Seven mo. old infant presented with frequent attacks of vomiting & diarrhea for 3 days duration ,he is on bottle feeding .The condition is associated with fever & decreased appetite .O/E he looks pale, temp. 38.5°C with some dehydration, & there is abdominal distension

Objectives per clinical Presentation

1-Recognize the Presentation

2-Analyse the Presentation

3-Establish a Diagnosis(DDX) Scenario

4-Treat the Patient

1-Why did the baby get vomiting & Diarrhea ?- Risk Factors

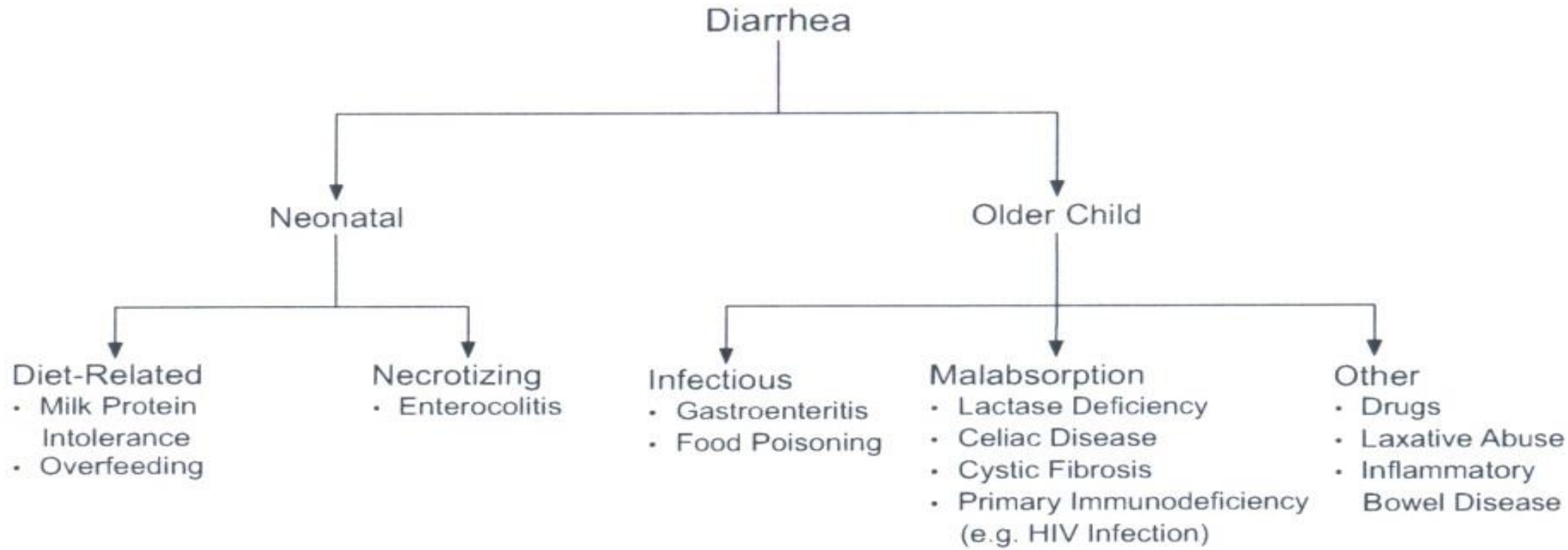
2-What are the suspected etiologic agents ?

3- What are Types of Diarrhea?

-Acute

-Chronic

PEDIATRIC DIARRHEA



What is the pathogenesis of infectious Diarrhea?

Mechanisms of Diarrhea

Primary mechanism	*defect*	*Stool exam*	*example*	*comment*
Secretory	↓ absorption, ↑secretion: electrolyte transport	Watery, normal osmolality; osmols = 2 × (Na^+ + K^+)	Cholera, toxigenic E. coli; carcinoid, VIP, neuroblastoma, congenital Cl diarrhea, Cl. difficile, cryptosporidiosis (AIDS)	Persists during fasting; bile salt malabsorption , may ↑ intestinal water secretion; no stool leukocytes
Osmotic	Maldigestion, transport defects, ingestion of unabsorbable solute	Watery, acidic, + reducing substances; ↑osmolality; osmosis > 2 × (Na^+ + K^+)	Lactase deficiency, glucose-galactose malabsorption, lactulose, laxative abuse	Stops with fasting, ↑breath H_2 with CHO malabsorption, no stool leukocytes
Motility				
↑motility	↓ transit time	Loose to normal- appearing stool, stimulated by gastrocolic reflex	IBS, thyrotoxicosis, postvagotomy dumping syndrome	Infection also may contribute to ↑ motility
↓motility	Defect in NM unit(s) Stasis (bacterial overgrowth)	Loose to normal- appearing stool	Pseudo-obstruction, blind loop	Possible bacterial overgrowth
Mucosal inflammation	Inflammation, ↓mucosal surface area &/or colonic reabsorption, ↑motility	Blood & ↑WBCs in stool	CD, Salmonella, Shigella, amebiasis, Yersinia, Campylobacter, rotavirus enteritis	Dysentery = blood, mucus, & WBCs

From Wyllie R: Major symptoms and signs of digestive tract disorders. In Behrman RE, Kliegman RM, Jenson HB (eds): Nelson Textbook of Pediatrics, 17th ed. Philadelphia, WB Saunders, 2004, p 1200

DDX of Osmotic Vs Secretory Diarrhea

Type of Diarrhea	OSMOTIC DIARRHEA	SECRETORY DIARRHEA
Volume of stool	< 200 mL/24 hr	> 200 mL/24 hr
Response to fasting	Diarrhea stops	Diarrhea continues
Stool Na^+	< 70 mEq/L	> 70 mEq/L
Reducing substances	Positive	Negative
Stool pH	< 5	> 6

Causes of Secretory Diarrhea

1-ACTIVATION OF c-AMP

Bacterial toxins: enterotoxins of *cholera, Escherichia coli* **(heat-labile),** *Shigella, Salmonella, Campylobacter jejuni, Pseudomonas aeruginosa*

Hormones: VIP ,gastrin, secretin

Anion surfactants: bile acids, ricinoleic acid

2-ACTIVATION OF c-GMP

Bacterial toxins: ***E. coli*** **(heat-stable) enterotoxin,** *Yersinia enterocolitica* **toxin**

3-CALCIUM-DEPENDENT

Bacterial toxins: ***Clostridium difficile*** **enterotoxin**

Neurotransmitters: acetylcholine, serotonin

Paracrine agents: bradykinin

Enteropathogens elicit

1- *Non-inflammatory diarrhea* through

*Enterotoxin production by some bacteria

*Destruction of villus (surface) cells by viruses,

*Adherence by parasites,

*And adherence &/or translocation by bacteria.

2-Inflammatory diarrhea is usually caused by bacteria that

*Directly invade the intestine

*Or produce cytotoxins with consequent fluid, protein, & cells *(RBCs, WBC*) that enter the intestinal lumen .

How Would You Assess the Degree of Dehydration ?

1-Key Signs of DEHYDRATION

A-Sensorium

B-Response to offered fluid

C-Skin turgor

2- Minor Signs(like ……..

Degrees of dehydration

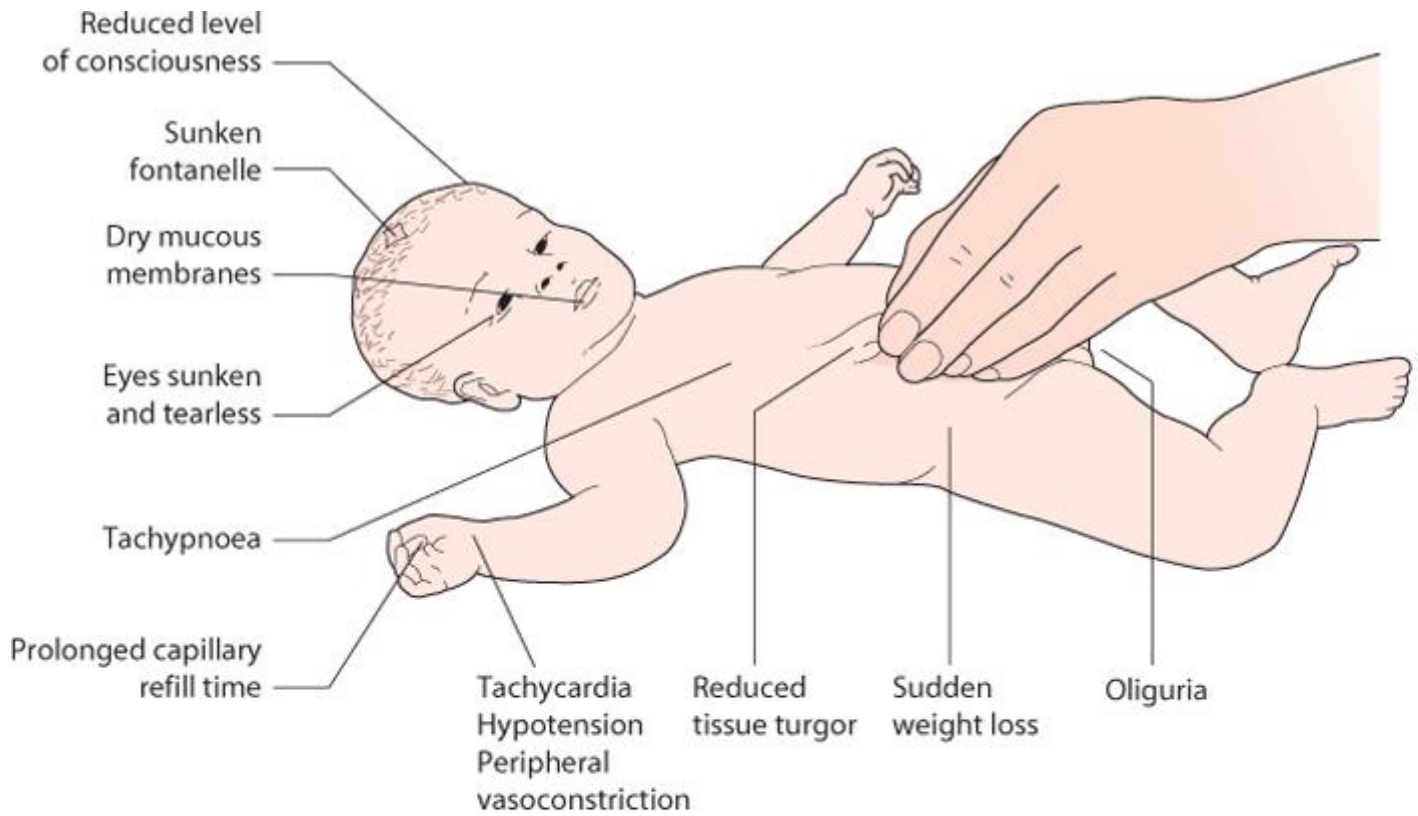
1-No or minimal Dehydration (<3%),

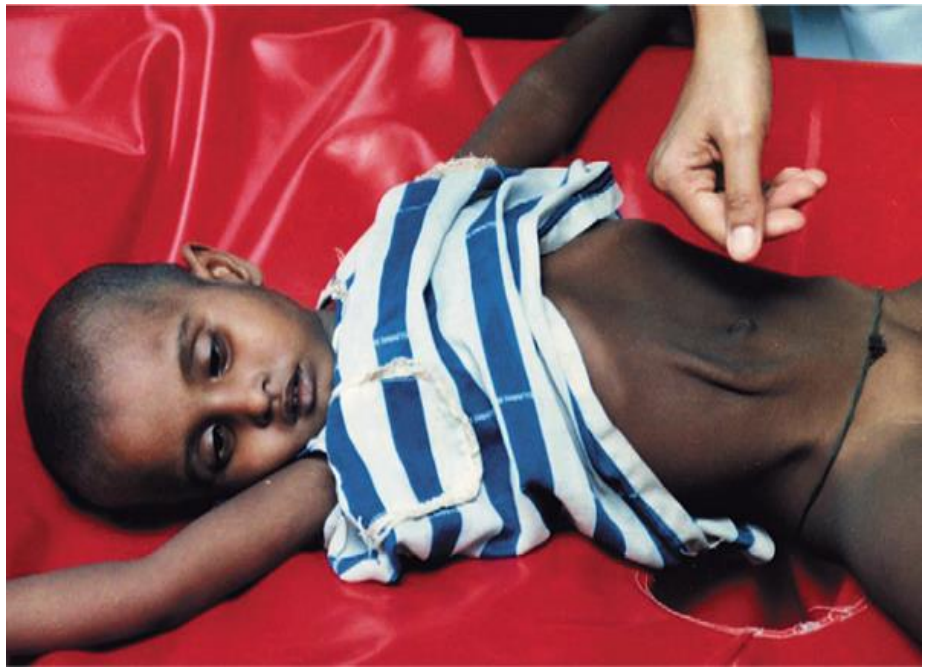
2-Mild-moderate(3-9%)

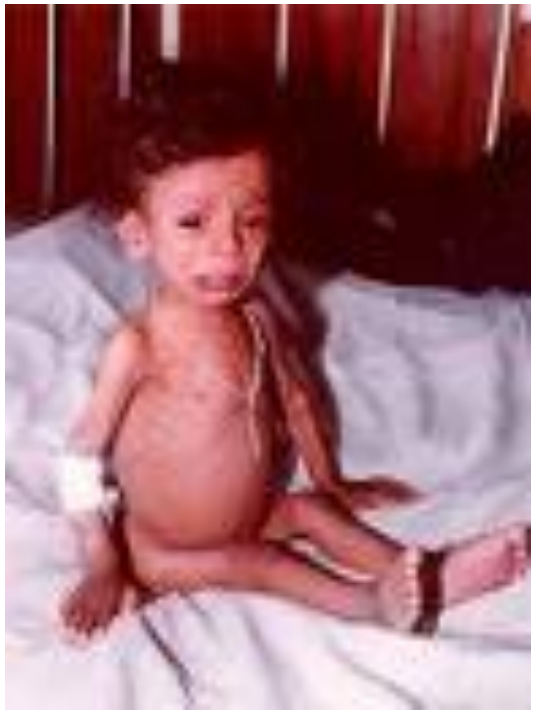
3- Severe Dehydration(>9%)

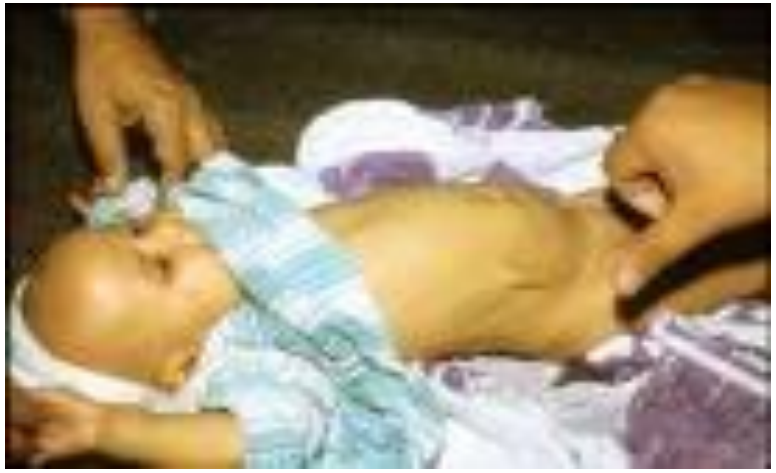
Symptoms Associated with Dehydration

SYMPTOM	MINIMAL OR NO DEHYDRATION (<3%)	MILD TO MODERATE DEHYDRATION (3–9%)	SEVERE DEHYDRATION (>9%)
Mental status	Well ; alert	Normal, fatigued or restless, irritable	Apathetic, lethargic, unconscious
Thirst	Drinks normally; might refuse liquids	Thirsty ; eager to drink	Drinks poorly; unable to drink
Heart rate	Normal	Normal to increased	Tachycardia, with bradycardia in most severe cases
Quality of pulses	Normal	Normal to decreased	Weak, thready , or impalpable
Breathing	Normal	Normal ; fast	Deep
Eyes	Normal	Slightly sunken	Deeply sunken
Tears	Present	Decreased	Absent
Mouth and tongue	Moist	Dry	Parched
Skinfold	Instant recoil	Recoil in <2 sec	Recoil in >2 sec
Capillary refill	Normal	Prolonged	Prolonged; minimal
Extremities	Warm	Cool	Cold; mottled; cyanotic
Urine output	Normal to decreased	Decreased	Minimal









Infants are at Particular Risk of Dehydration because of their:

1-Greater SA / wt, leading to greater insensible water losses (300 ml/m^2/Day, equivalent in infants to 15-17 ml/kg / day)

2-Inability to gain access to fluids when thirsty

3-Higher basal fluid requirements (100-120 ml/kg/day, i.e. 10-12% of body wt)

4-Immature renal tubular reabsorption processes.

Management of the problem

Management of a child presenting with diarrhea is a logical chain of

clinical decisions guided by answers to the following main questions.

(1) Does the pt have acute diarrhea?
(2) What is the presumed etiology of diarrhea (infectious vs. non-infectious)?
(3) Should the pt be treated in an ambulatory setting or in the hospital?
(4) Are stool cultures or any other lab. tests required?
(5) How should the pt be rehydrated: orally or i.v?
(6) How should the pt be managed nutritionally?
(7) Should the pt receive any antimicrobial drugs, & – if yes – which one is the most suitable?
(8) Should the pt be treated with any other drug or preparation (antidiarrheal, anti-motility, antiemetic)?
(9) Are there any complications or specific clinical situations that require modification of the recommended approach?

Conditions that should be considered in the DDX of acute diarrhea in children

(Enteral ,Parenteral)

Vomiting in infants:

- **Common chronic causes are-**

•GER & feeding problems, e.g. force-feeding or overfeeding

•**If transient, with other symptoms, e.g. fever, diarrhea or runny nose & cough, most likely to** *be GE or RTI , but consider urine infection & meningitis*

•**If projectile at 2-7 wks of age, exclude** *pyloric stenosis*

•**If bile stained, exclude** *intestinal obstruction, esp. intussusception, malrotation & a strangulated inguinal hernia*

•**Assess for dehydration &shock.**

Diagnostic clues in a vomiting infant

- **Bile-stained vomit** - intestinal obstruction must be excluded
- **Blood in the vomit** – suggests esophagitis or peptic ulceration or oral/nasal bleeding or malrotation
- **Projectile vomiting in the first few weeks of life** - is it pyloric stenosis?
- **Are there symptoms to suggest** urinary tract, CNS or GI infection?
- **Vomiting at the end of paroxysmal coughing** - is it (pertussis)?
- **Is the infant *dehydrated or in shock?***
- **Abdominal distension - is there lower intestinal obstruction?**
- **Check for a strangulated inguinal hernia**

Causes of vomiting

Infants

Gastro-oesophegeal reflux
Feeding problems
Infection
- Gastroenteritis
- Respiratory tract/otitis media
- Whooping cough (pertussis)
- Urinary tract
- Meningitis

Dietary protein intolerances
Intestinal obstruction
- Plyoric stenosis
- Atresia - duodenal, other sites
- Intussusception
- Malrotation
- Volvulus
- Duplication
- Strangulated inguinal hernia
- Hirschsprung's disease

Inborn errors of metabolism
Congenital adrenal hyperplasia
Renal failure

Preschool children

Gastroenteritis
Infection
- Respiratory tract/otitis media
- Urinary tract
- Meningitis
- Whooping cough (pertussis)

Appendicitis
Intestinal obstruction
- Intussusception
- Malrotation
- Volvulus
- Adhesions
- Foreign body - bezoar

Raised intracranial pressure
Coeliac disease
Renal failure
Inborn errors of metabolism
Torsion of the testis

School-age and adolescents

Gastroenteritis
Infection - including pyelonephritis, septicaemia, meningitis
Peptic ulceration and H. pylori infection
Appendicitis
Migraine
Raised intracranial pressure
Coeliac disease
Renal failure
Diabetic ketoacidosis
Alcohol/drug ingestion or medications
Cyclical vomiting syndrome
Bulimia/anorexia nervosa
Pregnancy
Torsion of the testis

Composition of (WHO) & European Society for Pediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) ORS

	WHO(2005)	ESPGHAN
1. Na (mmol/l)	75	60
2. K (mmol/l)	20	20
3. Cl (mmol/l)	65	60
4. Base (mmol/l)	10 (HCO3)	30 (citrate)
5. Glucose (g/l)	13.5	16
6. Osmolality (mOsm/l)	245	240

Complications

Delays in diagnosis and delays in the institution of appropriate therapy

Inappropriate Tx can lead to prolongation of the diarrheal episodes, with consequent malnutrition &complications like *2ndary infection & micronutrient deficiencies (Fe, zinc). Associated bacteremias* are well-recognized in malnourished children with diarrhea.

Extra-intestinal manifestations &complications

How Would You prevent Diarrheal Diseases?

PROMOTION OF EXCLUSIVE BREAST-FEEDING.

IMPROVED COMPLEMENTARY FEEDING PRACTICES

ROTAVIRUS , Shigella and ETEC IMMUNIZATION

Improved Water And Sanitary Facilities And Promotion Of Personal & Domestic Hygiene.

IMPROVED CASE MANAGEMENT OF DIARRHEA.

Summary of Treatment Based on Degree of Dehydration

DEGREE OF DEHYDRATION	REHYDRATION THERAPY	REPLACEMENT OF LOSSES	NUTRITION
Minimal or no dehydration	Not applicable	<10 kg BW: 60–120 mL (ORS) for each diarrheal stool or vomiting episode; >10 kg BW: 120–240 mL ORS for each diarrheal stool or vomiting episode	Continue breast-feeding, or resume age-appropriate normal diet after initial hydration, including adequate caloric intake for maintenance[*]
Mild - moderate	ORS, 50–100mL/kg over 3–4 hr	Same	Same
Severe dehydration	Lactated Ringer solution or N/S in 20 mL/kg i.v amounts until perfusion & mental status improve; then administer 100 mL/kg ,ORS over 4 hr or 5% dextrose ½ N/S i.v at twice maintenance fluid rates	Same ; if unable to drink, administer through NGT or administer 5% dextrose ¼ normal saline with 20 mEq/L KCl i.v	Same

Intravenous fluid Therapy

Body Weight Method for Calculating Daily Maintenance Fluid Volume

BODY WEIGHT	FLUID PER DAY
0–10 kg	100 mL/kg
11–20 kg	1,000 mL + 50 mL/kg for each kg > 10 kg
>20 kg	1,500 mL + 20 mL/kg for each kg > 20 kg

The maximum total fluid per day is normally 2,400 mL

Composition of Intravenous Solutions

FLUID	$[Na^+]$	$[Cl^-]$	$[K^+]$	$[Ca^{2+}]$	$[Lactate^-]$
Normal saline (0.9% NaCl)	154	154			
½ normal saline (0.45% NaCl)	77	77			
0.2 normal saline (0.2% NaCl)	34	34			
Ringer lactate	130	109	4	3	28

A normal plasma osmolality is 285–295 mOsm/kg.

Infusing an i.v. solution peripherally with a much lower osmolality can cause water to move into RBCs, causing hemolysis. Thus, i.v fluids are generally designed to have an osmolality that is either close to 285 or greater (*fluids with moderately higher osmolality do not cause problems).* Thus, 0.2 NS (osmolality = 68) should not be administered peripherally, but D5 0.2 NS (osmolality = 346) or D5 ½ NS + 20 mEq/L KCl (osmolality = 472) can be administered

Maintenance fluids *usually contain 5% dextrose (D5), which provides 17 cal./100 mL & ~ 20% of the daily caloric needs. This is enough to prevent ketone production & helps to minimize protein degradation,*

Sources of Water Loss

Urine: 60% *Insensible losses: ~35% (Skin &Lungs)* Stool: 5%

Fever ↑ evaporative losses from the skin.

These losses are somewhat predictable, leading to a 10–15% ↑ in maintenance water needs for each 1°C ↑ in temperature > 38°C

Replacement Fluid for Diarrhea

AVERAGE COMPOSITION OF DIARRHEA

Sodium: 55 mEq/L

Potassium: 25 mEq/L

Bicarbonate: 15 mEq/L

APPROACH TO REPLACEMENT OF ONGOING LOSSES

Solution: D5 /0.2 normal saline + 20 mEq/L sodium bicarbonate + 20 mEq/L KCl

Replace stool mL/mL every 1–6 hr

Replacement Fluid for Emesis or NGT Losses

AVERAGE COMPOSITION OF GASTRIC FLUID

Sodium: 60 mEq/L

Potassium: 10 mEq/L

Chloride: 90 mEq/L

APPROACH TO REPLACEMENT OF ONGOING LOSSES

Solution: normal saline + 10 mEq/L KCl

Replace output mL/mL every 1–6 hr

Adjusting Fluid Therapy for Altered Renal Output

OLIGURIA/ANURIA

Place pt. on insensible fluids (25–40% of maintenance)

Replace urine output mL/mL with ½ normal saline ----POLYURIA

Place patient on insensible fluids (25–40% of maintenance)

Measure urine electrolytes

Replace urine output mL/mL with solution based on measured urine electrolytes

Fluid Management of Dehydration

Restore intravascular volume

Normal saline: 20 mL/kg over 20 min

Repeat as needed

Rapid vol. repletion: 20 mL/kg normal saline or Ringer Lactate (maximum = 1 L) over 2 hr

Calculate 24-hr fluid needs: maintenance + deficit volume

Subtract isotonic fluid already administered from 24 hr fluid needs

Administer remaining vol. over 24 hr using D5 ½ normal saline + 20 mEq/L KCl

Replace ongoing losses as they occur

Monitoring Therapy

VITAL SIGNS

Pulse Blood pressure

INTAKE & OUTPUT

Fluid balance Urine output &specific gravity(. If <1.010 & the patient is clinically well hydrated, it may be appropriate to decrease the i.v fluid rate)

PHYSICAL EXAM.

Weight

Clinical signs of depletion or overload

Treatment Of Hypernatremic Dehydration

Restore Intravascular Volume

Normal Saline: 20 Ml/Kg Over 20 Min (Repeat Until Intravascular Volume Restored)

Determine Time For Correction Based On Initial Na Conc.

[Na]:145–157 mEq/L:24 Hr [Na]:158–170 mEq/L:48 Hr [Na]:171–183 mEq/L:72 Hr [Na]:184–196 mEq/L:84 Hr

Administer Fluid At Constant Rate Over Time For Correction

Typical Fluid: D5 ½ N/S(with 20 mEq/L Kcl Unless Contraindicated)

Typical Rate: 1.25–1.5 Times Maintenance

Follow Serum Na Conc. Adjust Fluid Based On Clinical Status & Serum Na Conc.

Signs Of Vol. Depletion: Administer N/S (20 Ml/Kg)

Na Decreases Too Rapidly

Increase Na Conc. Of I.V Fluid, Or Decrease Rate Of I.V Fluid

Na Decreases Too Slowly Decrease Na Conc. Of I.V Fluid, Or Increase Rate Of I.V Fluid

Replace Ongoing Losses As They Occur

LR should not be used because it is more hypotonic than NS &may cause too rapid a ↓ in the serum Na conc., especially if multiple fluid boluses are necessary

Seizures are manifestation of cerebral edema from an overly rapid ↓of the serum Na conc. during correction of hypernatremic dehydration.

Acutely, ↑ the serum conc. via an infusion of 3% NaCl can reverse the cerebral edema.

Each 1 mL/kg of 3% NaCl ↑ the serum Na conc. by ~ 1 mEq/L. An infusion of 4–6 mL/kg often results in resolution of the symptoms

The initial goal in treating Hyponatremia is correction of intravascular vol. depletion, with isotonic fluid (NS or LR). An overcorrection in the serum Na conc. (>135 mEq/L) is associated with an ↑ risk of Central Pontine Myelinolysis (CPM).

The risk of CPM also ↑ with overly rapid correction of the serum Na conc., so it is best to avoid ↑ the serum Na by >12 mEq/L each 24 hr.

Management as usual

To ↑ serum Na by 2mmol/L/h (max. safe rate)

infusion rate (ml/h)=8xwt(kg)/%saline being used

By the end of this presentation The student should know the following :

1-Definition, Etiology& Mechanism of diarrhea & vomiting

2-Assess the degree& Types of dehydration &Electrolytes disturbance

3-Put a Differential Dx.

4- Outline Management of diarrheal diseases including Intravenous fluid therapy

5-know the Expected Complications & Prevention

A 6-year-old girl is referred with chronic diarrhea. Over the last yr. she has been stooling five times a day, passing a loose watery stool every time. It is associated with crampy abdominal pain, usually after eating.....
Examination reveals a pale girl with mild abdominal distension ,her body wt is $<5^{th}$ centile

Chronic diarrhea *(Ch D) is defined as a diarrheal episode that lasts for ≥14 days.*

In Iraq, *Ch D is often the result of an infectious process that lasts longer than expected.*

This syndrome is often defined as protracted diarrhea & there is no clear distinction between protracted & Ch D .

In well developed countries, it is less common & the etiology is more diverse, showing an age-related pattern.

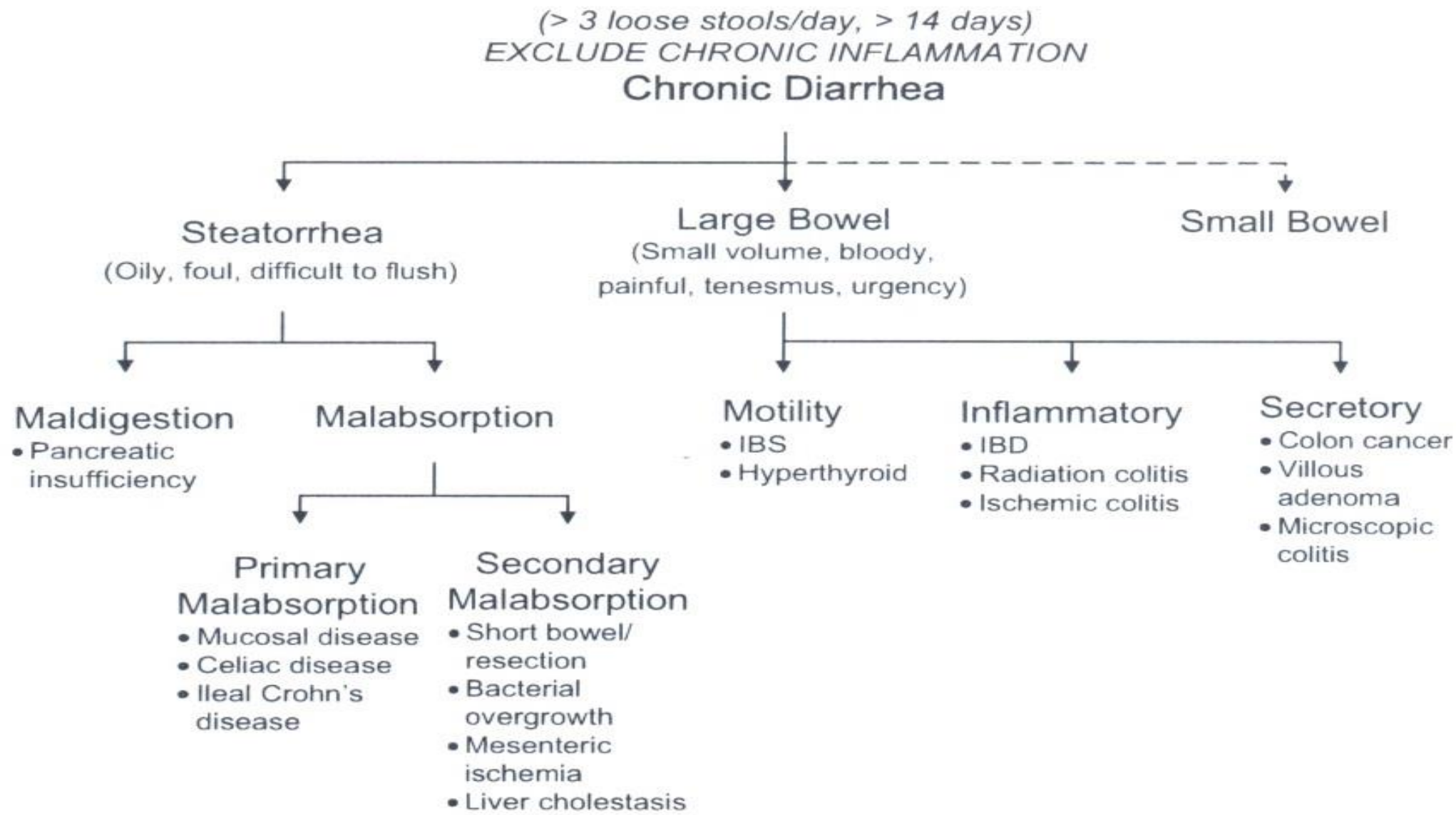
CHRONIC DIARRHEA: Small Bowel

(> 3 loose stools/day, > 14 days)
EXCLUDE CHRONIC INFLAMMATION

Chronic Diarrhea

- Steatorrhea
- Large Bowel
- **Small Bowel**
  (Large volume, watery, no pain, weight loss, no blood, malnourished)
  - **Secretory**
    - **Mucosal**
      - Crohn's disease
      - Celiac disease
      - Chronic inflammation
      - Whipple's disease
    - **Tumors**
      - **Neuroendocrine**
        - Gastrinoma/VIPoma
        - Carcinoid syndrome
        - Mastocytosis
      - **Neoplasia**
        - Adeno-carcinoma
        - Lymphoma
  - **Disordered Motility**
    - Irritable Bowel Syndrome
    - Diabetic neuropathy
    - Hyperthyroidism
  - **Osmotic**
    - Magnesium, phospahte, sulphate
    - Carbohydrate malabsorption
    - Lactose intolerance

CHRONIC DIARRHEA: Steatorrhea & Large Bowel

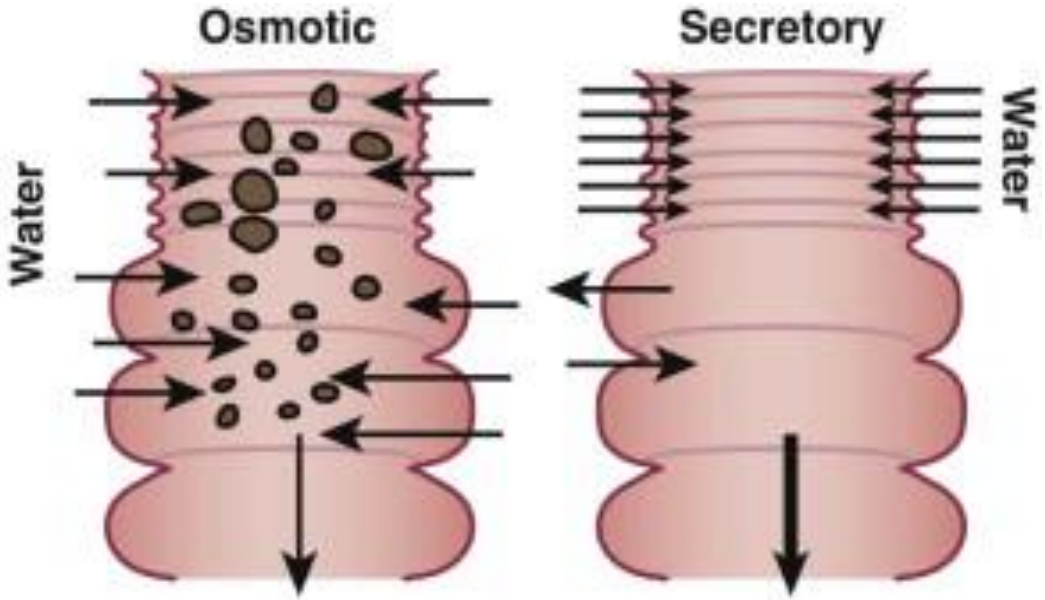


Pathophysiology (*mentioned earlier*)

The mechanisms of diarrhea are generally divided into secretory & osmotic, but often diarrhea is the result of both mechanisms.

Secretory diarrhea(SD) is usually associated with large vol. of watery stools & persists when oral food is withdrawn.

Osmotic diarrhea(OD) is dependent on oral feeding, & stool vol. are usually not as massive as in secretory diarrhea



Stool volume:	Moderately increased	Very large
Response to fasting:	Diarrhea stops	Diarrhea continues
Stool osmolality:	Normal to increased	Normal
Ion gap:	≥ 100 mOsm/kg	< 100 mOsm/kg

Pathways of OD & SD . OD is due to functional or structural damage of intestinal epithelium. Nonabsorbed osmotically active solutes drive water into the lumen. Stool osmolality & ion gap are generally increased.
Diarrhea stops in children when they are not eating.
In SD , ions are actively pumped into the intestine by the action of exogenous & endogenous secretagogues. Usually there is no intestinal damage. Osmolality & ion gap are within normal levels. Large vol. of stools are lost independent of food ingestion

INFECTIOUS AND NONINFECTIOUS CAUSES OF CHRONIC DIARRHEA

INFECTIOUS ETIOLOGIES		
		Bacterial
		Viral and protozoan agents
		Small intestinal bacterial overgrowth
		Postenteritis syndrome
		Tropical sprue
		Whipple disease

DIARRHEA ASSOCIATED WITH EXOGENOUS SUBSTANCES	
	Excessive intake of carbonated fluid
	Dietetic foods containing sorbitol, mannitol, or xylitol
	Excessive intake of antacids or laxatives containing lactulose or $Mg(OH)_2$
	Excessive intake of drinks containing methylxanthines (cola, tea, coffee)

ABNORMAL DIGESTIVE PROCESSES	Cystic fibrosis
	Shwachman-Diamond syndrome
	Isolated pancreatic enzyme deficiency
	Chronic pancreatitis
	Johanson-Blizzard syndrome
	Pearson syndrome
	Trypsinogen and enterokinase deficiency
	Chronic cholestasis
	Use of bile acids sequestrants
	Primary bile acid malabsorption
	Terminal ileum resection

NUTRIENT MALABSORPTION	Congenital or acquired lactase deficiency
	Congenital or acquired sucrase-isomaltase deficiency
	Glucose-galactose malabsorption
	Fructose malabsorption
	Congenital or acquired short bowel
IMMUNE AND INFLAMMATORY	Food allergy (cow's milk or soy proteins, others)
	Celiac disease
	Eosinophilic gastroenteritis
	Inflammatory bowel disease
	Autoimmune enteropathy
	IPEX syndrome (IPEX, immunodysregulation polyendocrinopathy enteropathy X-linked syndrome)
	Primary and secondary immunodeficiencies

STRUCTURAL DEFECTS	Microvillus inclusion disease
	Tufting enteropathy
	Phenotypic diarrhea
	Heparan-sulphate deficiency
	$\alpha_2\beta_1$ & $\alpha_6\beta_4$ integrin deficiency
	Lymphangiectasia
	Enteric anendocrinosis (neorogenin-3 mutation)
DEFECTS OF ELECTROLYTE & METABOLITE TRANSPORT	Congenital Cl diarrhea
	Congenital Na diarrhea
	Acrodermatitis enteropathica
	Selective folate deficiency
	A β-lipoproteinemia

MOTILITY DISORDERS	Hirschsprung disease
	Chronic intestinal pseudo-obstruction (neurogenic & myopathic)
	Thyrotoxicosis
NEOPLASTIC DISEASES	Neuroendocrine hormone-secreting tumors (APUDomas such as VIPoma)
	Zollinger-Ellison
	Mastocytosis
	Pheochromocytoma
	Lymphoma
CHRONIC NONSPECIFIC DIARRHEA	Functional diarrhea
	Toddler's diarrhea
	Irritable bowel syndrome

MAIN CAUSES OF CHRONIC DIARRHEA ACCORDING TO THE AGE OF ONSET

0-30 DAYS	1-24 MONTHS	2-18 YEARS
Microvillus inclusion disease	Apple juice and pear nectar	Apple juice or pear nectar
	Autoimmune enteropathy	Antibiotic-associated Clostridium difficile colitis
	Intestinal infection	Intestinal infection
Congenital short bowel syndrome	Short gut	
Food allergy	Food allergy	Lactose intolerance
	Functional diarrhea	Irritable bowel syndrome
	Celiac disease	Celiac disease
Hirschsprung's disease	Cystic fibrosis	
Malrotation with partial blockage	Post-gastroenteritis diarrhea	Post-gastroenteritis diarrhea
Neonatal lymphangectasia	Tufting enteropathy	----------
Primary bile-salt malabsorption	----------	----------
Intestinal pseudo-obstruction	Intestinal pseudo-obstruction	----------

Clinical approach

Anthropometric measures are essential to evaluate "if, since when, & how much" diarrhea has affected body wt. The combined evaluation of the duration & amount of wt loss provides an estimate of the severity of diarrhea.

Initial clinical exam. should include evaluating general & nutritional status. Dehydration, marasmus, or kwashiorkor requires prompt supportive interventions to stabilize the patient.

Nutritional evaluation is crucial to establish the need for rapid intervention. It should start with the evaluation of the wt & ht curves & of the wt for ht index to determine the impact of diarrhea on growth.

Wt. is generally impaired before Ht, but with time linear growth also becomes affected, & both parameters may be equally abnormal in the long term.

Assessment of nutritional status includes the dietary Hx & biochemical & nutritional investigations.

Caloric intake should be quantitatively determined

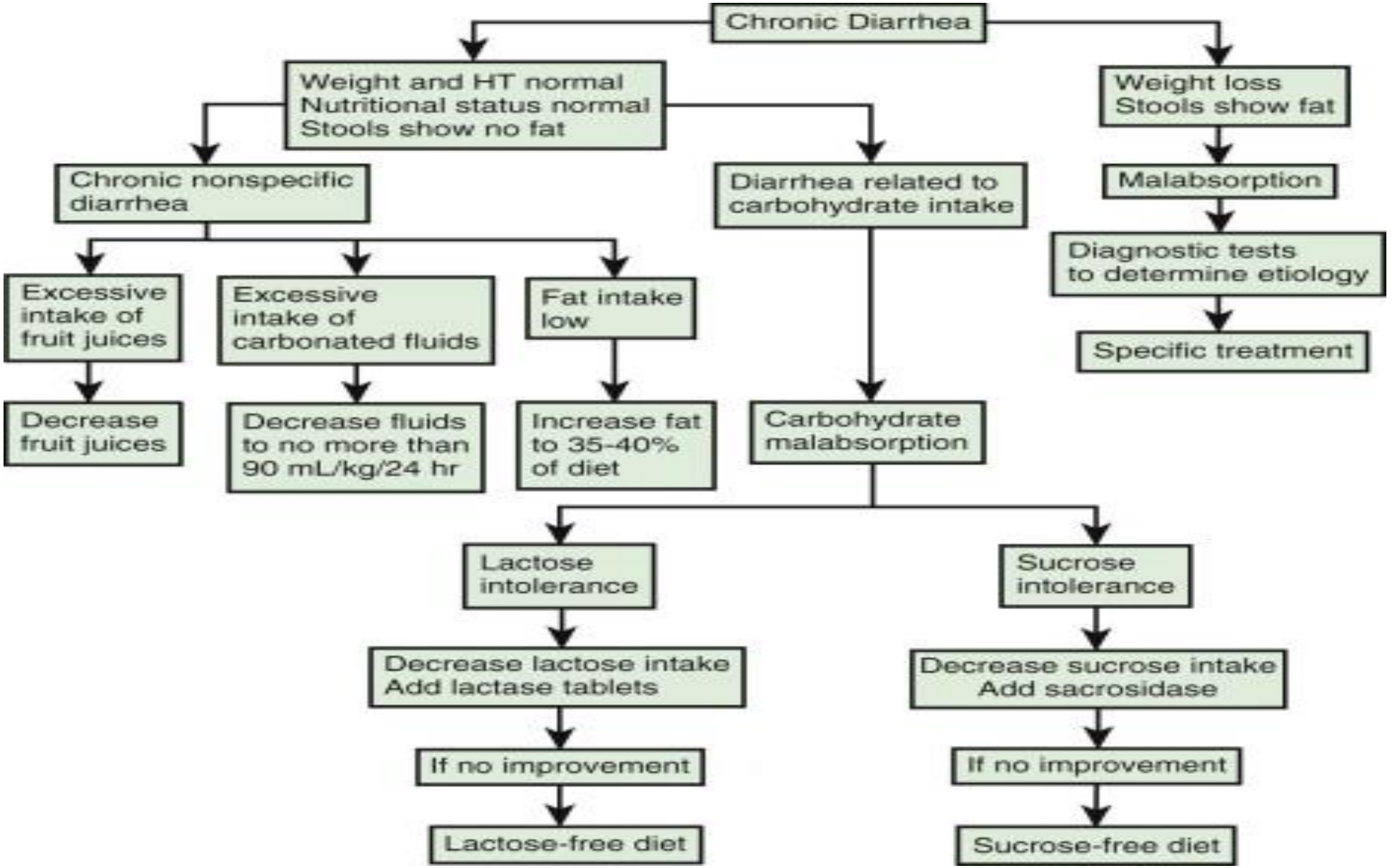
STEPWISE DIAGNOSTIC WORK-UP FOR CHILDREN WITH CHRONIC DIARRHEA

STEP 1	Intestinal microbiology
	Stool cultures
	Microscopy for parasites
	Viruses
	Stool electrolytes
	H_2 breath test
	Screening test for celiac disease (transglutaminase 2 autoantibodies)
	Noninvasive tests for:
	Intestinal function
	Pancreatic function & sweat test
	Intestinal inflammation
	Tests for food allergy
	Prick/patch tests

STEP 2	Intestinal morphology
	Standard jejunal/colonic histology
	Morphometry
	PAS staining
	Electron microscopy
STEP 3	**Special investigations**
	Intestinal immunohistochemistry
	Anti-enterocyte antibodies
	Serum chromogranin and catecholamines
	Autoantibodies
	^{75}SeHCAT measurement
	Brush border enzymatic activities
	Motility and electrophysiological studies

PAS, periodic acid–Schiff; ^{75}SeHCAT, ^{75}Se–homocholic acid–taurine

General therapeutic approaches to management of chronic diarrhea. HT, height



Malabsorption

•Disorders affecting the digestion or absorption of nutrients manifest as:
• Abnormal stools
•Failure to thrive or poor growth in *most but not all cases*
•Specific nutrient deficiencies, either singly or in combination

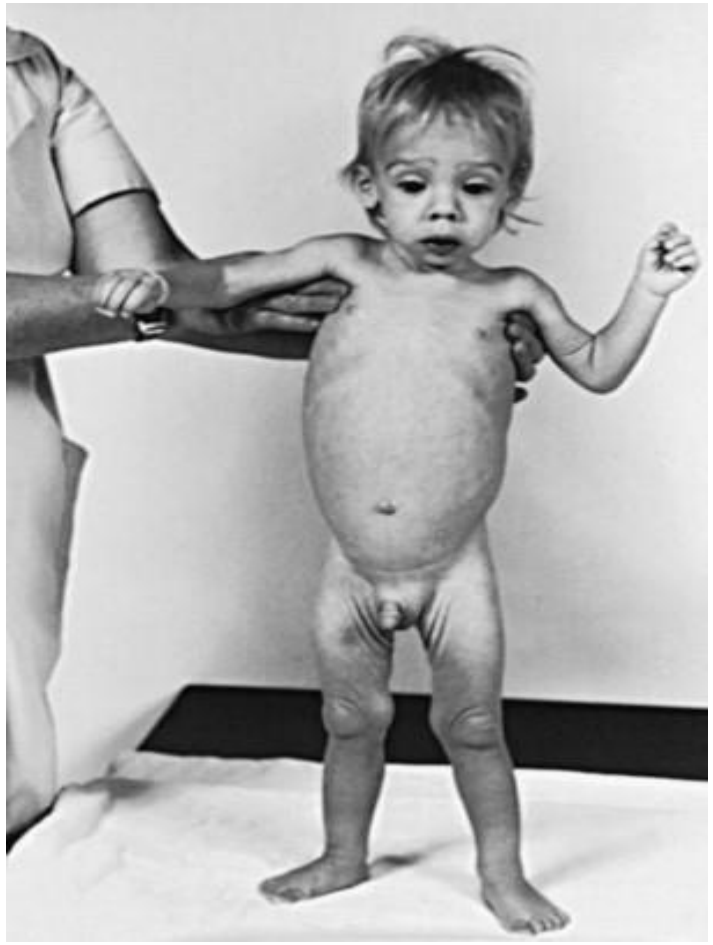
The true malabsorption stool is difficult to flush down the toilet & has an odor which pervades the whole house. In general, color is a poor guide to abnormality.
Reliable dietetic assessment is important.
Some disorders affecting the SI mucosa or pancreas may lead to the malabsorption of many nutrients (pan-malabsorption), whereas others are highly specific, e.g. zn malabsorption in *acrodermatitis enteropathica.*

Celiac Disease (CD)

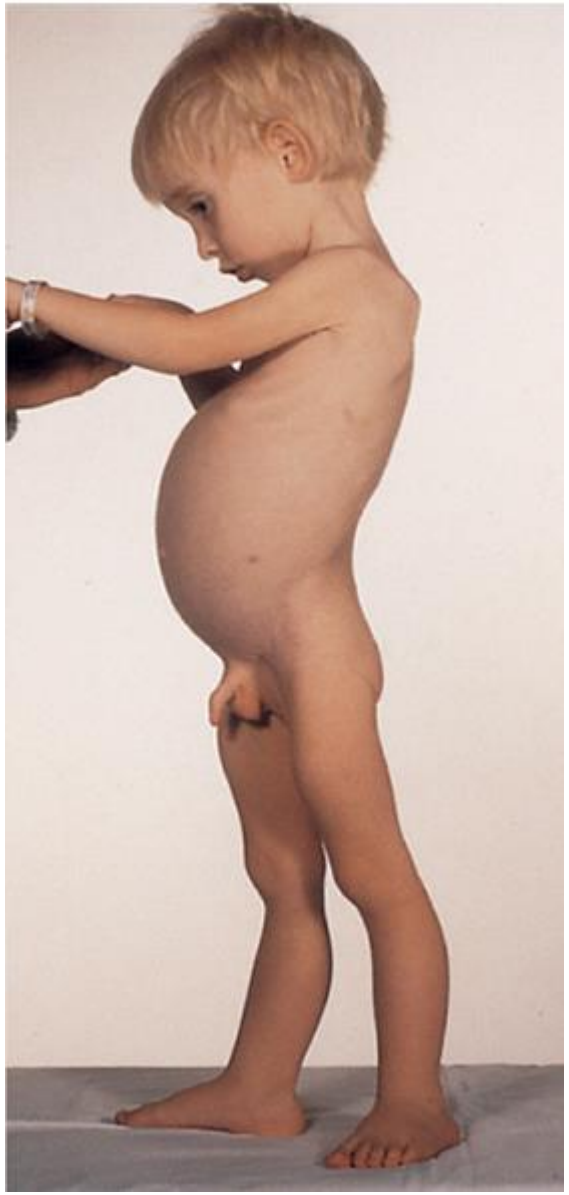
CD is an enteropathy in which the gliadin fraction of gluten provokes a damaging immunological response in the proximal small intestinal mucosa. As a result, the rate of migration of absorptive cells moving up the villi (enterocytes) from the crypts is massively ↑but is insufficient to compensate for ↑ cell loss from the villous tips. Villi become progressively shorter and then absent, leaving a flat mucosa.

Classically, children present in the first few yrs of life with FTT following the introduction of gluten in cereals. ***General irritability, abnormal stools, abdominal distension & buttock wasting are the usual symptoms***. Increasingly, children may present in later childhood with anemia (iron &/or folate deficiency) or growth failure, with little or no GI symptoms.

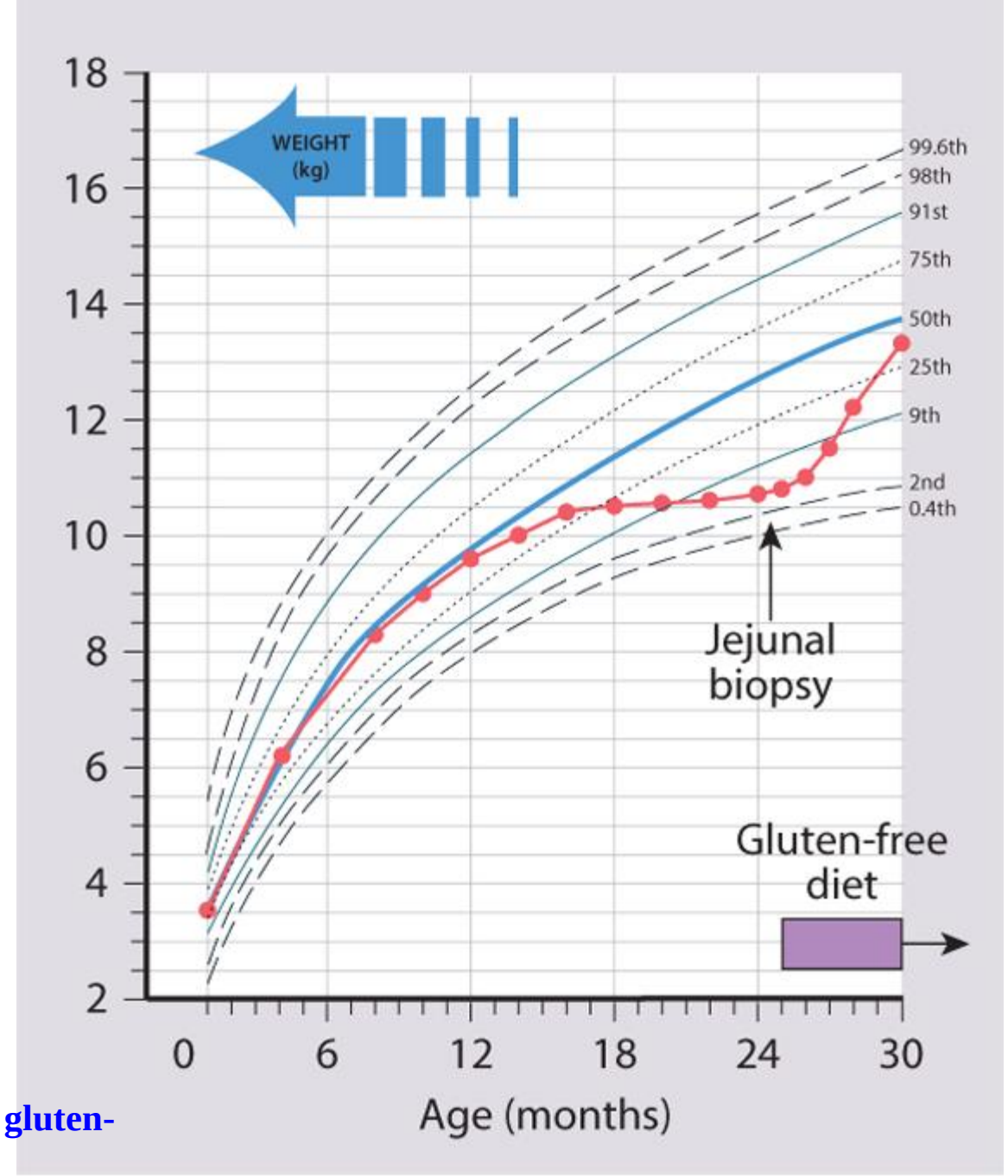
The introduction of screening tests (tissue transglutaminase Ab & anti-endomysial Ab) has provided evidence that CD is more common than previously thought & as many as 1 in 100 school-age children may be AB positive(Western) . type 1 DM , is about 5% in children with CD



An 18 mo old boy with active CD . Note the loose skinfolds, marked proximal muscle wasting, & distended abdomen. The child looks ill.



CD causing wasting of the buttocks and distended abdomen

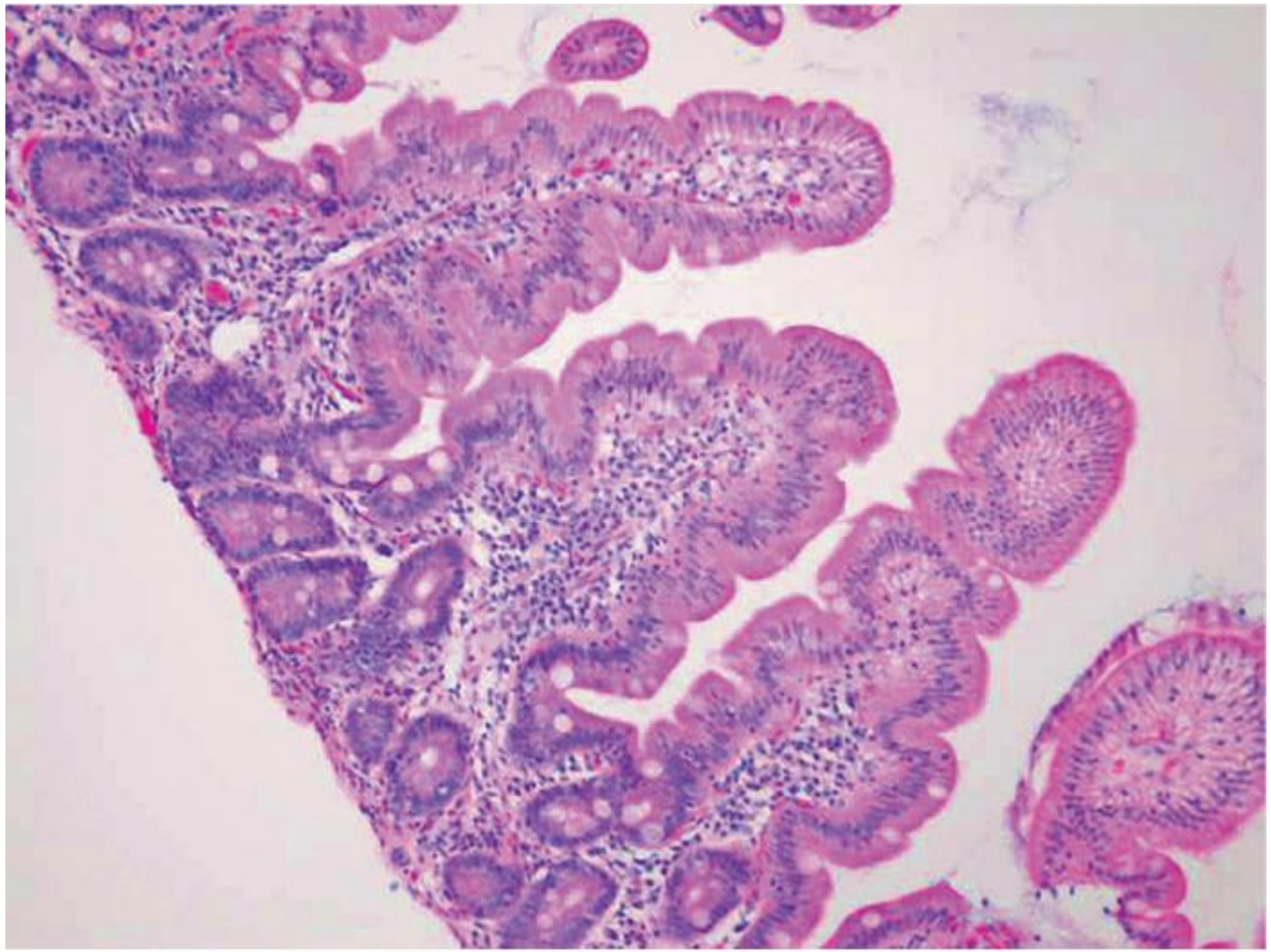


Growth chart showing failure to thrive and response to a gluten-free diet

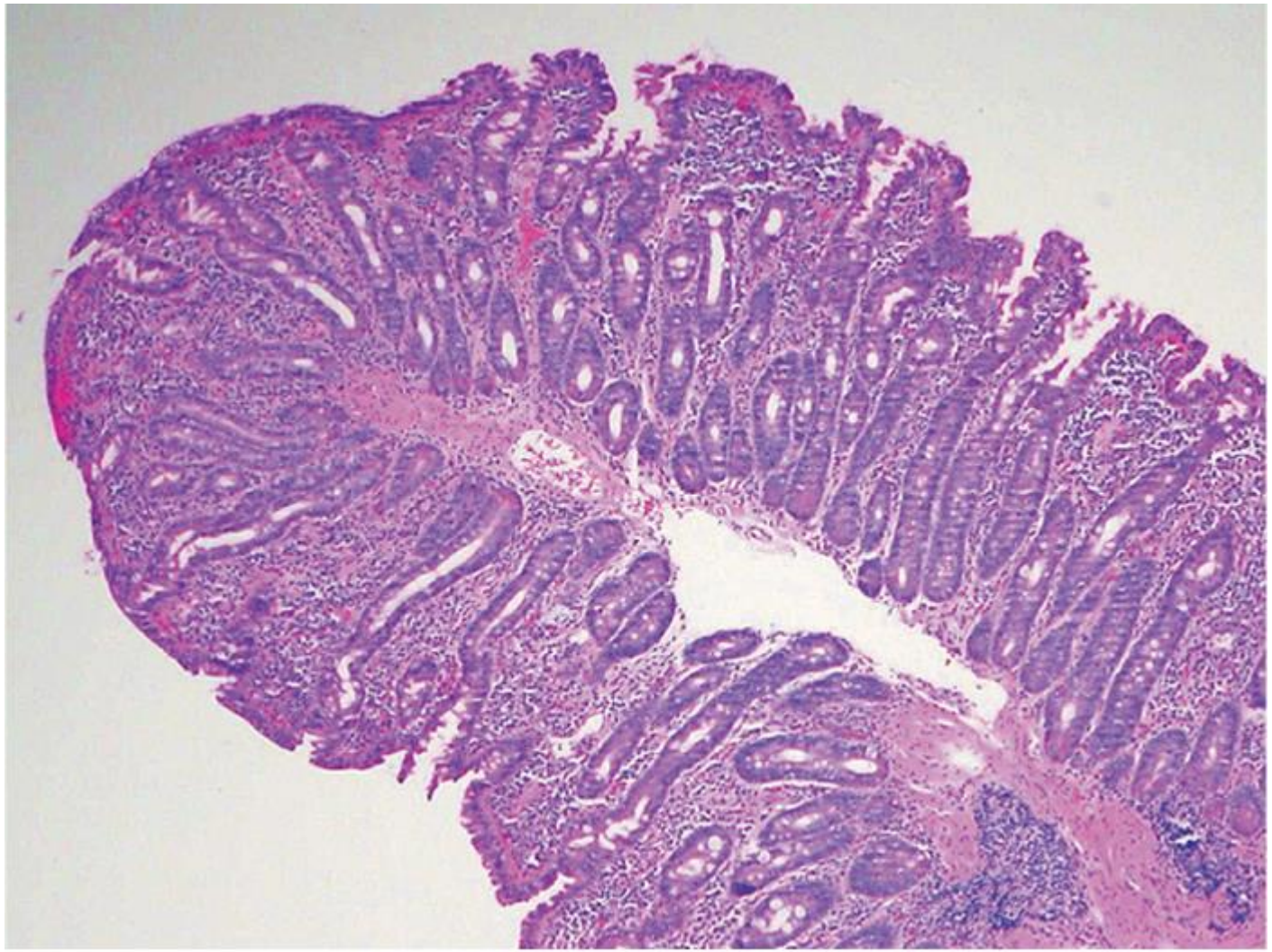
SYSTEM	MANIFESTATION	(POSSIBLE) CAUSE
Gastrointestinal	Diarrhea Distended abdomen Vomiting Anorexia Wt loss FTT Aphthous stomatitis	Atrophy of the small bowel mucosa Malabsorption
Hematologic	Anemia	Fe malabsorption
Skeletal	Rickets Osteoporosis Enamel hypoplasia of the teeth	$Ca+_2$ /vitamin D malabsorption
Muscular	Atrophy	Malnutrition
Neurologic	Peripheral neuropathy Epilepsy Irritability	B1 /vitamin B_{12} deficiency
Endocrinologic	Short stature Pubertas tarda Secondary hyperparathyroidism	Malnutrition $Ca+_2$/vitamin D malabsorption
Dermatologic	Dermatitis herpetiformis Alopecia areata Erythema nodosum	Autoimmunity
Respiratory	Idiopathic pulmonary hemosiderosis	

OTHER CAUSES OF FLAT MUCOSA

Autoimmune enteropathy
Tropical sprue
Giardiasis
HIV enteropathy
Bacterial overgrowth
Crohn disease
Eosinophilic gastroenteritis
Cow's milk enteropathy
Soy protein enteropathy
Primary immunodeficiency
Graft-versus-host disease
Chemotherapy & radiation
Protein energy malnutrition
TB
Lymphoma
Non-gluten food intolerances



Normal jejunal histology is shown for comparison



Histology of a jejunal biopsy showing lymphocytic infiltration and villous atrophy confirming CD

CLINICAL SPECTRUM OF CELIAC DISEASE

SYMPTOMATIC
Frank malabsorption symptoms: chronic diarrhea, failure to thrive, weight loss
Extraintestinal manifestations: *anemia, fatigue, hypertransaminasemia, neurologic disorders, short stature, dental enamel defects, arthralgia, aphthous stomatitis*
SILENT
No apparent symptoms in spite of histologic evidence of villous atrophy
In most cases identified by serologic screening in at-risk groups
LATENT
Subjects who have a *normal histology*, but at some other time, before or after, have shown a gluten-dependent enteropathy
POTENTIAL
Subjects with positive celiac disease serology but without evidence of altered jejunal histology
It might or might not be symptomatic

The ultimate Dx of CD relies on the demonstration of specific, though not pathognomonic, histopathologic abnormalities in the SI mucosa .

According to The ESPGHAN current criteria, the 2 requirements mandatory for the Dx of CD are ***the finding of villous atrophy with hyperplasia of the crypts and abnormal surface epithelium, while the patient is eating adequate amounts of gluten, and a full clinical remission after withdrawal of gluten from the diet***.

Management

All products containing wheat, rye & barley are removed from the diet and this results in resolution of symptoms. Supervision by a dietician is essential. In children in whom the initial biopsy or the response to gluten withdrawal is doubtful, or when the disease presents before the age of 2, a gluten challenge is required in later childhood to demonstrate continuing susceptibility of the jejunal mucosa to damage by gluten. The gluten-free diet should be adhered to for life.

The incidence of SI malignancy in adulthood is ↑ in CD although a gluten-free diet probably ↓ the risk to normal.

Chronic Diarrhea & Malabsorption

Learning Objectives:

-Define chronic diarrhea as > 2 weeks in duration.

-Differentiate small bowel & large bowel diarrhea

-Differentiate osmotic from secretory diarrhea, & maldigestion from Malabsorption

-List & interpret clinical & lab. findings which were key in the processes of exclusion,DDx & Dx

-Outline plan of management for patients with ch. diarrhea, including the prevention & treatment of related complications (e.g. pts with CD, pancreatic insufficiency, vitamin & mineral deficiencies.