

PedsCases Podcast Scripts

This is a text version of a podcast from PedsCases.com on “**Approach to Acute Diarrhea.**” These podcasts are designed to give medical students an overview of key topics in pediatrics. The audio versions are accessible on iTunes or at www.pedcases.com/podcasts.

Approach to Acute Diarrhea

Developed by Katie Girgulis, Dr. Chris Novak, and Dr. Karen Forbes for
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Intro

Hi everyone, my name is Katie Girgulis. This two-part podcast series is designed to give medical students an organized approach to the diagnosis and management of diarrhea in children. This podcast was developed by Dr. Chris Novak (pediatric resident at the University of Alberta), Katie Girgulis (medical student at the University of Alberta), and Dr. Karen Forbes (pediatrician and medical educator at the Stollery Children’s Hospital).

In this first podcast, will give a general overview of the pathophysiology of diarrhea and then discuss an approach to acute diarrhea. The second podcast will review chronic diarrhea.

After listening to this podcast, the learner will be able to:

- 1) Categorize diarrhea based on pathophysiology, using the four main pathologic categories of osmotic diarrhea, secretory diarrhea, dysmotility, and inflammatory diarrhea.
- 2) Identify key features to elicit when taking the history in a child presenting with acute diarrhea
- 3) Identify key features to elicit when conducting a physical exam for a child presenting with acute diarrhea, paying particular attention to hydration status.
- 4) List appropriate investigations to help determine a cause of acute diarrhea.
- 5) Describe the initial management for a child with acute diarrhea.

Before we jump into all of this learning about diarrhea, let’s explore a clinical scenario to provide some context to the subsequent discussion. As we work through the objectives, we will continue to learn about Oliver, a little boy with diarrhea, and practice our approach.

Clinical Case

Oliver is a previously healthy 4-year-old boy who presents to the pediatric emergency department with a three-day history of diarrhea. His parents are quite concerned

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because he not eaten or drank much in the past 48 hours, and today he seems very tired and uninterested in playing with his siblings.

Definitions and Epidemiology

Now, before we delve into history-taking, let's take a step back to review the bigger picture about diarrhea and how an understanding of the pathophysiology will help you organize your thoughts and your differential diagnosis.

Diarrhea is a common, messy problem in children. It can represent a simple self-limited infection, or it can be a sign of serious underlying systemic disease. The WHO defines diarrhea as the passage of three or more loose or watery stools per day. There is a large range of normal bowel habits, so perhaps a more useful definition would be to describe diarrhea as an increase in frequency and decrease in consistency of stools from baseline that causes a problem.

Worldwide, diarrheal illness is the second leading cause of mortality in children less than five years, leading to 1.5-2 million deaths per year. Advances in sanitation and oral rehydration have significantly reduced mortality from diarrhea, with the WHO oral rehydration solution being hailed as one of the greatest public health achievements of the past century.

Pathophysiology

To understand what diarrhea is, we need to start by looking at the physiology of the gastrointestinal tract. Each day the intestines are faced with a large volume of fluid passing through it. In a healthy adult, approximately 8L of water enter the small intestine each day from both oral fluid intake, and gastrointestinal secretions. We have less data in children about precise numbers, but assume it is proportionately less. Water is absorbed into the circulation throughout the intestines following the passage of solutes. Ion transporters work to create a concentration gradient, and water will diffuse from an area of low concentration to high concentration. When working normally, the small intestine will absorb approximately 90% of this fluid, and the large intestine will absorb about 9%. This is an overall efficiency of 99%! So, in the healthy adult with 8L of fluid per day, only ~100 mL of fluid remains by the time feces reaches the end of the GI tract. Moreover, in the healthy patient, there is a careful balance of oral intake, GI secretions, and reabsorption. When this balance is lost, diarrhea results. A reduction in water absorption by as little as 1% can cause diarrhea.

The causes of diarrhea can be broken into 4 main categories based on pathological process: Osmotic, Secretory, Dysmotility and Inflammation. In simple terms these processes work in the following way:

- 1) Osmotic diarrhea pulls water into the lumen with non-absorbed solutes.
- 2) Secretory diarrhea adds more water to the lumen than the gut can absorb.

- 3) Dysmotility usually means that fluids pass through the gut faster than they can be absorbed; and
- 4) Inflammation leads to impaired absorption and increased exudate leading to water loss.

We will review the pathophysiology of each of these four processes in more detail in part 2 of this podcast when we discuss chronic diarrhea.

History

Now that we have a basic understanding of the basic pathophysiology behind diarrhea, let's bring our discussion back to the clinic and how this knowledge can be applied in a practical way. Certain characteristics about the diarrhea can help point you in the direction of a specific pathophysiologic process, which helps shape a differential diagnosis of what could be causing it.

Furthermore, when considering the differential diagnosis for diarrhea in a pediatric population, it is helpful to first determine a few key features to help guide you:

- 1) Is the diarrhea acute or chronic?
- 2) Is the child seriously ill?
- 3) Is the diarrhea bloody?

Is the diarrhea acute or chronic? In pediatrics, acute diarrhea is defined as lasting less than 2 weeks, whereas chronic diarrhea lasts more than 2 weeks. The differential for acute and chronic diarrhea are quite different and we will explore them separately. For this podcast, we will focus on causes of acute diarrhea in regions with access to clean water and sanitation; however, keep in mind that the differential in regions without this type of access would be quite different. It is also important to remember that any case of acute diarrhea could be the first presentation or an acute flare of a chronic diarrheal illness.

Once you've established that you have a case of acute diarrhea, the next question is "**Is the child seriously ill?**" Does the child look unwell and lethargic? It is important to ask about fluid intake, urine output, and volume of emesis and diarrhea during the history, as well as to assess the patient's hydration status on physical exam. In extreme cases, diarrheal illness can lead to dehydration, hypovolemic shock, or sepsis – which must be managed in a timely manner.

If the child is not seriously ill, the next question is, "**Is the diarrhea bloody or non-bloody?**" Small amounts of blood can be seen in about 10% of children with diarrhea, typically in small drops on the surface of the stool. This is likely due to mucosal irritation and is not overly concerning. However, profusely bloody diarrhea should prompt you to add conditions such as bacterial enteritis to the differential.

Back to the case

Let's go back to Oliver's case and try to figure out what is going on. You start by asking some questions to get more clarification around these three key features.

- The diarrhea started rather abruptly 3 days ago, so it can be classified as acute
- Based on quick observations, Oliver appears sluggish and inactive. His parents tell you he has been drinking a few sips of water here and there, perhaps totaling 100-200mL between today and yesterday. He definitely hasn't peed today, and they think he maybe went once yesterday morning. It seems like "a lot" of diarrhea, and he has 5-6 episodes in a 24hr period.
- They have not noticed any blood in the stool.

So far, we have learned that Oliver is presenting with acute onset non-bloody diarrhea, and he seems fairly unwell. That was a helpful start, but we will need more from the history! Let's discuss some important details that will help with your differential diagnosis and clinical decision making.

History continued

History of presenting illness – As with all histories, begin with open-ended questions about the parents' and child's concern, including what prompted them to come in *today*. Try to get a good idea of the onset and duration of the diarrhea to classify it as acute or chronic. Ask further questions about the onset - explore sick contacts (anyone at home, school, or daycare with similar symptoms?), recent travel, exposure to unclean drinking water, undercooked foods or unpasteurized dairy products, and recent hospitalization and antibiotics. Next, inquire about the quality of the stools, perhaps using a visual stool chart. Are the stool soft or completely liquid? Is there any blood? Is it a small or large volume of stool? Quantify the number of diarrheal episodes per day. Along with this, ensure to ask about food and fluid intake and urine output or number of wet diapers, as this will provide you with some information about the child's hydration status. Ask if there are any associated symptoms, such as nausea, vomiting, abdominal pain, or fever. It can also be helpful to ask if there a pattern to the diarrhea and if there is anything that makes the diarrhea better or worse. Inquire if anything like this has ever occurred before. Remember to do a head-to-toe review of systems to ensure nothing is missed, including fevers, lethargy, weight loss, abdominal pain, muscle or joint pains, rashes and skin changes, and any changes in sleep pattern, appetite, or activity, as these features may suggest a more sinister or multisystem etiology for the diarrhea.

Past Medical History – This includes growth and development. A history of failure to thrive or weight may loss points towards a more severe chronic illness. Consider if the patient might be immunocompromised.

Immunizations – In particular, in young children, inquire if he or she has received the vaccine for Rotavirus.

Medications – Ask about any new medications or changes to medications. In particular, note if the patient is taking immune-modulating medications, as this could make them more susceptible to GI infections. Also inquire about recent antibiotic use, as this is a risk factor for antibiotic associated diarrhea or C difficile.

Differential Diagnosis

After a thorough history, you should be thinking of a differential diagnosis. Let's start by discussing the differential diagnosis of acute diarrhea for each of the pathophysiologic categories. Then we will return to Oliver and consider a possible differential.

Watery Diarrhea

By far, the most common cause of acute non-bloody diarrhea is viral gastroenteritis, often referred to as "viral gastro". Studies in the pediatric emergency department have found that greater than 50% of children presenting to the emergency with acute diarrhea had a viral etiology. Children with viral gastro present with an increase in frequency of loose, watery stools, with or without vomiting. Other symptoms can include fever, anorexia, abdominal pain, and dehydration. Rotavirus has traditionally been the most common cause of gastroenteritis, but the introduction of childhood immunization for rotavirus is changing infection patterns. Other common viral pathogens include norovirus, sapovirus, astrovirus and enteric adenovirus. Viral gastroenteritis is very contagious, so the patient or parents will often be able to identify sick contacts. Illness generally begins 12 hours to 5 days after exposure and lasts for 3-7 days. Of note, it is important to remember to use soap and water to clean your hands and prevent the spread of infection, as hand sanitizer is insufficient for infectious agents such as norovirus.

Most parasitic infections endemic to resource-rich country present with watery diarrhea, although patients with these infections tend to have less severe and more prolonged symptoms. These include giardia and cryptosporidium, as well as other less common parasites that tend to infect immunocompromised patients.

Extra-intestinal infections may present with a mild, self-limiting course of diarrhea in children. In a patient who is not seriously ill, this could include pneumonia, viral respiratory tract infections, otitis media, or a UTI. In a patient who is seriously ill, this could include more ominous infections such as sepsis or meningitis.

A non-infectious cause of acute watery diarrhea is antibiotic-associated diarrhea. Diarrhea is a common side effect of antibiotics and can be seen in up to 18% of children less than 2 years. Antibiotic-associated diarrhea is likely related to a disruption in the bacterial flora of the gut. This diarrhea is usually mild and self-limiting, however in hospitalized children, antibiotics can predispose a patient to a more serious infection with *C. difficile*.

Bloody Diarrhea

Acute bloody diarrhea in a non-septic child suggests bacterial enteritis. Bacterial diarrhea may present with or without blood in the stool, however the presence of blood should raise your suspicion to a bacterial cause. Bacterial infections are more common in children older than 2 years. Other features which increase the likelihood of bacterial infection include high fever, tenesmus (or a sensation of incomplete emptying), severe abdominal pain, exposure to contaminated water or meat, and leukocytosis. Common pathogens include *Salmonella*, *Shigella*, certain strains of *E. coli*, *Yersinia*, and

Campylobacter. An important complication to consider in suspected E. coli diarrhea is hemolytic uremic syndrome or HUS. We will discuss HUS in detail later in the podcast. C. difficile can also cause bloody diarrhea, but it is the toxin that causes the symptoms, and not the organism itself. Other causes of bloody diarrhea largely present as chronic diarrhea, and therefore will be discussed in Part Two of this podcast series.

Okay, to this point we've covered watery and bloody diarrhea in a patient who is not seriously ill. To review, common causes of watery diarrhea include viral gastroenteritis, parasitic infections, other extra-intestinal infections, and antibiotics. Bloody diarrhea in a child who is not seriously ill generally suggest a bacterial enteritis. Next, let's move on to the seriously ill child with acute diarrhea.

Most of the illnesses above will lead to a mild to moderate illness with some degree of dehydration. However, if the child appears sick, septic, or presents with acute peritonitic abdominal pain in association with their diarrhea, you should expand your differential to consider emergent diagnoses. These include sepsis, appendicitis, hemolytic uremic syndrome, intussusception, volvulus, toxic megacolon, anaphylaxis or rarely, organophosphate poisoning. These are medical or surgical emergencies and require acute management. Specific management of each of these emergent conditions is beyond the scope of this podcast, however, we would like to further explore hemolytic uremic syndrome (or HUS).

HUS is an important complication of bacterial enteritis, typically caused by E coli. It is defined by a triad of microangiopathic hemolytic anemia, thrombocytopenia and acute kidney injury. The majority of cases of HUS present with bloody diarrhea due to Shiga toxin-producing E. coli (STEC; also known as enterohemorrhagic E. coli), most commonly the serotype O157:H7. Less commonly, it can also be caused by Shigella and other bacterial pathogens. HUS is typically seen in children less than 5 years, and while rates vary with E. coli outbreaks, it affects about 2-3 per 100,000 children <5 each year, or up to 20% of children with STEC infection (depending on the strain). STEC-related HUS occurs when the bacteria attach to the intestinal cell wall and begin releasing Shiga toxin into circulation. Shiga toxin attacks endothelial cells in blood vessels, leading to a bloody diarrhea prodrome. In some patients, Shiga toxin triggers platelet activation and the formation of small intravascular thrombi. The formation of these thrombi consumes platelets leading to thrombocytopenia. These thrombi begin to obstruct small vessels, such as those in the kidney, leading to acute kidney injury. Red blood cells passing through these obstructed blood vessels are sheared by the small thrombi, leading to a microangiopathic hemolysis. Thus, the toxin produces bloody diarrhea, thrombocytopenia, acute kidney injury and a hemolytic anemia. There are also a number of less common causes of HUS, including complement gene mutations, other infections, drug toxicity, and autoimmune disorders that may present without diarrhea; these are beyond the scope of this podcast. HUS is a medical emergency with high rates of mortality. Thus, it is important to consider and recognize HUS in children presenting with bloody diarrhea.

Diarrhea in an immunocompromised patient has a far broader diagnosis and can lead to significant complications. This includes children who have active HIV infection, immune deficiencies, hyposplenism, and those on immune-modulating medications or long-term steroids for autoimmune or inflammatory diseases.

Now that we have talked about the pathophysiology of diarrhea and some important conditions on the differential, let's return to the clinic to learn more about Oliver.

Back to the case

As we learned before, Oliver has been having 5-6 episodes of non-bloody diarrhea each day for three days. His parents believe he's had a fever, but they don't have a thermometer at home and he just felt warm. He "just wasn't himself" this morning, so they decided it was time to come to the emergency department. No one at home has similar symptoms, although they've noticed that a few kids at preschool have been absent. He has never travelled out of the country and has never been hospitalized. He once needed antibiotics when he was 2 years old for an ear infection. There haven't been any dietary changes or food exposures that they can recall. Oliver has vomited two to three times each day since things began. He complained of abdominal pain on and off for three days. Nothing like this has ever occurred before. He was born at term from an uncomplicated pregnancy and delivery. There have not been any concerns about growth and development. He does not have any medical conditions. He does not have any allergies and does not make any medications other than Vitamin D. All of his immunizations are up to date.

Based on this history, the differential diagnosis for Oliver includes infectious gastroenteritis and first presentation of a chronic diarrheal condition (these will be reviewed in part 2 of the podcast). We will also keep HUS in the back of our mind given the possible fever and oliguria along with diarrhea. Next up is the physical exam.

Physical Exam

First, consider your question, "**Is the child seriously ill?**" Does the child look unwell and lethargic? Before diving in to a thorough exam, start with a quick general inspection to ensure that the child is non-toxic and does not require any urgent management. Check the vital signs - a child may be febrile with a bacterial infection, or tachycardic and hypotensive if severely dehydrated.

Measure height and weight and plot along the appropriate growth curve. Make sure to assess for dehydration. This includes checking heart rate and blood pressure, capillary refill and peripheral perfusion, sunken fontanelle (in infants), tear production, mucous membranes, skin turgor, urine output, and level of consciousness. Urine output is often one of the first things to change when a child is mildly dehydrated. A normal urine output is $>1\text{ mL/kg/hr}$, or approximately >5 wet diapers per day. It is helpful to determine the degree of dehydration as mild, moderate, or severe, as this has implications for management. Please refer to the PedsCase on dehydration for more details. It is also important to do an abdominal exam for any distention, pain, or masses, and to inspect the peri-anal region. Note any rashes and look for petechial or bruising, which may be

seen in HUS. Lastly, look for other extra-abdominal findings on exam (including signs suggestive of extra-intestinal infections like acute otitis media or pneumonia).

After you finish the physical exam, remember to wash your hands with soap and water. Several causes of infectious diarrhea aren't effectively cleaned with alcohol sanitizer, so it's important to use soap and water to prevent spreading infection to other children, or catching it yourself!

Back to Oliver

On exam, Oliver looks unwell. He is resting on his mom's lap and will not engage with you despite your favourite tricks that work with most 4-year-olds. His temperature is 37.9 degrees Celsius and he is tachycardic with a heart rate of 135. His level of consciousness, blood pressure and circulation are appropriate. Given his tachycardia, dry mucous membranes, and reduced urine output, you assess him as moderately dehydrated. His abdomen is diffusely tender but without signs of peritonitis. There are no masses nor organomegaly. His peri-anal region is unremarkable. You do not note any rashes or skin changes.

Investigations

The next step is investigations. If a child presenting with acute non-bloody diarrhea is well-appearing, well-hydrated, and has no risk factors for a bacterial infection, they can often be managed without any laboratory investigations.

Investigations are likely warranted if: the child is ill-appearing, moderate to severe dehydration, febrile, has bloody diarrhea, or has risk factors for a bacterial or parasitic infection (i.e. travel to developing countries, backcountry camping, food exposures).

For children with concerns for more than mild dehydration, electrolytes, creatinine, and urea should be ordered to look for acute kidney injury due to pre-renal insult. A venous blood gas should also be considered to assess acid-base status. If there is clinical suspicion for bacterial enteritis, you may also consider ordering a CBC (to look for anemia or leukocytosis), peripheral smear (look for hemolysis), hemolytic workup (LDH, haptoglobin, bilirubin, reticulocyte count). In general, stool viral cultures for acute diarrhea presumed to be caused by viral gastroenteritis are not warranted as they do not change management. However, in the case of bloody diarrhea, a stool culture + sensitivity should be ordered to look for bacterial pathogens. Stool C difficile toxin could also be considered in keeping with a clinical history of antibiotic exposure. Of note, testing for C difficile is not recommended in children less than one year of age. Infants are frequently colonized with C difficile, but numerous studies have shown that, due to differences in their gastrointestinal systems, C difficile does not cause clinical disease in young children.

As always, the investigations ordered should be targeted to what is suspected from the history and exam. Imaging is only warranted if there are signs of an acute abdomen or bowel obstruction.

Back to Oliver

Oliver is sick enough to warrant further investigations. Since you assessed him to be moderately dehydrated, you decide to order electrolytes, creatinine, and urea. A CBC is also warranted, as HUS is on the back of your mind. Please note, testing the stool for viruses is not a useful investigation to order as it does not change management. The investigations come back showing an acute kidney injury with an elevated creatinine and urea. You are relieved to see that the Hb and platelets are within normal range, helping you rule out HUS. You reason the most likely diagnosis is viral gastroenteritis and pre-renal AKI.

Management

The cornerstone of management of acute diarrhea with concomitant dehydration is rehydration. Dehydration is much more likely to occur if the diarrhea is accompanied by vomiting; often, with just diarrhea alone, a child's thirst will allow them to maintain hydration as long as they have access to fluids. For mild to moderate dehydration, oral rehydration is generally adequate. This can be achieved through frequent small sips oral rehydration solution like Pedialyte. However, a recent study showed that giving diluted juice may be equally effective and much better tolerated, and is much tastier for little kids. For severe dehydration, a bolus of IV fluids may be required to restore intravascular volume. For more information on this, please see our PedsCases podcast on dehydration in children. Apart from managing hydration, most cases of acute diarrhea are self-limited and do not require further medical management.

It is also important to know what not to do. It can be tempting to order antibiotics for cases suggestive of a bacterial diarrhea; however, this is not recommended. Studies have shown that giving antibiotics to children with bloody diarrhea can actually increase the risk of progression to HUS by stimulating toxin release from dying bacteria. Anti-diarrheal agents like loperamide can decrease gut motility and reduce the number of stools/day, however this is also not recommended in most cases of acute diarrhea. These drugs have the potential for severe side effects, including paralytic ileus and toxic megacolon, and can prolong the course of infection in bacterial diarrhea by slowing transit time.

Back to Oliver

Oliver is given a 20mL/kg bolus of IV isotonic fluids, and you calculate an appropriate infusion rate to replace his fluid deficit and provide him with maintenance hydration. You also order accurate measurement of ins & outs so that you can quantify his urine and stool outputs and monitor his fluid balance. You asked his parents to encourage oral fluid intake. He starts having more urine output. Labs are re-checked the next day, and his renal function has normalized. As his diarrhea becomes less frequent and he begins to tolerate oral fluids, you slow down the rate of his IV fluids. He is soon eating and drinking well and urine output normalizes. His IV is discontinued and he is discharged home!

That wraps things up! We've now covered everything from initial presentation to management plan. Let's finish with a few key take home points:

- 1) Diarrhea is a common presenting issue in pediatrics with a large differential
- 2) Start by classifying the diarrhea as acute vs. chronic and watery vs. bloody
- 3) Further organize your approach and differential by classifying kids as ill-appearing or well-appearing
- 4) Viral gastroenteritis is the most common cause of acute diarrhea in children and classically presents with watery diarrhea, nausea and emesis. There are usually sick contacts. If the child is well-appearing, investigations are often unnecessary, and the child can be managed accordingly
- 5) Bacterial enteritis is a common cause of acute bloody diarrhea. In bloody diarrhea, remember to consider HUS.
- 6) Remember to think about atypical causes of acute diarrhea, including antibiotic-associated diarrhea, parasitic infection, and initial presentation of a chronic diarrheal disease.

Going back to the objectives of this podcast, you should now be able to:

- 1) Categorize diarrhea based on pathophysiology, using the four main pathologic categories of osmotic diarrhea, secretory diarrhea, dysmotility, and inflammatory diarrhea.
- 2) Identify key features to elicit when taking the history in a child presenting with acute diarrhea
- 3) Identify key features to elicit when conducted a physical exam for a child presenting with acute diarrhea, paying particular attention to hydration status.
- 4) List appropriate investigations to help determine a cause of acute diarrhea.
- 5) Describe the initial management for a child with acute diarrhea.

That concludes our presentation. Thanks for listening to PedsCases podcasts! Remember to tune in for Part 2: Approach to Chronic Diarrhea.

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