitted to the ICU. Treatment is primarily supportive, but investigations are ongoing looking at specific management strategies.

Findings in laboratory confirmed, symptomatic U.S. children include fever (subjective or documented), cough, or shortness of breath (73%), myalgia (23%), runny nose (7%), sore throat (24%), headache (28%), nausea/vomiting (11%), abdominal pain (6%), diarrhea (13%). Median age in one report was 11 years (range 0-17) and 57% of pediatric cases occurred in males. About 23% had at least one underlying condition, most commonly chronic lung disease (including asthma), cardiovascular disease, and immunosuppression. Some patients develop worsening of illness during the second week of symptoms. Findings of bilateral infiltrates, multiple areas of consolidation, ground glass opacities on chest imaging and lymphopenia occur in some hospitalized patients.[3]

The multisystem inflammatory syndrome in children (MIS-C) associated with COVID-19 was first reported by the United Kingdom at the end of April 2020. MIS-C is a rare but severe condition that generally occurs 2–4 weeks after the onset of COVID-19 in children and adolescents. Cases may have overlapping clinical findings with toxic shock syndrome and atypical Kawasaki disease. Most patients with MIS-C have features of shock, with cardiac involvement, gastrointestinal symptoms, and significantly elevated markers of inflammation, with positive laboratory test results for SARS-CoV-2.[4] In a recent CDC summary of 565 MIS-C patients, all had a positive test result by reverse-transcriptase polymerase chain reaction (RT-PCR) or serology. Hispanic and black patients accounted for the largest proportion (73.6%) of reported MIS-C patients. Over 80% of patients had four or more organ system involvement. Two-thirds did not have preexisting underlying medical conditions before MIS-C onset. Common signs and symptoms included abdominal pain (61.9%), vomiting (61.8%), skin rash (55.3%), diarrhea (53.2%), hypotension (49.5%), and conjunctival injection (48.4%). Most patients had gastrointestinal (90.9%), cardiovascular (86.5%), or dermatologic or mucocutaneous (70.9%) involvement. Substantial numbers of MIS-C patients had severe complications, including cardiac dysfunction (40.6%), shock (35.4%), myocarditis (22.8%), coronary artery dilatation or aneurysm (18.6%), and acute kidney injury (18.4%). The majority of patients (63.9%) were admitted to an ICU. The median length of ICU stay was five days.[5] Through early August 2020, we have managed six patients with MIS-C at Dayton Children's.

The CDC MIS-C case definition includes:

- An individual aged <21 years presenting with fever (> 24 hours)
- Laboratory evidence of inflammation (CRP, ESR, fibrinogen; procalcitonin, d-dimer, ferritin, LDH, or IL-6, neutrophilia, lymphopenia, low albumin)
- Evidence of clinically severe illness requiring hospitalization
- Multisystem (>2) organ involvement (cardiac, renal, respiratory, hematologic, gastrointestinal, dermatologic or neurological), AND
- No alternative plausible diagnoses, AND
- Positive for current or recent SARS-CoV-2 infection by RT-PCR, serology, or antigen test, or COVID-19 exposure within the 4 weeks prior to the onset of symptoms

Treatment of MIS-C utilizes a multidisciplinary approach of many pediatric specialists, including but not limited to cardiology, infectious disease, immunology, hematology, rheumatology, pediatric hospital medicine, and critical care. Patients with MIS-C have been treated with intravenous immunoglobulin (IVIG), steroid therapy (methylprednisolone) and biologics (such as anakinra). Many patients have received concurrent antibiotic therapy given the need for early intervention and the necessity to initiate treatment for multiple possible etiologies. Assessment of clotting risk and need for treatment/prophylaxis is warranted. Distinguishing patients with MIS-C from those with acute COVID-19 and other hyperinflammatory conditions is critical for early diagnosis and appropriate management.

steps we are taking to stop the spread at Dayton Children's

Our number one priority at Dayton Children's will always be the health and wellbeing our staff and the patients and families we care for every day. We continue to make changes to our policies and procedures as COVID-19 is a very fluid situation. Some of the changes include:

- Mandated masks for anyone over the age of two in indoor public spaces where social distancing is not possible. This was mandated by Governor Mike DeWine in July and we continue to align our policies around the state's recommendation.
- Screening for staff and families has become a permanent part of entering Dayton Children's as we continue to navigate through the pandemic.
- Starting August 14 all patient facing staff are required to wear eye protection including goggles or a face shield in addition to their mask.
- We are allowing two adult caregivers for patients but encourage one when possible. No other caregivers are permitted, including siblings. These restrictions apply for both clinic appointments and inpatient stays.

  - If a parent is COVID-19 positive and isn't able to attend their child's appointment, we do allow a non-parent or guardian (i.e. babysitter, aunt, grandma, etc.) to attend if the parent signs our consent form. This form can be found at childrensdayton.org by searching "patient forms" and selecting "Consent to treat without parent."

references

1. Children's Hospital Association and the American Academy of Pediatrics. Children and COVID-19: State data report. Version: July 30, 2020. https://downloads.aap.org/AAP/PDF/AAP%20and%20CHA%20-%20Children%20and%20COVID-19%20State%20Data%20Report%207.30.20%20FINAL.pdf

2. Kim L, Whitaker M, O'Halloran A, et al. Hospitalization Rates and Characteristics of Children Aged <18 Years Hospitalized with Laboratory-Confirmed COVID-19 — COVID-NET, 14 States, March 1–July 25, 2020. MMWR Morb Mortal Wkly Rep. ePub: 7 August 2020. DOI: http://dx.doi.org/10.15585/mmwr.mm6932e3external icon.

3. CDC. Coronavirus Disease 2019 in Children — United States, February 12–April 2, 2020. MMWR Morb Mortal Wkly Rep 2020;69:422–426. DOI: http://dx.doi.org/10.15585/mmwr.mm6914e4

4. Feldstein LR, Rose EB, Horwitz SM, et al. Multisystem Inflammatory Syndrome in U.S. Children and Adolescents. N Engl J Med 2020;383:334-46. https://www.nejm.org/doi/full/10.1056/NEJMoa2021680

5. Godfred-Cato S, Bryant B, Leung J, et al. COVID-19–Associated Multisystem Inflammatory Syndrome in Children — United States, March–July 2020. MMWR Morb Mortal Wkly Rep. ePub: 7 August 2020. DOI: http://dx.doi.org/10.15585/mmwr.mm6932e2external icon

stay up to date on the latest coronavirus information

Many institutions and organizations continue to monitor the SARS-CoV-2 pandemic. Be sure to check the resources below for the latest information. Stay in touch with your local and state health departments.

Please feel free to contact the division of infectious disease at Dayton Children's at 937-641-3329 if you have any questions or need additional information.

related Links

• CDC's COVID-19 gateway page: **CDC.gov/coronavirus**

• NIH's Coronavirus (COVID-19) gateway page links to news releases on vaccine trials: **nih.gov/health-information/coronavirus**

• WHO's Coronavirus Disease (COVID-19) Outbreak gateway page links to WHO's Situation Reports web page: **who.int/emergencies/diseases/novel-coronavirus-2019**

• Johns Hopkins University's Coronavirus Resource Center gateway page provides data on COVID-19 that is updated every morning.

• The Ohio Department of Health's coronavirus site COVID-19 (Novel Coronavirus) - Ohio provides statewide data and recommendations. **coronavirus.ohio.gov/wps/portal/gov/covid-19/home**

• The Point-of-Care Solutions COVID-19 webpage for the AAP's Red Book Online provides information and links. **https://redbook.solutions.aap.org/selfserve/ssPage.aspx?SelfServeContentId=rbo_outbreaks_page_3**

• The AAP's Critical Updates site provides daily guidance, practice management information, and advocacy resources to help address COVID-19 and pediatrics. **https://services.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/**

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 — http://cmequiz.childrensdayton.org/SummerPedForum2020. 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, 2020 for the credit to be awarded

pediatric forum | volume 34, issue 2

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

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

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pediatric forum

october 2020

One Children's Plaza
Dayton, Ohio
45404-1815
937-641-3000
childrensdayton.org

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:

Sue Strader, coordinator
department of continuing medical education
Dayton Children's
One Children's Plaza
Dayton, OH 45404-1815
Fax 937-641-5931
Email straders@childrensdayton.org

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sponsorship/accreditation information

author information

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Rachel Cinlemis, DO
cinlemisr@childrensdayton.org

Daniel Evans, MD
evansd@childrensdayton.org

Rasika Venkatraman, MD
venkatramanr@childrensdayton.org

Drs. Cinlemis, Evans and Venkatraman have nothing to disclose with regard to commercial support.

Drs. Cinlemis, Evans and Venkatraman do not plan on discussing unlabeled/investigational uses of a commercial product.

Oliver S. Soldes, MD, FACS, FAAP
soldeso@childrensdayton.org

Dr. Soldes has nothing to disclose with regard to commercial support.

Dr. Soldes does not plan on discussing unlabeled/investigational uses of a commercial product.

Amanda Smith, MD, Capt, USAF
smitha14@childrensdayton.org

Dr. Smith has nothing to disclose with regard to c ommercial support.

Dr. Smith does not plan on discussing unlabeled/investigational uses of a commercial product.

Claire Beimesch, MD
beimeschc@childrensdayton.org

Ann Smith, PT, DPT, OCS, PCS
smitha1@childrensdayton.org

puthoffe@childrensdayton.org
venkatramanr@childrensdayton.org

Tessa Hill, BS
hillt3@childrensdayton.org

Dr. Beimesch, Ms. Smith, Ms. Puthoff and Ms. Hill has nothing to disclose with regard to commercial support.

Dr. Beimesch, Ms. Smith, Ms. Puthoff and Ms. Hill does not plan on discussing unlabeled/investigational uses of a commercial product.

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

Dayton Children's Hospital
One Children's Plaza
Dayton, Ohio 45404-1815