

Developmental Milestones

Jason Ryan, MD, MPH



Developmental Milestones

- Motor, language, and social skills for various ages
- Developmental delay = failure to reach milestones
- Reversible causes:
 - Hearing loss
 - Lead poisoning
- Often occurs with dysmorphic features
 - Facial, limb and other abnormalities
 - Down syndrome
 - Fragile X (long face, large ears, large testes)

Developmental Milestones

- Gross motor
- Fine motor
- Language
- Social
- Emotional
- Self-help
- Cognitive

Developmental Milestones

Gross Motor

- Goal first year: **walk**
- Newborn babies lie face down
- Motor development proceeds from top down
 - Head before legs

Time	Milestone
2 months	Lift head
4 months	Roll over
6 months	Sit up
9 months	Crawl/pull up/stand
12 months	Walk



Piqsels

Developmental Milestones

Fine Motor

- Goal first year: **pincer grasp and throw objects**
- Newborns: hands in fists

Time	Milestone
2 months	Open hands/hands together
4 months	Grasps rattle
6 months	Transfer objects
9 months	Three-finger/clumsy grasp Bangs two cubes
12 months	Pincer grasp Throws objects



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Developmental Milestones

Language/Communication

- Requires **hearing**
- Goal first year: **say ONE word with meaning - “mama” and “dada”**

Time	Milestone
2 months	Coos
4 months	Laughs
6 months	Babbles
9 months	Says “mamamama” and “bababababa”
12 months	“Mama” and “Dada”

Developmental Milestones

Social

Time	Skill
2 months	Begins to smile at people
4 months	Smiles spontaneously
6 months	Recognizes faces Stranger anxiety
9 months	Waves bye-bye Separation anxiety
12 months	Points

Stranger and Separation Anxiety

- **Stranger anxiety**
 - Baby becomes upset when unfamiliar person approaches them
 - Occurs around six months
- **Separation anxiety**
 - Baby becomes upset when separated from parents
 - Occurs by nine months
 - Requires object permanence
- **Object permanence**
 - Baby knows objects exist when out of sight
 - Occurs by nine months

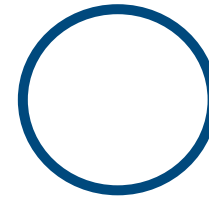
Developmental Milestones

2-year-old

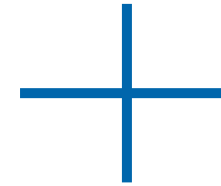
- Run and climb **two** steps
- **Two**-word phrases
- **Two**-step commands
 - “Give me the ball and then get your shoes.”
- Stacks 6 blocks
- 50- to **200**-word vocabulary
- Copy a line



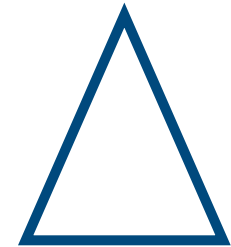
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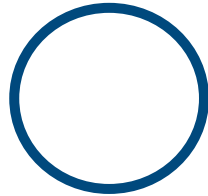
Developmental Milestones

3-year-old

- Ride a **tri**cycle
- **Three-word** sentences
- **300+** word vocabulary
- Copy a circle



2



3



4



5



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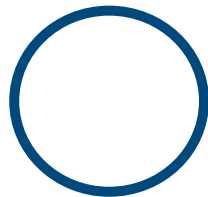
Developmental Milestones

4-year-old

- Hop
- Copy a cross
- Tells detailed stories



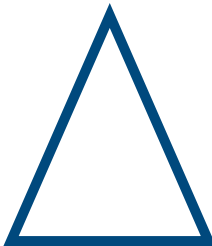
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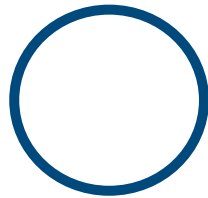
Developmental Milestones

5-year-old

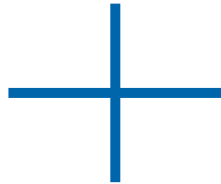
- Skip
- Copy a triangle



2



3



4



5



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Language

- Age 2: 50% understandable
- Age 3: 75% understandable
- Age 4: 100% understandable



Developmental Delay

- **Global developmental delay**
 - Failure to meet milestones in ≥ 2 of major domains
 - Gross motor, fine motor, language, cognition, or social
 - Large differential diagnosis: CNS, metabolic, other
- **Hearing loss**
 - Can present as speech, language, or social delay



Red Flags

Age	Features
6 Months	No smile, grasp, or roll; poor head control
12 Months	Unable to pick up objects; no crawling; no standing; no babbling
2 Years	Less than 50-word vocabulary; difficulty holding small objects; Can't climb stairs; not feeding or dressing themselves

Rett Syndrome

- Neurodevelopmental disorder of **females**
 - Contrast with autism: 4x more common in males
- Initially normal development
- Slow symptom onset 1-2 years of age
- Hallmark: **regression** of cognitive/motor skills
 - Diagnostic criteria for disorder



Rett Syndrome

- Deceleration of head growth
- *Loss* of motor, intellectual, speech abilities
- *Loss* of balance (ataxia)
- **Repetitive hand movements**
 - Hand-to-mouth licking
 - Grabbing of clothing or hair
 - Hand wringing



Rett Syndrome

Genetics

- **X-linked disorder**
 - X-linked dominant: 1 abnormal gene → disease
 - 99% cases: sporadic gene mutation
- Girls
 - Two X chromosomes
 - Random X inactivation → some cells with normal gene
- Males
 - One X chromosome: all abnormal genes
 - Lethal

Developmental Delay

Select Causes

	Autism	Selective Mutism	Hearing Loss
Motor	Normal	Normal	Normal
Language	Impaired	Impaired	Impaired
Behavior	Stereotyped patterns of behavior	Won't speak in specific situations	Does not react to sounds

Primitive Reflexes

- Present at birth
- Resolve as corticospinal neurons become myelinated
- Can return in adults with neurologic damage

Reflex	Description	Disappears by
Hand Grip	Grasp object placed in palm	3M
Sucking	Suck when roof of mouth touched	4M
Moro	Extend arms when startled	4M
Rooting	Turn head toward side of cheek stimulus	6M
Galant	Stroke spine on side, baby swings torso toward touch	9M
Plantar	Dorsiflexion of foot and flexion of toes with plantar stimulation	12M

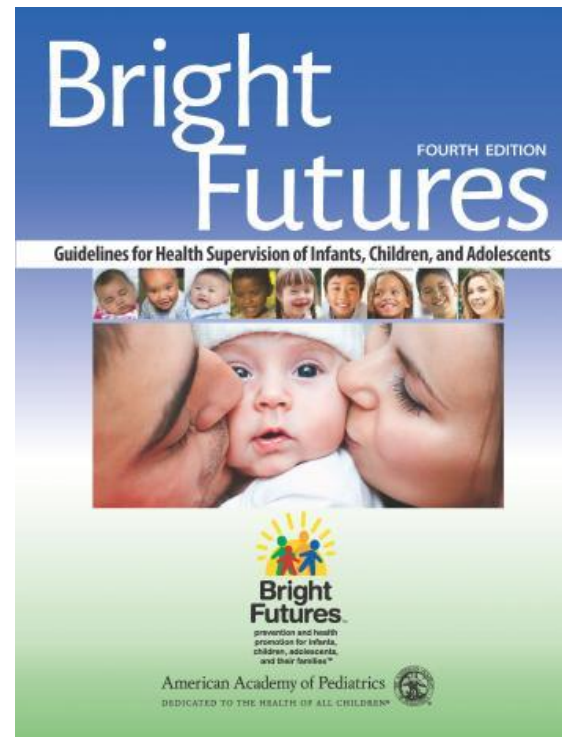
Pediatric Screening

Jason Ryan, MD, MPH



Pediatric Screening

- American Academy of Pediatrics (AAP) guidelines
- Bright Futures



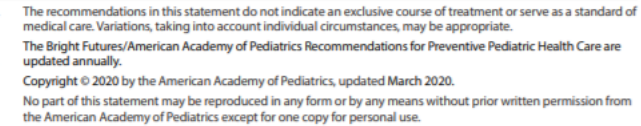
Fluoride varnish		
Fluoride Supplementation ²¹		
ANTICIPATORY GUIDANCE	●	

BR **E** **STUDY SMARTER™**

Each child and family is unique; therefore, these Recommendations for Preventive Pediatric Health Care are designed for the care of children who are receiving competent parenting, have no manifestations of any important health problems, and are growing and developing in a satisfactory fashion. Developmental, psychosocial, and chronic disease issues for children and adolescents may require frequent counseling and treatment visits separate from preventive care visits. Additional visits also may become necessary if circumstances suggest variations from normal.

These recommendations represent a consensus by the American Academy of Pediatrics (AAP) and Bright Futures. The AAP continues to emphasize the great importance of continuity of care in comprehensive health supervision and the need to avoid fragmentation of care.

Refer to the specific guidance by age as listed in the *Bright Futures Guidelines* (Hagan JF, Shaw JS, Duncan PM, eds. *Bright Futures: Guidelines for Health Supervision of Infants, Children, and Adolescents*. 4th ed. Elk Grove Village, IL: American Academy of Pediatrics; 2017).

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Pediatrics Screening

- AAP recommendations for screening based on age/condition
- More frequent in children with special risk factors
 - Example: hearing loss in children with recurrent otitis media with effusion

Screening

Select Screening Measures

- Iron deficiency
- Autism
- Hearing
- Vision
- Lead poisoning
- Oral health
- Tobacco, alcohol, substance use (9 years and older)
- Depression (ages 12 to 21 years)
- Poverty

Iron Deficiency

- Up to 9% toddlers have iron deficiency in US
- Commonly caused by insufficient dietary intake
- Babies have increased iron demand due to growth
- Reduced risk with iron-fortified formula
- Breast milk has some iron



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Iron Deficiency

- AAP guidelines: **screening at ~1 year of age**
- Usual screening: **measurement of CBC**
 - Measures hemoglobin, MCV, RDW
 - Iron deficiency: low hemoglobin, MCV; Increased RDW
- Repeated screening if risk factors present
 - Prematurity or low birth weight (risk of anemia of prematurity)
 - High consumption of cow's milk
 - Low consumption of iron-containing foods

Iron Deficiency



Iron Supplementation

- Use iron-fortified formula
- For breastfed infants
 - Add iron supplement at four months
 - Continue until baby eating iron-rich foods
- Avoid cow's milk until 12 months of age



Autism

- Screening at 18 and 24 months
- **Modified Checklist for Autism in Toddlers, Revised with Follow-Up**
 - MCT-RF
 - Two-stage assessment
 - First stage: 20-item parent questionnaire
 - Second stage: Follow-up questionnaire administered by health care professional
 - Score from 0 – 20 (higher = higher risk)

Hearing Loss

- Can cause speech, language, and cognitive delays
- Screening at birth (congenital causes)
- Screening in older children (acquired causes)
 - Often conductive hearing loss
 - Middle ear dysfunction (otitis, fluid)
- AAP: screening **age 4 and up**
- Office screening tools:
 - Tone audiology
 - Tympanometry
- Abnormal screen: audiology referral

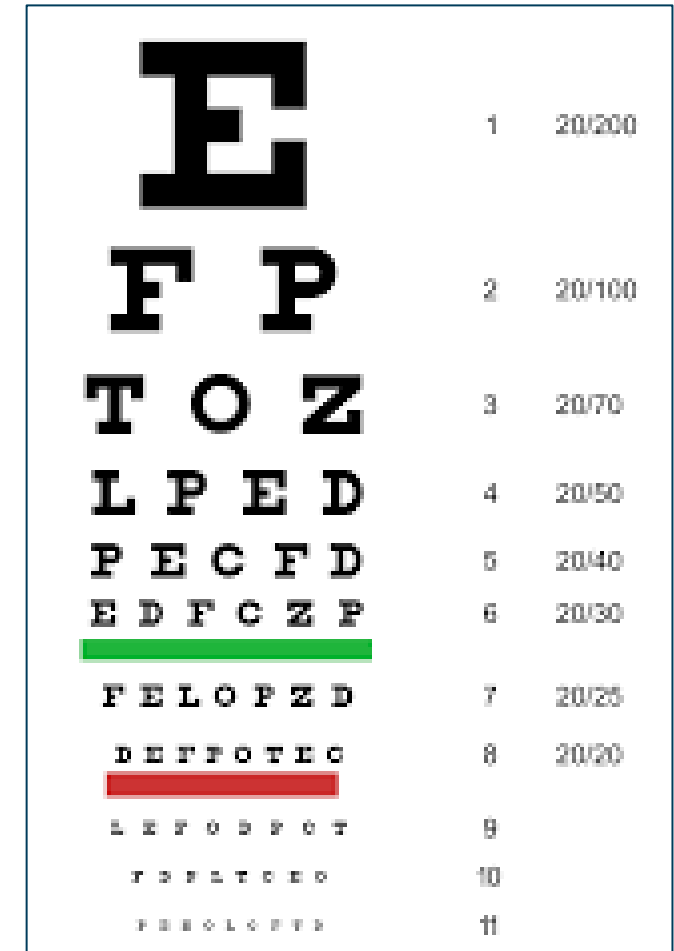


Vision Loss

- Screening begins ~ age 3
- Also examine eyes for **strabismus**
 - Misalignment of eyes
 - Common in children
 - Can cause vision problems
 - Potentially treatable



Public Domain



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Hyperlipidemia

- Once ages 9 to 11
- Again ages 17-21
- None 12 to 16 (puberty)



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Drug and Alcohol Use

- Annual screening starting at age 11
- Commonly done with CRAFFT screen

CRAFT Screening

Substance Use Screen for Children

- **Car** – Have you ever ridden in a car driven by someone who has been using alcohol or drugs?
- **Relax** – Do you ever use alcohol or drugs to relax?
- **Alone** – Do you ever use alcohol or drugs while alone?
- **Forget** – Do you ever forget things you did while using alcohol or drugs?
- **Friends** – Do your family or friends ever tell you that you should cut down on your drinking or drug use?
- **Trouble** – Have you ever gotten into trouble while you were using alcohol or drugs?
- Score ≥ 2 = high risk adverse outcomes

Depression

- Annual screening starting at age 12
- Patient Health Questionnaire-2 item screen (PHQ-2)
- Any of the following over the past two weeks:
 - Little interest or pleasure in doing things
 - Feeling down, depressed, or hopeless



Public Domain

Adolescent Medicine

Jason Ryan, MD, MPH



Puberty

- Thelarche: development of breasts
 - Estradiol action on breast tissue
- Menarche: first menstrual period
- Spermatarche: first sperm production
 - Often followed by nocturnal emission
- Pubarche: development of pubic hair
 - Primarily due to androgens from adrenal gland



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Puberty

Age of Onset

- Girls start puberty 8 to 13 years
 - Menarche: 12 to 13 years
- Boys start puberty 10 to 15 years
 - First ejaculations: 13 to 14 years
- Pubertal growth spurt
 - Girls: 12 years
 - Boys: 14 years



PXfuel

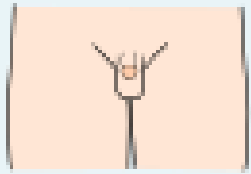
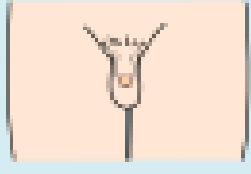
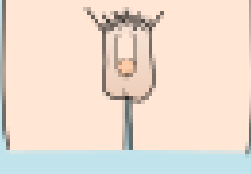

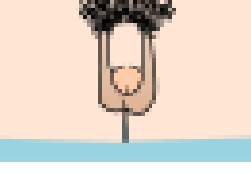
Puberty

Tanner Stages

- Assigns stage number to pubertal development
- Range from stages I to V
- Separate stages for:
 - Male genitalia
 - Female breasts
 - Pubic hair
- Stage I: prepubertal
- Stage V: adult sexual characteristics
 - Usually occurs by age 15

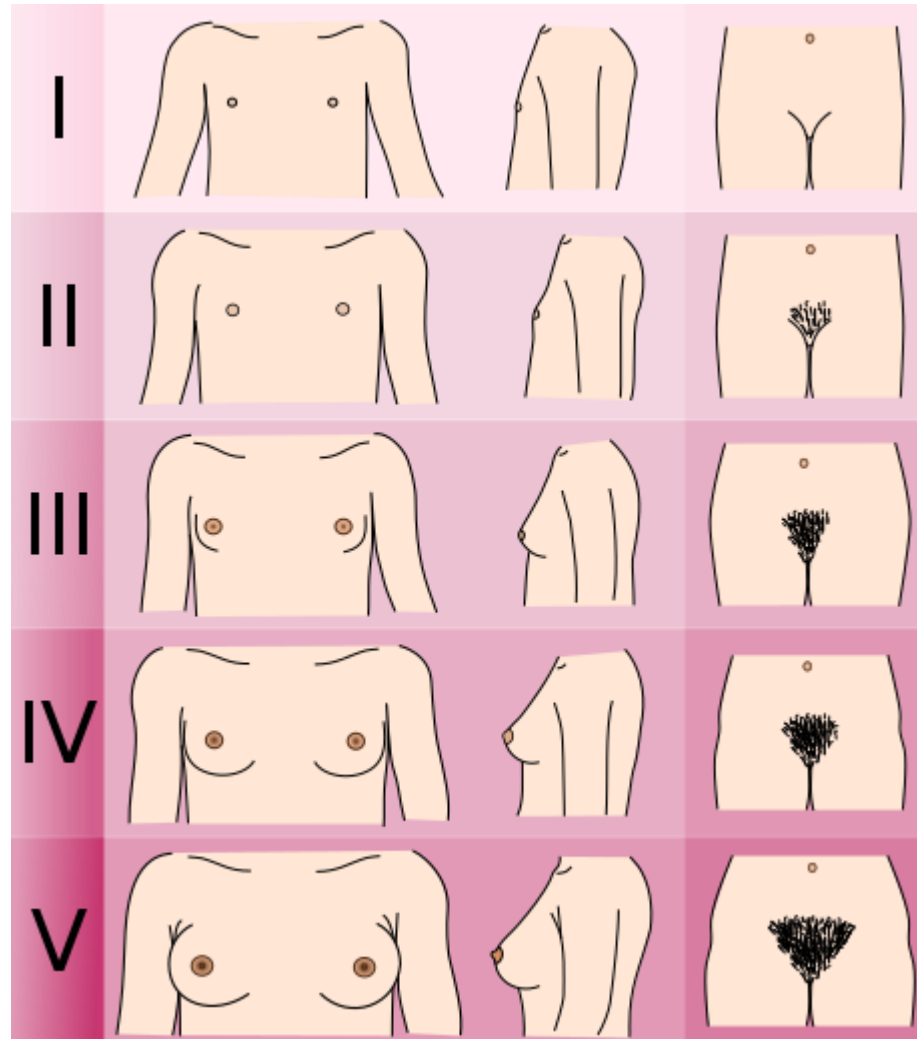
Tanner Stages

Males

I		3 ≤ 2.5
II		4 2.5-3.2
III		10 3.0
IV		16 4.1-4.5
V		25 ≥ 4.5

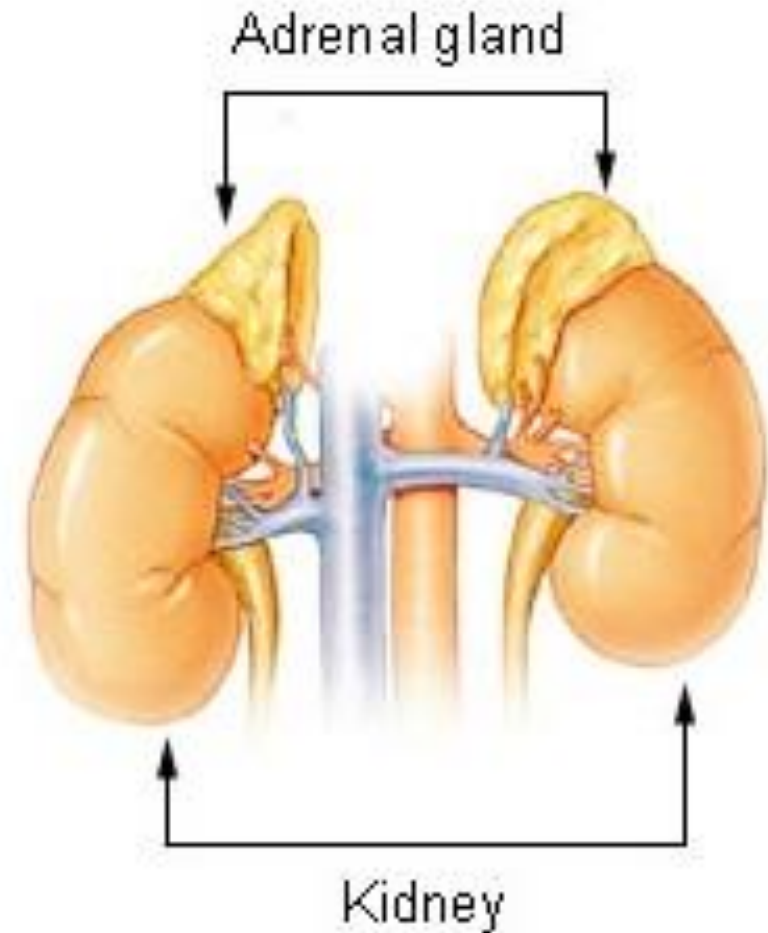
Tanner Stages

Females



Precocious puberty

- Occurs at early age, usually less than 8-9 years old
- Excess androgens (boys) or estrogens (girls)
- Boys: **congenital adrenal hyperplasia**



Delayed puberty

- No evidence of puberty by age 12-14 years
- Most common cause: **constitutional delay of growth and puberty**
 - Transient defect in GnRH release from hypothalamus
 - Often familial
- Underproduction of androgens or estrogens from hypogonadism:
 - Turner (girls)
 - Klinefelter (boys)
- Kallman syndrome (GnRH deficiency, anosmia)

Adolescent Screening

- HEADSSS interview instrument
- **H**ome
- **E**ducation
- **A**ctivities
- **D**rugs
- **S**ex
- **S**uicide
- **S**afety

Drug and Alcohol Use

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Confidentiality

- Critical to providing care to adolescents
- Exceptions:
 - **Sexual or physical abuse**
 - **Suicidal or homicidal thoughts**

Minors and Consent for Care

- Minor: usually defined as person under 18 years of age
- Only parent or legal guardian may give consent
- Exceptions
 - Emergencies
 - Emancipated minors
 - Special situations



Minors

Emergency Care

- Consent not required (implied)
- Care administered even if parent not present
- Care can be administered against parents' wishes
 - Classic example: Parents are Jehovah's Witnesses
 - Physician may administer blood products to child
 - Do not need court order



Emancipated Minor

- Minors can attain “legal adulthood” before 18
- Common criteria:
 - Marriage
 - Military service
 - Living separately from parents, managing own affairs
- Emancipated minors may give consent

Minors

Special Situations

- Most U.S. states allow minors to consent for certain interventions
- May be done without parental consent
- Contraceptives
- Prenatal Care
- Treatment for STDs
- Treatment for substance abuse



Abortion

- Rules on parental notification vary by state
- Some states require parental notification
- Some states allow consent with counseling



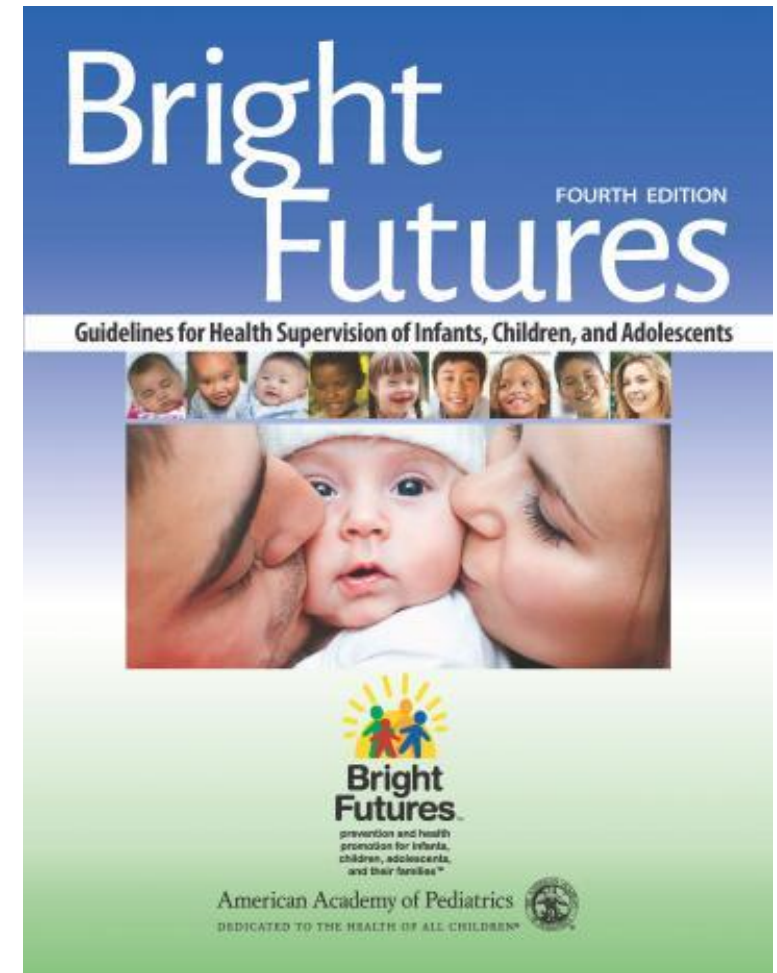
General Pediatrics

Jason Ryan, MD, MPH



Anticipatory Guidance

- Given by provider to parents
- Varies by child's age
- Expected growth and development
- Safety reminders
- Informs parents of child's needs
- Avoids health problems in children
- Component of the AAP Bright Futures guidelines

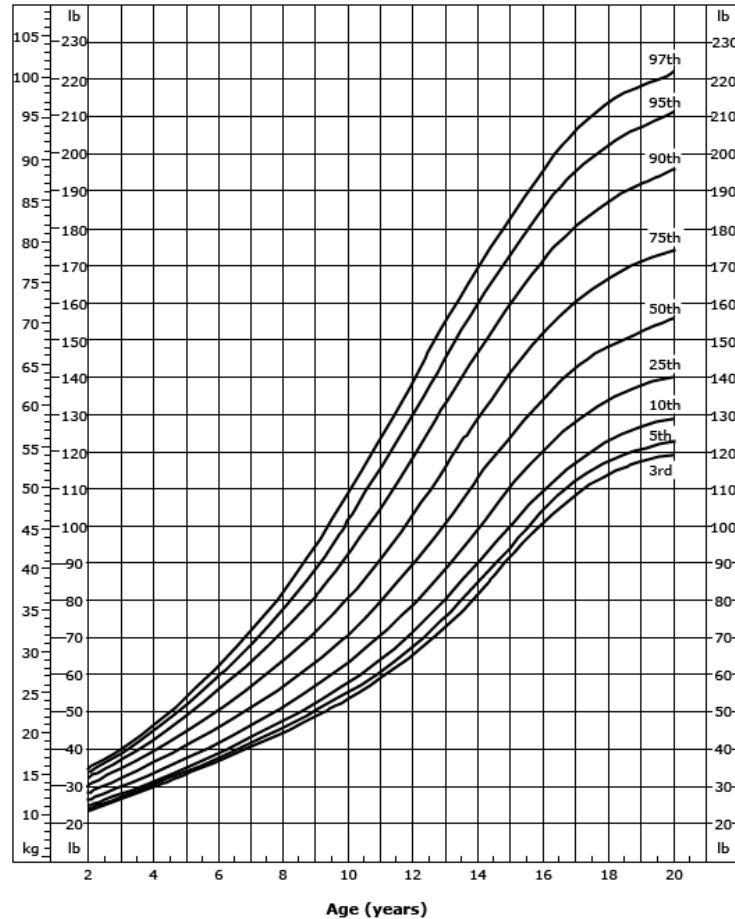


Normal Growth

- Usually occurs in a predictable course
- Influenced by nutrition, health
- Key metrics monitored by pediatricians:
 - Weight
 - Height
 - Head circumference (until 2 years)
- Compared to norms for age group
- Often reported as percentile (10th, 50th, 99th)

Growth Charts

Height, Weight, Head Circumference



Newborn Weight

- Full term babies **lose weight** after birth
 - Up to 10 percent of birth weight
 - Occurs in first few days of life
 - Usually regained by 10 to 14 days
- Infants double birth weight by four months
- Triple birth weight by one year
- Children gain ~4 to 5 lbs/yr from 2 to puberty



Piqsels

Linear Growth

- Non-linear with **spurts and slowing**
- Average length at birth: 20 inches
- Increases 50% by 1 year
- Grow about 2 to 4 inches per year from 1 to 10 years
- Children reach half adult height by 24 to 30 months
- Normal deceleration of height velocity before puberty
- Followed by growth spurt at puberty



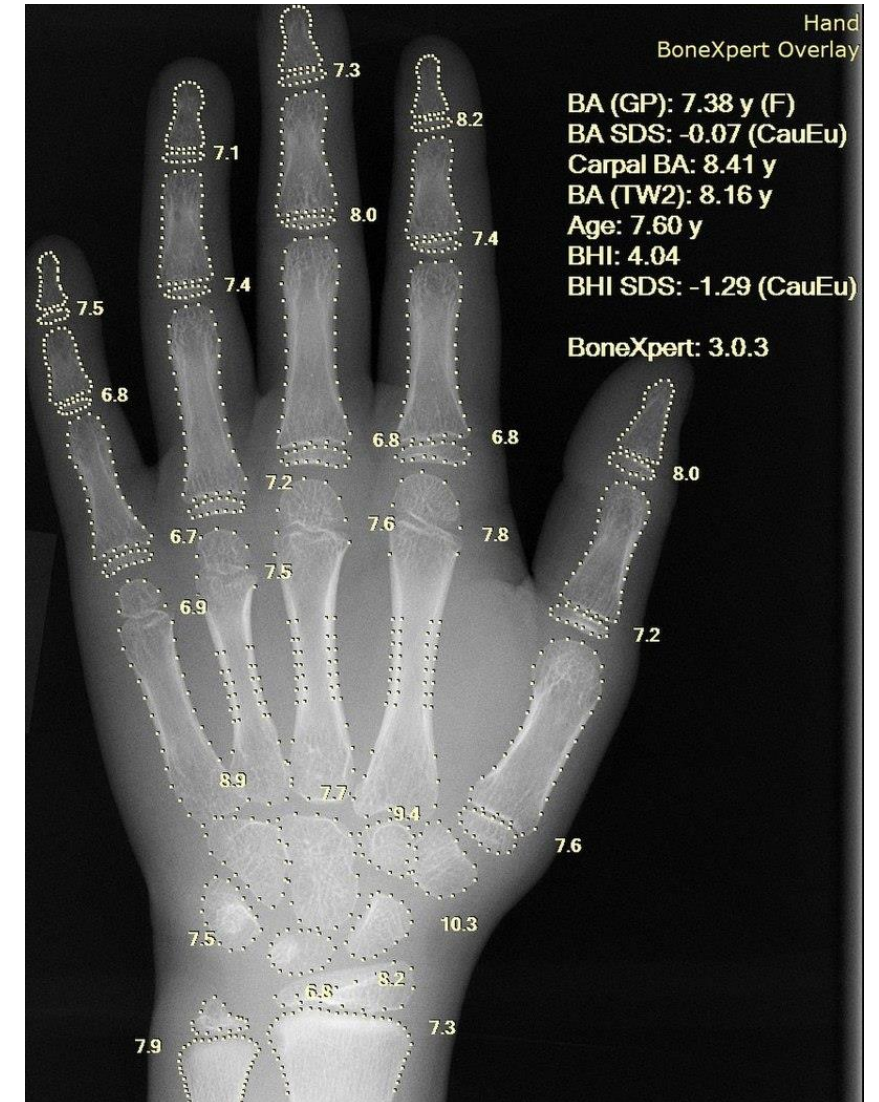
Linear Growth

- Most common causes of short stature after age two:
 - Constitutional growth delay (most common)
 - Familial (genetic) short stature
 - Both variants of normal
- Constitutional delay of growth and puberty (CDGP)
 - Late adolescent growth spurt
 - Delayed puberty
 - Adult height often normal



Bone Age

- X-ray of left hand and wrist
- Bone age determined from population norms
- Used in children with abnormal growth
- Bone age less than chronologic age
 - Seen in constitutional delay of growth and puberty
 - Child should eventually grow
- Bone age identical to chronologic age
 - Seen in familial short stature



Head Growth

- Reflects growth of brain
- Small head: microcephaly
 - Occipitofrontal circumference $< 2SD$ below age mean
- Large head: macrocephaly
 - Occipitofrontal circumference $> 2SD$ above age mean



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Microcephaly

Selected Causes

- Many, many causes of microcephaly
- Occurs with dysmorphism in genetic disorders
 - Abnormal facial, limb features
 - Down syndrome (trisomy 21)
 - Angelman syndrome (imprinted gene disorder)
 - Williams syndrome (deletion on chromosome 7)

Congenital	Acquired
TORCH Infections Teratogens (ETOH) Trisomy 13, 18, 21	Meningitis Ischemic brain injury Metabolic disorders (hypothyroid)

Macrocephaly

Selected Causes

- Increased brain size (often familial and present at birth)
- **Hydrocephalus**
- Hemorrhage
- Mass lesions
- Key test: **ultrasound**
 - For infants with open fontanelles
 - Noninvasive
 - Can identify ventricular enlargement
- Other tests: head CT or MRI



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Failure to Thrive

- Poor growth
- No formal definition
- Fall off **weight curve first** then height then head
- Organic causes
 - Chronic medical illness
- Non-organic causes
 - No underlying medical disorder
 - Malnutrition
 - Poor caregiver support
 - Treatment: interdisciplinary care, high calorie feedings



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Pediatric Dehydration

Severity	Symptoms
Mild (3-5%)	Sticky or slightly dry oral mucosa Increased thirst Normal vitals Normal/slightly decreased urine output
Moderate (6-9%)	Dry oral mucosa Increased thirst, irritable Sunken eyes/fontanelle, reduced skin turgor Tachycardia, tachypnea, possible hypotension Decreased urine output
Severe (>10%)	Very dry oral mucosa Lethargy, coma Sunken eyes/fontanelle, reduced skin turgor Cool skin, acrocyanosis Tachycardia, tachypnea, hypotension Anuria

Fluid Replacement

- Mild to moderate dehydration: **oral fluids**
- Moderate to severe: **intravenous fluids**
 - **20mL/kg** bolus of isotonic fluids
 - Repeat as needed



Diet

- Breastfeeding recommended
- Can feed on demand
- Feeds should occur every 2 to 4 hours
- 8 to 12 feeds per day
- Start iron-fortified cereals ~ 6 months
 - Baby must be able to sit, hold head up
- Whole milk may be consumed ~12 months
- Avoid juices, sweets



PxFuel.com

Bowel Movements

- First bowel movement usually within 36 hours of birth
- Ninety percent newborns pass meconium within 24 hours
- First week: about 4 stools per day
- First three months: 2 to 3 stools/day
 - Breastfed infants have more stools/day on average
- By two years : mean number of bowel movements under two per day
- After four years : mean number of bowel movements ~ one per day

Urine

- First week: # wet diapers = age in days
- After first week: ≥ 4 wet diapers per day
- Can start toilet training 18 months
- Most toddlers trained by 3 to 4 years



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Sleeping

- Newborns sleep 3 to 4 hours at a time for about 18 to 20 hours/day
- Sleep through the night by 6 months (usually)
- 1 to 2 naps/day normal up to 4 years of age
- As child gets older: less overall sleep, longer sleep duration



PickPic

Car Seats

- Age < 2 years: rear-facing car seat in back
- Age 2 – 4 years: forward-facing car seat in back
- Age 4 – 8 years: booster seat in back until 4'9" tall
- Older children < 12 years: back seat belt
- Air bags (front seat) dangerous for < 12 years



Injuries

- **Leading cause of death**
- Often predictable and preventable
- **Car injuries:** car seats and seat belts
- **Firearms (guns)**
 - Gun avoidance (most effective means of prevention)
 - Safe handling and storage of firearms
- **Bicycle Injuries**
 - Usually head injuries
 - Prevention with bicycle helmets



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SIDS

Sudden Infant Death Syndrome

- Sudden death of infant < 1 year of age
- Unexplained by other causes
- Risk factors
 - Stomach sleeping
 - Maternal smoking during/after pregnancy
 - Very young maternal age (< 20)
 - Bed sharing (infant/parent)



SIDS Prevention

- Smoking avoidance
- Sleeping prone or on side
- Firm sleep surface
- No extra blankets or pillows
- No bed sharing



BRUE

Brief Resolved Unexplained Event

- Sudden, brief episode of:
 - Cyanosis or pallor
 - Absent, decreased, or irregular breathing
 - Marked change in tone (hyper- or hypotonia)
 - Altered level of responsiveness
- Parents often concerned for SIDS
- No known association between low-risk BRUE SIDS

BRUE

Brief Resolved Unexplained Event

- Evaluation: **history and physical exam**
- Low risk features
 - Age > 60 days
 - Born at gestational age ≥ 32 weeks
 - Only 1 BRUE (no prior BRUE or clusters)
 - Duration of BRUE < 1 minute
 - No CPR required
 - No concerning historical features or physical examination findings
- If all low-risk features: **reassurance**
 - No further testing indicated
 - Remind parents of standard SIDS prevention

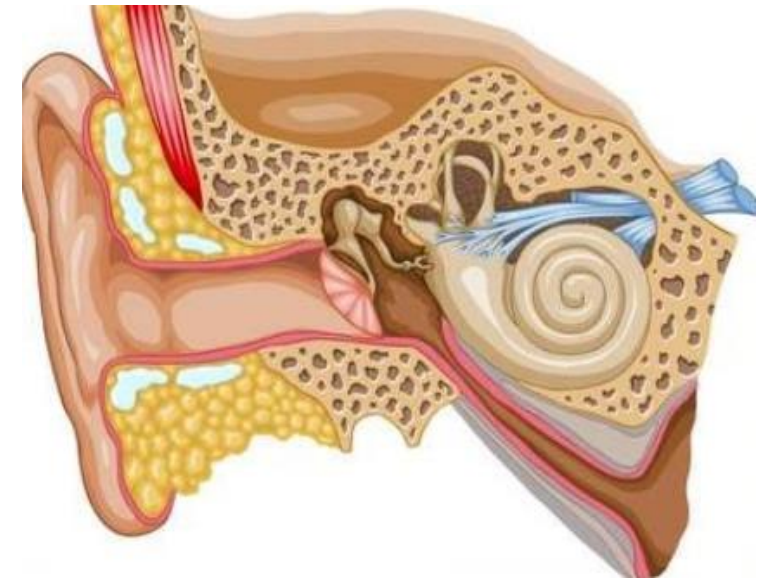
Ear Infections and Fever

Jason Ryan, MD, MPH



Otitis Media

- Acute infection of the **middle ear**
- Usually preceded by **viral upper respiratory tract infection**
- Inflammatory edema obstructs Eustachian tube drainage
- Upper respiratory tract bacteria enter middle ear
- Microbial growth occurs

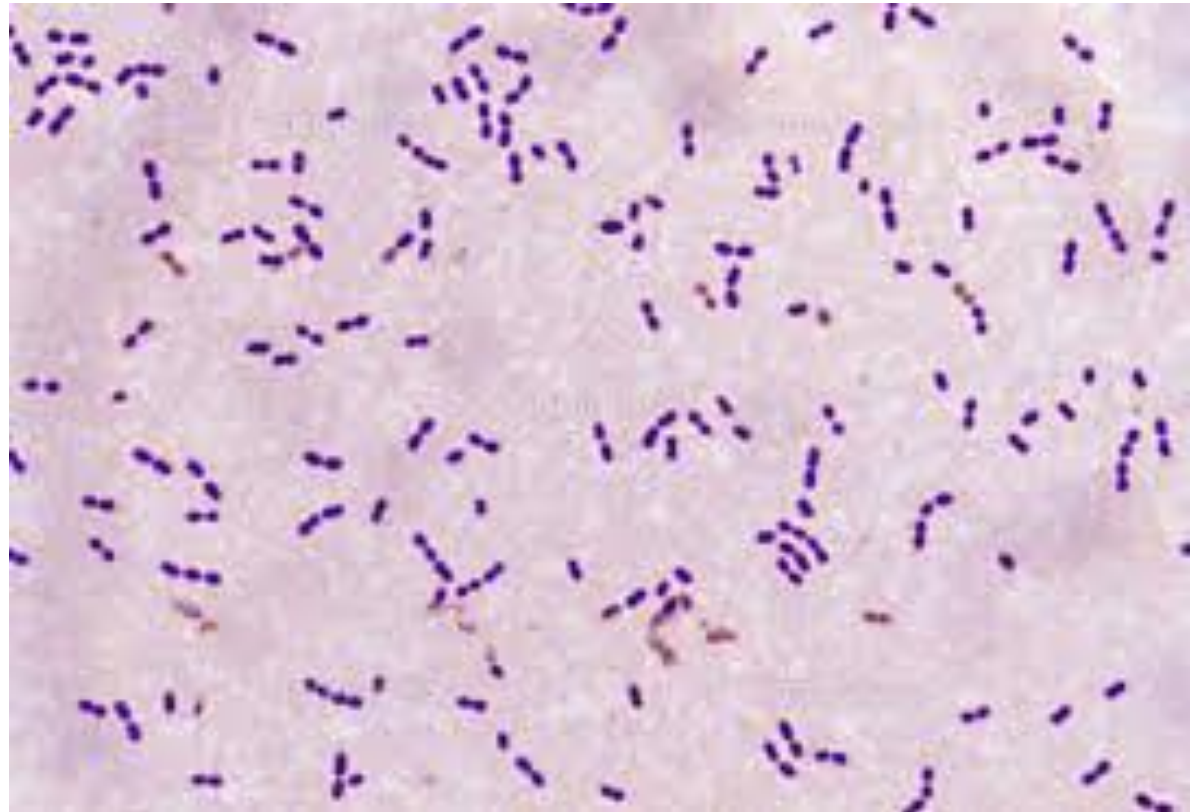


Otitis Media

Microbiology

- *S. pneumoniae*
- *H. influenzae* (non-typeable)
- *Moraxella catarrhalis*

Strep pneumoniae



Otitis Media

Clinical Features

- Most common complaint: **ear pain**
- Fever in up to two-thirds of cases
- Hearing loss
- Ear drainage



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Otitis Media

Diagnosis

- **Clinical diagnosis**
- Middle ear effusion PLUS signs of middle ear inflammation
 - Tympanic membrane erythema, fever, ear pain
 - If signs of inflammation are absent diagnosis is OME
- **Bulging of the tympanic membrane**
 - Most specific sign of acute inflammation



Michael Hawke MD/Wikipedia

Otitis Media

Treatment Indications

- All adults
- Children under 2 years old
- Children over 2 years old with certain features
 - Toxic appearance
 - Temperature > 102.2°F
 - More than 48 hours of ear pain
- Healthy children over 2 years old with mild symptoms may be observed

Otitis Media

Treatment

- First-line therapy: **amoxicillin**
- Amoxicillin-clavulanate in special cases
 - History of recurrent AOM
 - Recent treatment with a beta-lactam antibiotic
 - Covers H. influenza resistant to amoxicillin
- Surgical therapy in recurrent cases



Myringotomy

- Surgical incision of tympanic membrane
- Prevents negative pressure in Eustachian tube
- Allows drainage of fluid
- Allow topical antibiotics
- Perforations often close rapidly
- **Tympanostomy tubes**
 - Straight, narrow polyethylene tubes
 - Can remain in ear for months

Tympanostomy Tube



Public Domain

Otitis Media

Complications

- Tympanic membrane perforation
- Mastoiditis
 - Infection of mastoid process
- Labyrinthitis
 - Vertigo, nausea, vomiting
- Intracranial infection
- Conductive hearing loss

Mastoid Process of Temporal Bone



Mastoiditis

- Bacterial infection of **mastoid air cells**
- Found in mastoid bone (part of temporal bone)
- *S. pneumoniae*, *S. pyogenes*, and *S. aureus* (MRSA)
- Erythema, tenderness, and swelling
- Diagnosis: **clinical plus CT scan**
- Treatment: antibiotics
 - Vancomycin or linezolid (cover MRSA)
 - Other agents often added based on patient features
- Myringotomy +/- tympanostomy tube

Mastoiditis



B. Welleschik

Otitis Media with Effusion

Serous Otitis Media

- Middle ear serous effusion
- No evidence of infection
- Often develops after AOM
- Often asymptomatic
- Most common symptom: **hearing loss**
- Often resolves with observation
- Tympanostomy tubes used in some cases

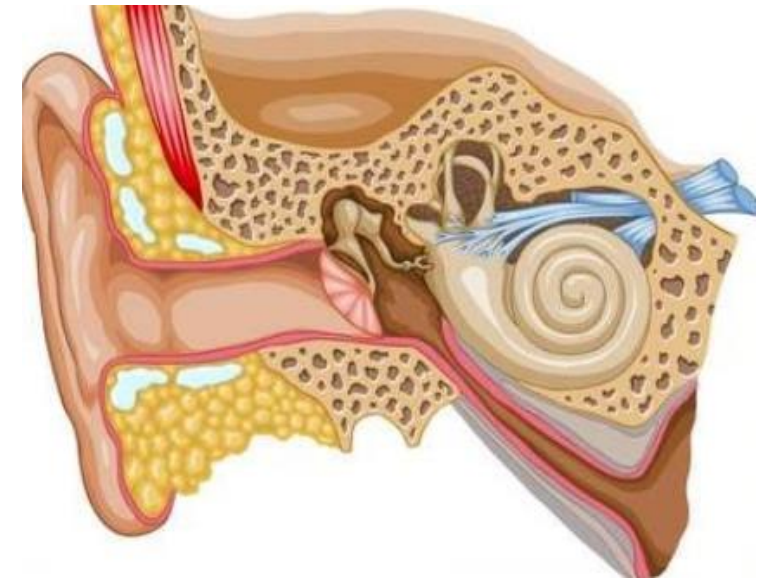


Otitis Media with Effusion
ENT Lecture Series
Youtube

Otitis Externa

Swimmer's Ear

- Infection and inflammation of external auditory canal
- Occurs in all age groups
- More common in summer among swimmers
- Ear pain with pruritus and discharge
- May cause hearing loss
- Most common bacteria
 - **P. aeruginosa (38%)**
 - S. epidermidis (9%)
 - S. aureus (8%)



Otitis Externa

Swimmer's Ear

- **Tenderness with ear tug**
- External ear canal edematous and erythematous
- May see white, patchy exudate
- Clinical diagnosis
- Treatment: **ear drops**
 - Antibiotics (ciprofloxacin/ofloxacin)
 - Steroids
 - Antiseptics: alcohol or acetic acid



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Wikipedia

FWS

Fever Without a Source

- Acute febrile illness (temp > 100.4°F)
- Previously healthy child
- Etiology not apparent based on H&P
- Common problem in pediatrics
- Management varies by age
- Under 90 days: high risk sepsis
- 3 months and older: lower risk

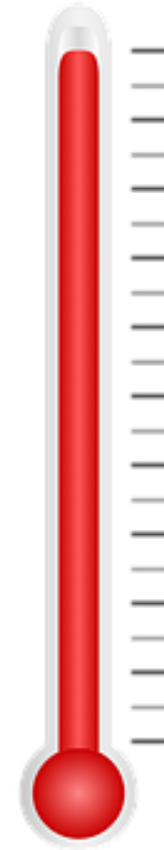


Shutterstock

FWS in Infants

Up to 90 Days of Age

- High risk of **sepsis or septic shock**
- Many possible underlying infections
 - Urinary tract infections
 - Bacteremia
 - Meningitis
 - Pneumonia
 - Septic arthritis
 - Osteomyelitis
- Approach varies by specific age group



FWS

Infants < 7 Days

- High risk of infant bacterial infection
- Must consider **neonatal sepsis** and **meningitis**
- Blood, urine and CSF cultures
- Treatment: empiric antibiotics
 - Usually ampicillin/gentamycin
 - Covers GBS, Listeria, Enterococcus, and most E. coli



Wikipedia/Public Domain

FWS

Infants 7 to 90 Days

- Work-up based on age
- Younger infants (< 60 days)
 - Full sepsis workup most cases
 - Hospitalization often necessary
 - Empiric antibiotics often used
- Older infants (60 to 90 days)
 - Limited workup in some cases
 - Inpatient or outpatient management

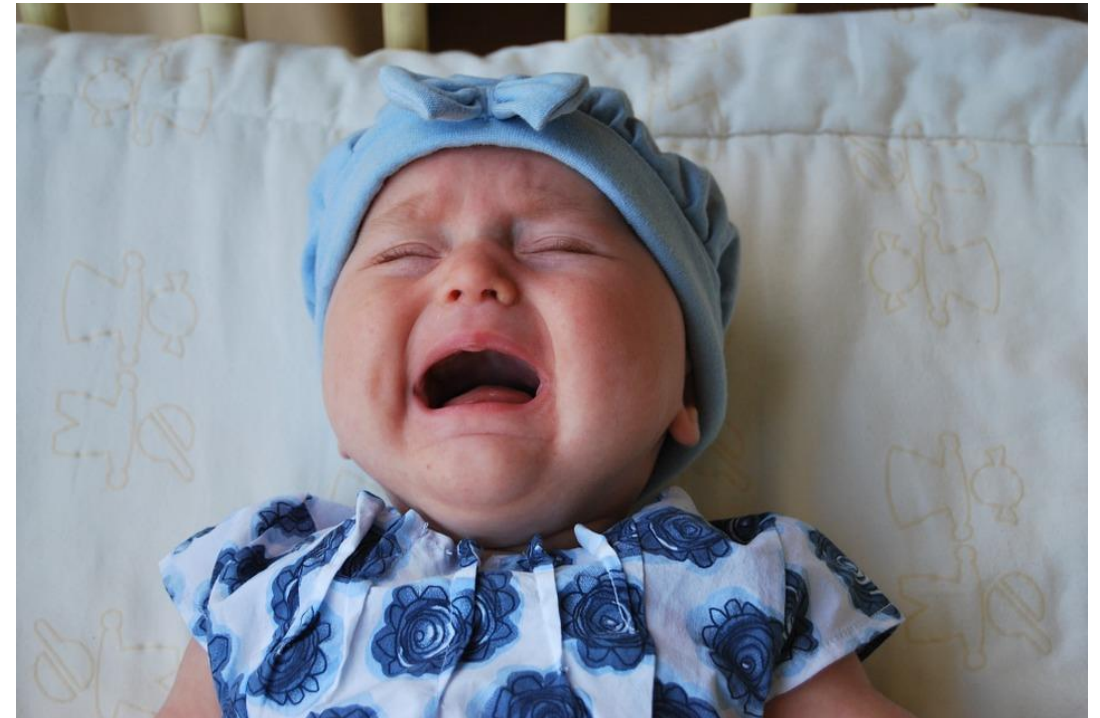


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FWS

Children 3 to 36 Months

- Management based on child appearance
- **Ill-appearing**
 - Weak cry
 - Constant cry
 - Falls to sleep or will not rouse
 - Pale, cyanotic, mottled or ashen skin
 - Dry mucous membranes
 - Sunken eyes
 - No smile
 - Anxious, dull, or expressionless face
- **Well-appearing**



Pixabay.com

FWS

Children 3 to 36 Months

- Most well-appearing children have **self-limited viral illness**
 - In many cases, can be monitored as outpatients without further testing
- Ill-appearing children may have **occult bacterial infections**
 - May require full work-up, hospitalization, empiric antibiotics



FUO

Fever of Unknown Origin

- Fever $> 101^{\circ}\text{F}$
- **At least eight days**
- No apparent diagnosis
- Broad differential
 - Unusual infections (mycobacterial, fungal)
 - Autoimmune disease (SLE, Kawasaki)
 - Malignancy
- Detailed history and physical
- Many additional tests possible



Wikipedia/Public Domain

Vaccination

Jason Ryan, MD, MPH



Types of Vaccines

- Toxoid vaccines
 - Chemically modified protein toxin
 - Cannot cause infection (non-toxic)
 - Elicits strong immune response
 - Tetanus, diphtheria
- Conjugate vaccines
 - Bacterial polysaccharide
 - Conjugated to protein (e.g., tetanus toxoid)
 - Hemophilus influenza type B



Public Domain

Types of Vaccines

- Killed (inactivated) viral vaccines
 - Virus killed (inactivated) by a chemical
 - Viral replication not possible
 - Polio, hepatitis A, influenza (shot), rabies
 - Can be used in immunocompromised
- Live, attenuated viral vaccines
 - Weakened viral vaccines
 - Replicate poorly inside the body
 - **MMR, varicella, rotavirus**
 - Others: oral polio, intranasal influenza
 - **Cannot be given to immunocompromised**
 - **Not used in pregnancy**

Rs are Alive

MMR

Varicella

Rotavirus

Types of Vaccines

- **Monovalent**
 - Protects against a single strain/pathogen
- **Polyvalent**
 - Protects against two or more strains/pathogens
 - Divalent
 - Trivalent
 - Quadrivalent



Public Domain

Childhood Vaccines

Contraindications and Precautions

- Contraindications
 - Prior severe allergic reaction to vaccine
- Precautions
 - Moderate to severe febrile illness



Shutterstock

Childhood Vaccines

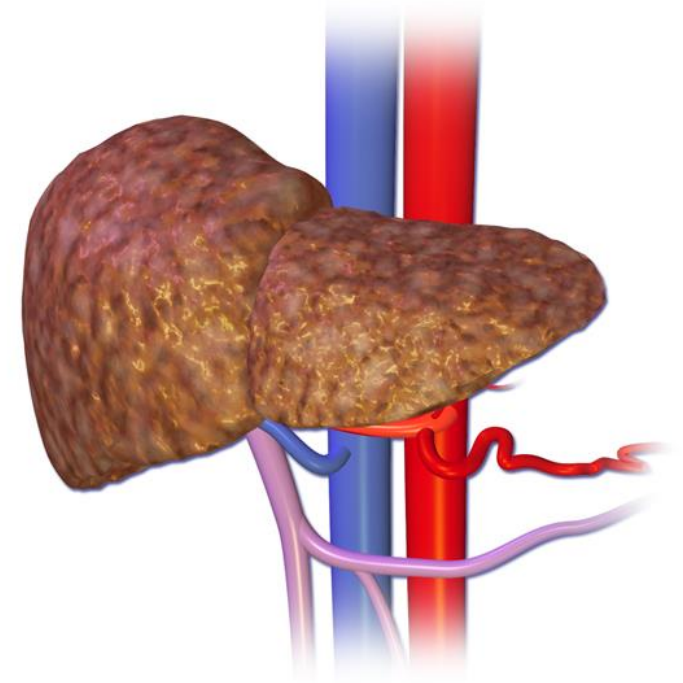
- Immunization before 6 weeks: weak response
- Magnitude of antibody response higher with older age at first dose
- Vaccines in babies require multiple doses to generate lasting response



	0M	1M	2M	4M	6M	9M	12M	15M	18M	2Y	2.5Y	3Y	4Y	5Y	7-10Y	11-12Y	13-18Y
Hep B	#1	#2			#3												
DTaP			#1	#2	#3			#4					#5				
Hib			#1	#2	#3		#4										
PCV13			#1	#2	#3		#4										
IPV			#1	#2	#3								#4				
Rota			#1	#2	*3												
MMR							#1						#2				
Varicella							#1						#2				
Hep A							#1		#2								
Influenza					Yearly Vaccination (2 doses at first ever)												
MenACWY																#1	#2 (@16)
MenB																*: 2 Dose Series	
HPV																#: 2 Dose Series	
Tdap																#1	
#= Normal recommended vax. *= Special Circumstances																	

Hepatitis B

- “Recombinant vaccine”
- Hepatitis B surface antigen (HBsAg)
- Produced through recombinant DNA in yeast cells
- Only vaccine given first 24 hours of life
- Infection can be passed mother to baby
- Newborn infection often leads to chronic disease
- Booster doses 1 month and 6 months
- Hepatitis **B** is for newborn **Babies**



Liver Cirrhosis

Hepatitis B

- If mother is known HepB +
 - **HBIG + HBV vaccine**



1-Year Vaccines

- Must wait until 12 months of age
 - Avoid neutralization by maternal antibodies (disappear by 6-9 months)
 - Earlier age for vaccination increases risk of vaccine failure
- **MVA vaccines**
- **M** measles, mumps and rubella (MMR)
- **V**aricella
- Hepatitis **A**

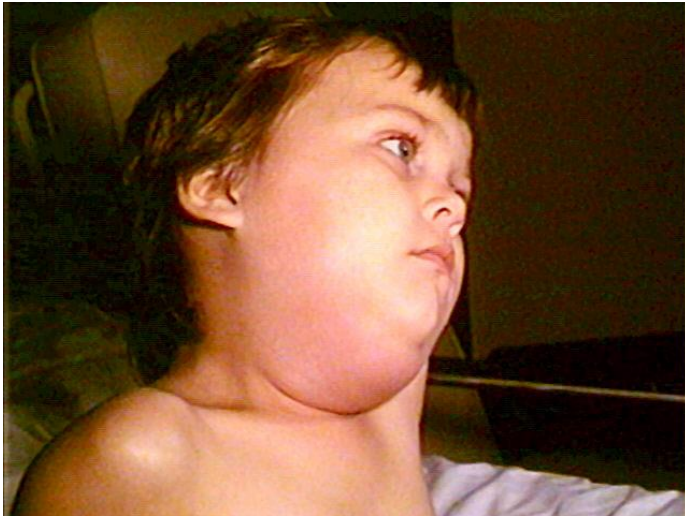
MVA1

MMR

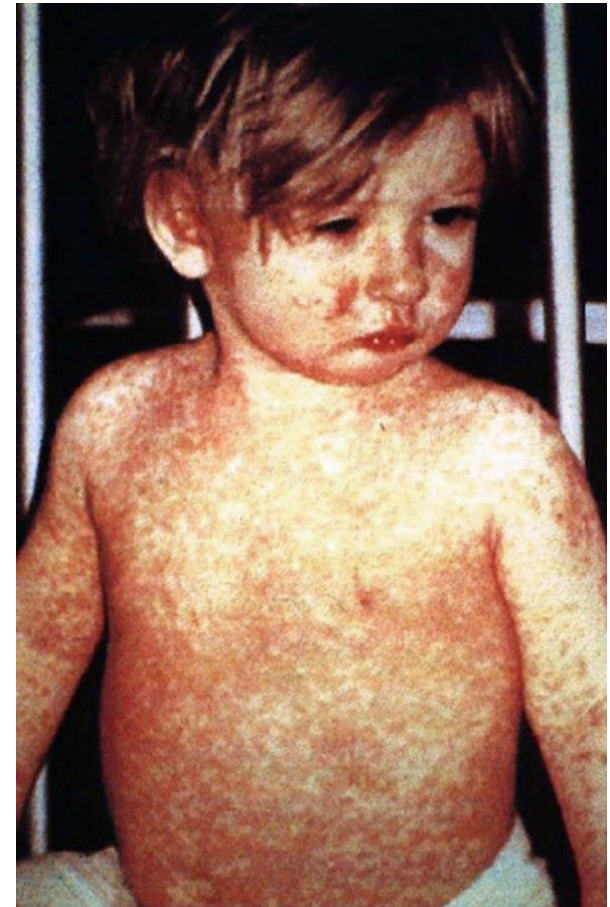
Measles, Mumps, Rubella

- Live, attenuated virus vaccine
- Combined to decrease number of shots

Mumps



Measles



Varicella

- Prevents chickenpox
- Live, attenuated virus vaccine
- May cause mild illness
- Licensed in 1995
- Given at 12 months and 4 years
- Post-exposure prophylaxis
 - Give vaccine

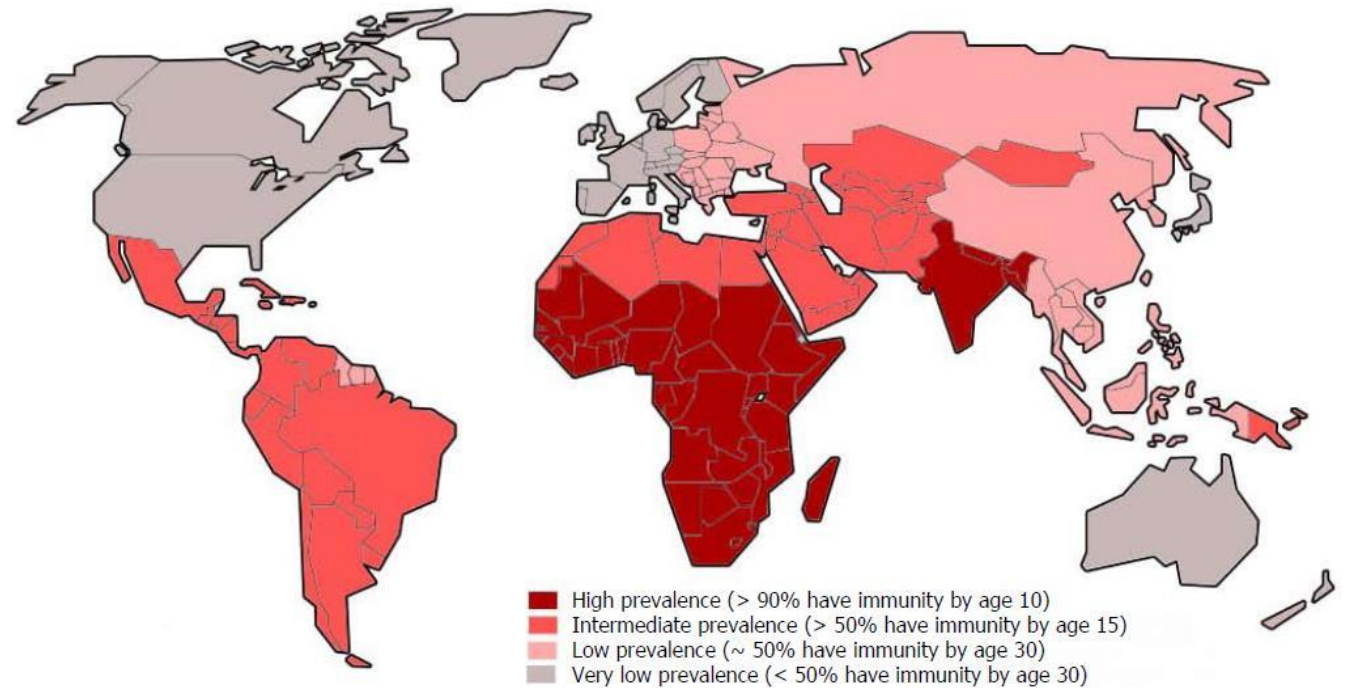
Chickenpox



Wikipedia/Public Domain

Hepatitis A

- Self-limited hepatitis: symptoms resolve < 6 months
- Inactivated hepatitis A vaccine (most formulations)
- More common outside US



Source: Jacobsen KH. Globalization and the Changing Epidemiology of Hepatitis A Virus. Cold Spring Harb Perspect Med 2018 Mar 2 PMID: 29500305

Prevalence of hepatitis A

2-4-6 Month Vaccines

- DTaP
- Hib
- Pneumonia (PCV13)
- Polio (IPV)
- Rotavirus
- All given at 2, 4 and 6 months
- Most require a booster dose later



DTaP Vaccine

Diphtheria, Tetanus, and Acellular Pertussis

- Combined to decrease number of shots
- **Corynebacterium diphtheriae**
 - Pharyngitis with great-white membrane
 - Systemic disease can cause cardiomyopathy
 - Toxoid vaccine
- **Clostridium tetani**
 - Blocks inhibitory neurons
 - Muscle spasms
 - Trismus (lockjaw)
 - Toxoid vaccine

Diphtheria



DTaP Vaccine

Diphtheria, Tetanus, and Acellular Pertussis

- **Bordetella pertussis**
 - Causes whooping cough
- Initial vaccines (1900s): killed whole-cell *B. pertussis*
 - Often caused fever, drowsiness, and anorexia
 - Rare cases of encephalopathy
- Acellular vaccines (1990s)
 - Purified bacterial components and inactivated toxin
 - Fewer side effects
- Special contraindication: **encephalopathy**
 - Rare cases of pertussis vaccine encephalopathy
 - Occurs within 7 days
 - Should not receive additional doses of pertussis vaccines

Whooping Cough



Wikipedia/Public Domain

Hib Vaccine

- **Haemophilus influenzae serotype b (Hib)**
- Bacterial meningitis and pneumonia
- **Epiglottitis**
 - Fever, sore throat, stridor
- Conjugate vaccine
 - Hib capsular polysaccharide with protein carrier
 - Either tetanus toxoid or N. meningitidis protein complex

Hib Chocolate Agar



Wikipedia/Public Domain

PCV13 Vaccine

- **Streptococcus pneumoniae**
- Causes pneumonia, meningitis, bacteremia and otitis media
- Conjugate vaccine
 - Polysaccharides from 13 serotypes
 - Conjugated to diphtheria toxoid
- Adult vaccine: PPSV23
 - Contains 23 pneumococcal polysaccharides
 - Does not elicit immune response in children under 2
- Asplenia: both vaccines administered

Pneumonia



IPV Vaccine

- Polio virus vaccine
- Prevents poliomyelitis
- **IPV = inactivated polio vaccine (Salk vaccine)**
 - Inactivation of wild type poliovirus strains
 - Virus treated with formalin
 - Viral proteins remain as antigens
- OPV = oral polio vaccine (Sabin vaccine)
 - Used in developing countries
 - Live attenuated virus
 - Virus grown in cells causing mutations
 - Rarely causes vaccine-associated paralytic poliomyelitis (VAPP)

Child with Polio



Boston Children's Hospital Archive

Rotavirus Vaccine

- Causes gastroenteritis
- Live, attenuated viral vaccine
- Oral vaccines: drops in child's mouth
- Introduced 2006
- Contraindicated with **history of intussusception**
 - Fatal intussusception after second dose reported
 - Occurred in infants with intussusception after first dose



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Influenza Vaccine

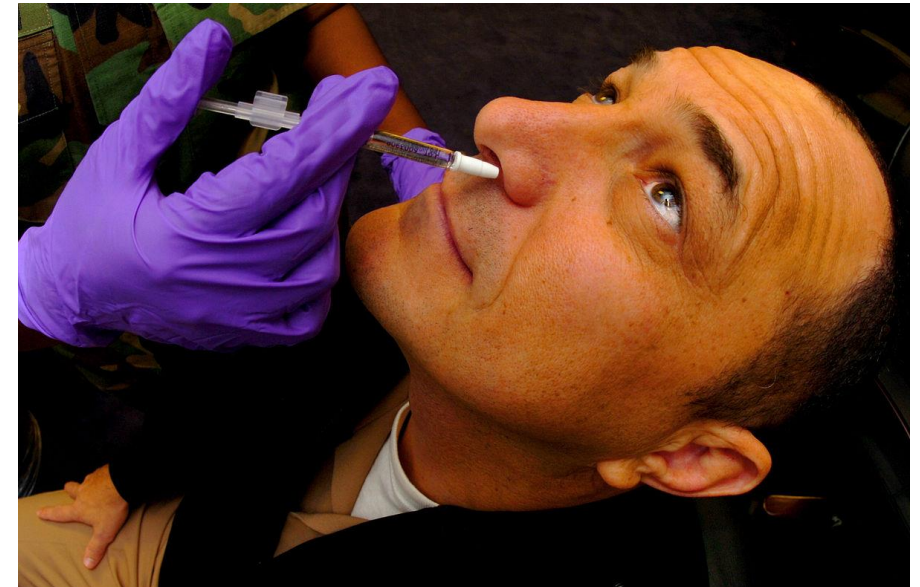
- Influenza A and B viruses
- Quadrivalent
 - Two strains of influenza A and two strains of influenza B
- Updated each year with new strains
 - Contain strains expected in flu season (fall/winter)
- **Given annually to children ≥ 6 months old**
 - Vaccine Influenza = **VI** months



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Influenza Vaccine

- **Inactivated influenza vaccines (IIV)**
 - Intramuscular injection
 - Only contraindication: prior severe allergic reaction to vaccine
- Live attenuated influenza vaccine (LAIV)
 - Licensed in 2012
 - Administered intranasally
 - Must be healthy and nonpregnant
 - Only ages 2 through 49
 - No thimerosal
 - May contain residual amounts of egg protein



Public Domain

Influenza Vaccine

Cautions

- **Sensitivity to thimerosal**
 - Preservative used in multi-dose vials
 - Can use single-dose vials without thimerosal



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Eggs

- Most flu vaccines manufactured using eggs
- Contain small amounts of egg protein ovalbumin
- Amount of egg proteins very low in modern vaccines
- Studies indicate severe allergic reactions unlikely
- Patients with allergies **can receive influenza vaccine**
- No need for skin testing or special observation
- No need to screen for egg allergies



Wallpaperflare

Meningitis Vaccines

- **Neisseria meningitidis**
- Polysaccharide vaccines with toxoid
- **MenACWY**
 - Quadrivalent vaccine: types A, C, W, and Y
- Infection requires throat colonization
- Does not occur until adolescence
- All patients **11 to 18 years old**
- Others at increased risk for invasive meningococcal disease
- **Neisseria** = **11** years old



Public Domain

Meningitis Vaccines

- **MenB**
 - Monovalent vaccine against type B
 - Newer vaccine
- **≥ 10 years old at increased risk**
 - Complement component deficiencies
 - Anatomic or functional asplenia
 - Exposed to an outbreak

HPV Vaccine

- HPV types 16 and 18
 - 70 percent of cervical cancers worldwide
 - 90 percent of anal cancers
- HPV types 6 and 11
 - Anogenital warts
- 9-valent vaccine available since 2016 in US
 - Types 6, 11, 16, 18, 31, 33, 45, 52, and 58
- ACIP Guidelines
 - **Ages 11 to 12 years**
 - Females (1A) and males (1B)

HPV

Cervical intraepithelial neoplasia



Lee, Makin, Mtengezo, and Malata

HPV Vaccine

- **If start before 15 years**
 - Two doses
 - Zero
 - 6 to 12 months
- **If start 15 or later**
 - Three doses
 - Zero
 - Two months
 - Six months

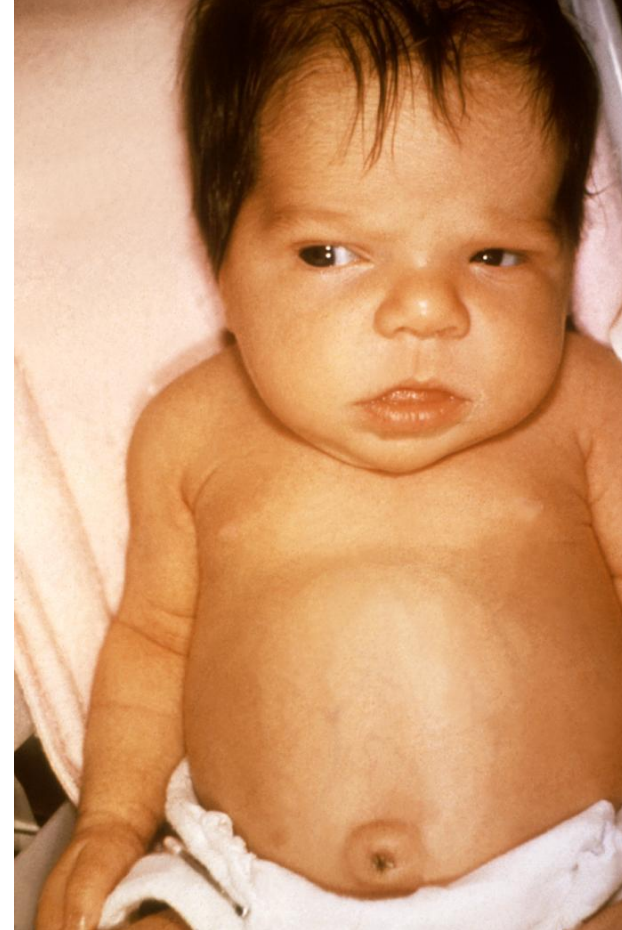
Tdap

Tetanus, Diphtheria and Pertussis

- Different from DTaP
 - Contains Td not DT
 - Td = tetanus toxoid with reduced diphtheria toxoid
 - Used as a booster
- Given at age 11 as booster
- Puncture wounds after age 11
 - **Td** given as booster immunization
 - If more than 10 years since last tetanus immunization

Premature or Low Birth Weight Babies

- Do not delay or dose adjust vaccinations
- Immunize according to **chronologic age**
 - Normal schedule
 - One exception: first dose HepB
 - HepB at hospital discharge or 30 days of age
 - Whichever earlier



Wikipedia/Public Domain

Pediatric Rashes

Jason Ryan, MD, MPH



Impetigo

- Superficial bacterial skin infection
- Macules → papules → rupture → erosions
- “Honey-colored” crust
- Highly contagious



CNX OpenStax/Wikipedia

Impetigo

Impetigo contagiosa (non-bullous)

- Traditional, most common form
- Face and extremities
- Caused by *S. aureus*
 - Also “Beta-hemolytic step” – mostly *S. Pyogenes*
- Treatment: **antibiotics**
 - Limited: topical antibiotics (Mupirocin)
 - Extensive: dicloxacillin or cephalexin
- Return to school 24 hours after starting treatment



CNX OpenStax/Wikipedia

Impetigo

Other Forms

- Bullous impetigo
 - Trunk commonly involved
 - *S. aureus*
- Ecthyma
 - Crusted sores with ulcers

Bullae



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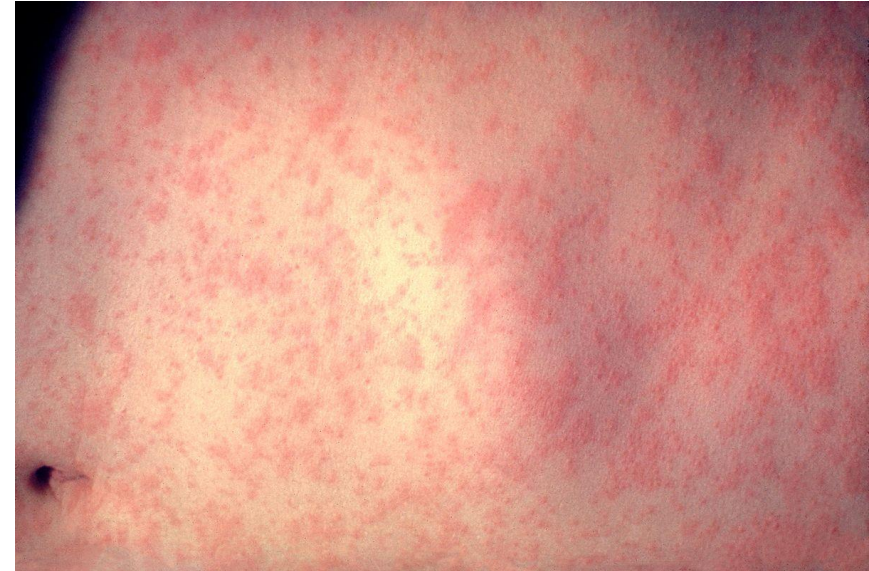
Ecthyma



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Morbilliform Rash

- Resembles measles
- Diffuse maculopapular rash
 - Macule: flat skin lesion ≤ 1 cm
 - Papule: raised bump ≤ 1 cm
- Adults: usually drug reaction
- Children: usually viral infection
 - Roseola
 - Measles
 - Rubella



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Roseola Infantum

- **Five days of high fever**
- May develop febrile seizures
- Fever breaks → rash develops
- Child feels well with rash
- Parents may worry child has measles
 - In measles: sick during rash
- Benign, self-limited
- No longer contagious when afebrile 24hrs



Shutterstock

Measles

Rubeola

- RNA viral infection
- Highly contagious – respiratory/airborne spread
- Incubation: 6 to 21 days after exposure
- Prodrome: 2 days to 1 week
 - Fever (may be as high as 104°F)
 - 3C's: Cough, Coryza, Conjunctivitis
 - Koplik spots: small, white lesions in mouth
- Koplik spots precede exanthem



Measles

Rubeola

- Exanthem: days after fever onset
- Classic maculopapular rash
- Starts at head → spreads to feet



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Measles

Complications

- Diarrhea (most common complication)
- Otitis media: 5 to 10 percent of cases
- Pneumonia
 - Most common cause of death in children
- Measles encephalitis
- Acute disseminated encephalomyelitis
 - Demyelinating disease triggered by infection
- Subacute sclerosing panencephalitis (SSPE)
 - YEARS after infection
 - Personality changes, odd behavior, dementia

Viral Pneumonia



Measles

Outbreaks

- 2014 outbreaks in U.S. among **unvaccinated children**
- Can spread to vaccinated children
 - Vaccine 95% effective
- Test of choice:
 - Measles IgM
 - Not positive first few days of infection
- Treatment: mostly supportive
- **Vitamin A**
 - Deficiency prolongs infection
 - Virus may cause deficiency
- Ribavirin: weak evidence of benefit

Rubella

German measles; 3-day measles

- Also acquired by inhalation of respiratory droplets
- **Mild, low-grade fever**
- Maculopapular rash (1-5 days after fever)
 - Starts on face, spreads to trunk and extremities
- **Characteristic lymphadenopathy**
 - Posterior cervical
 - Posterior auricular
- No cough, coryza, conjunctivitis or Koplik spots
- No specific treatment
- Causes congenital rubella syndrome



Scarlet Fever

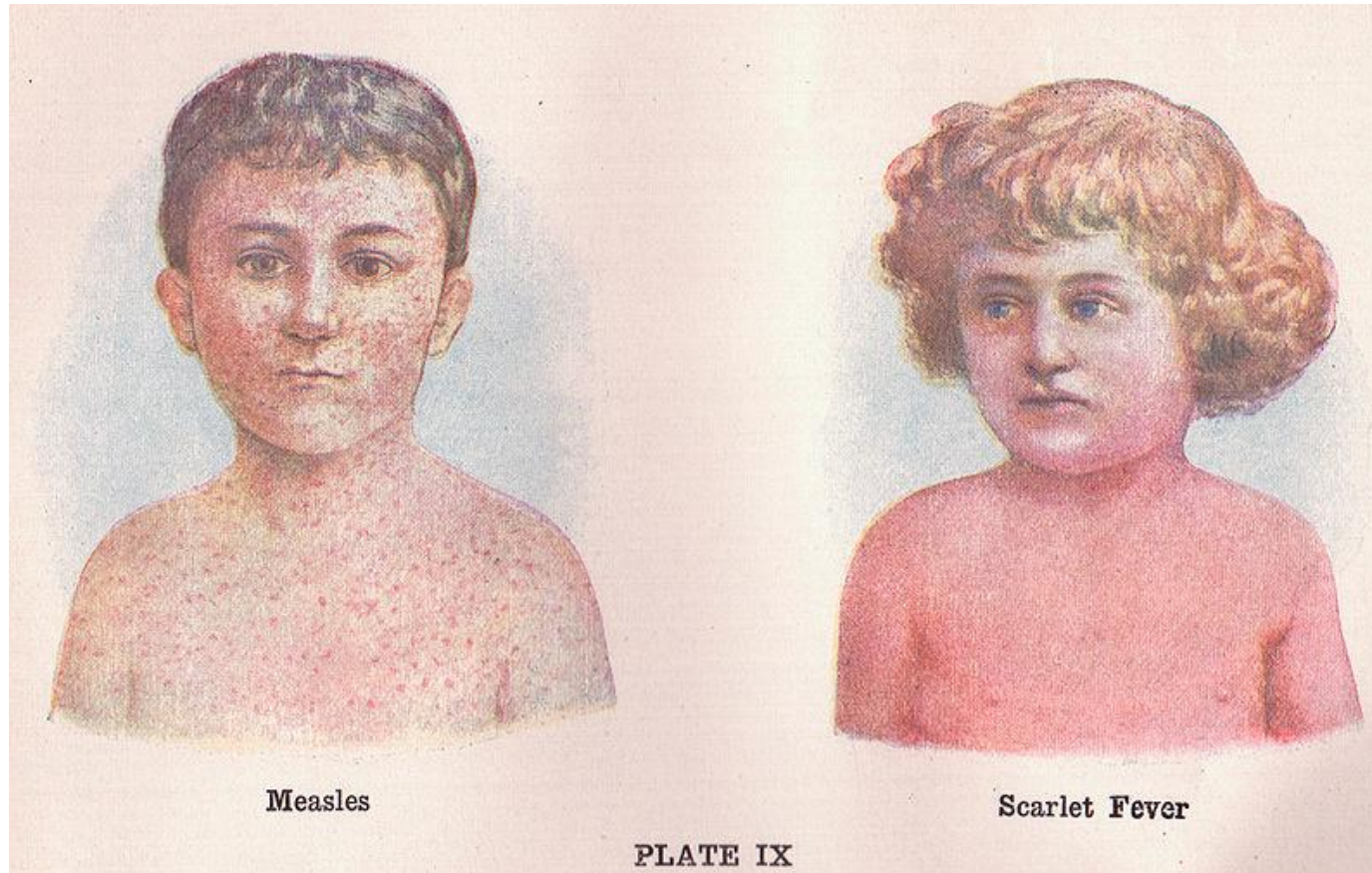
- Rash following **pharyngitis**
- Skin reaction to *S. pyogenes* erythrogenic toxin
- Fever, sore throat, diffuse red rash
- Many small papules (“sandpaper” skin)
- Starts head/neck → expands to cover trunk
- Classic finding: **strawberry tongue**
- Eventually skin desquamates
- Palms and soles are usually spared

Strawberry Tongue



Image courtesy of Afag Azizova/Wikipedia

Scarlet Fever



Parvovirus

- Single-stranded DNA virus
- B19 is predominant parvovirus in humans
- Four important syndromes
 - Fifth disease in children
 - Arthritis in adults
 - Aplastic crisis in sickle cell anemia
 - Hydrops fetalis

Fifth Disease

Erythema infectiosum; slapped cheek disease

- Mild fever and rash in children
- Outbreaks among school aged children
- Fever, runny nose
- Followed by rash (few days later)
- Cheeks look like they have been slapped
- Face rash often followed later by rash on trunk/limbs
- Self-limited: no diagnostic test or treatment
- Adults may catch this: mild arthralgia/arthritis



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Contact Dermatitis

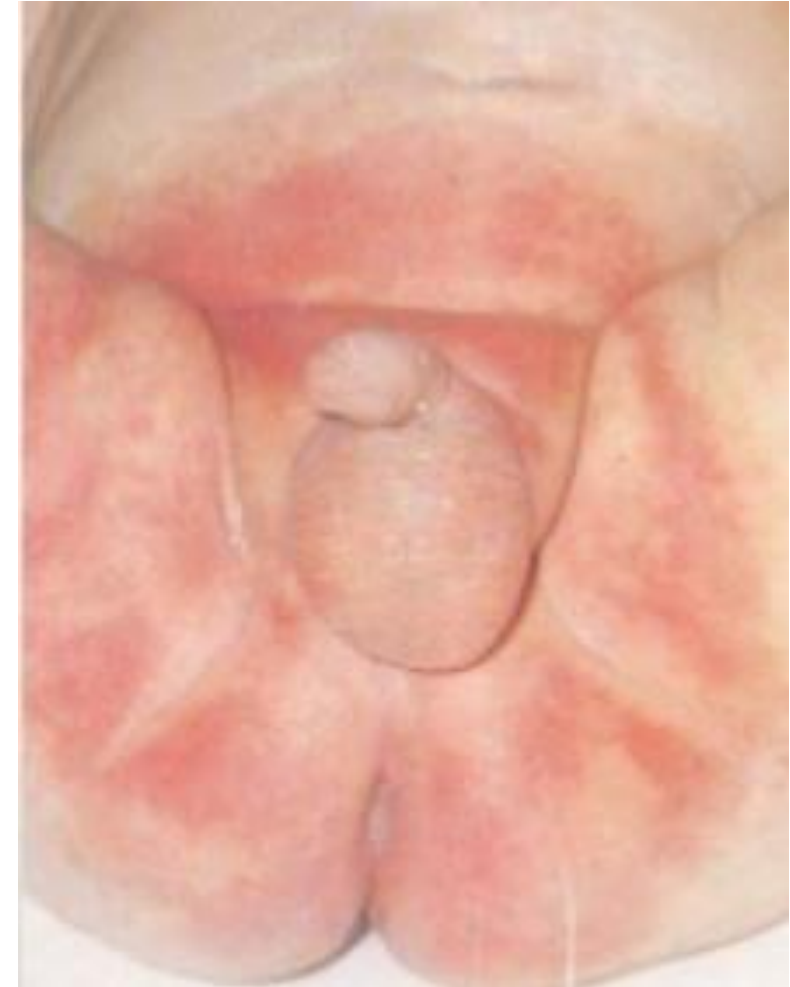
- Type IV hypersensitivity reaction
- Many possible allergens:
 - Poison ivy or oak
 - Iodine
 - Rubber
 - Nickel or other metals
- Erythematous papules and vesicles
- Oozing may occur
- Severe pruritus
- Treatment: topical or oral corticosteroids

Contact Dermatitis



Diaper Rash

- Most common skin rash infants
- Usually form of **contact dermatitis**
- Moist environment irritates skin
- Erythematous patches
- **Spare inguinal creases**
- Diagnosis: clinical
- Treatment:
 - Maintain clean skin
 - Topical barriers/ointments



Kezha Zutso /slideshare

Candida

- Beefy red plaques
- Satellite papules
- Commonly **involve the skin folds**
- Diagnosis: clinical or KOH prep



USMLEpathslides/Tumblr

Molluscum Contagiosum

- Molluscum contagiosum virus (MCV)
- Highly contagious
- Transmitted skin to skin
- Firm, dome shaped papules
- Central umbilication/indentation
- Resolves over weeks/months
- Treatment (optional):
 - Cryotherapy
 - Curettage
 - Cantharidin (topical agent)



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Chickenpox

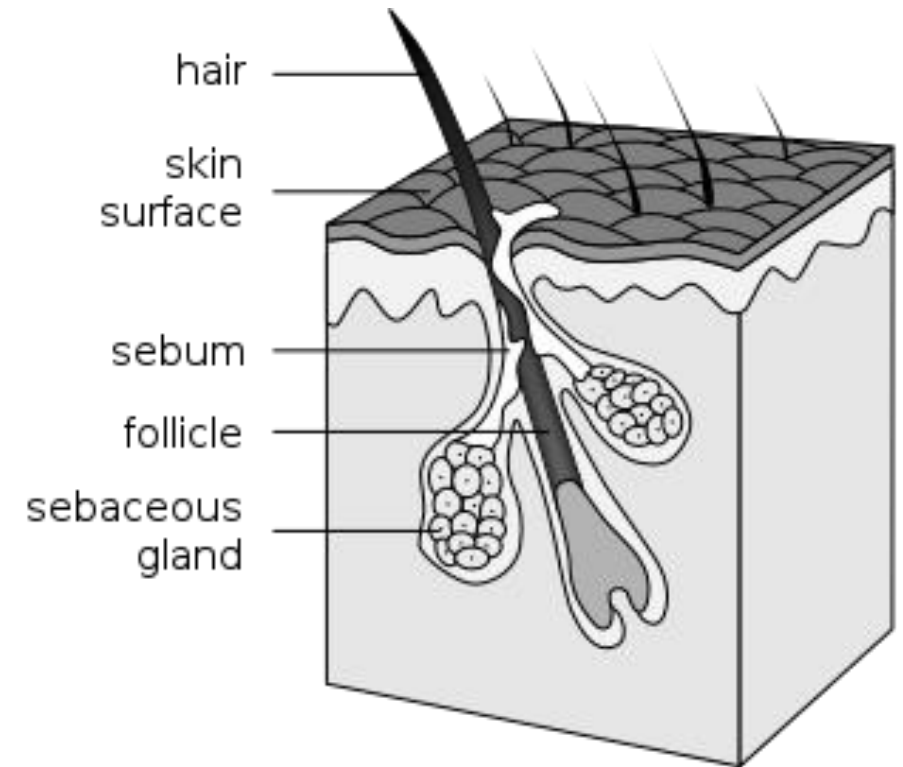
- Primary varicella zoster infection
- Prodrome: fever, malaise, or pharyngitis
- Generalized vesicular rash within 24 hours
- Pruritic
- Macules (flat) → papules (raised) → vesicles (fluid)
- Lesions can develop pus → crusted papules
- Lesions in different stages
- Treatment: valacyclovir or acyclovir
- No longer contagious when lesions crusted



Wikipedia/Public Domain

Acne

- Inflammation of **hair follicles and sebaceous glands**
 - Exocrine glands in skin in dermis
 - Secrete oily substance called sebum
 - Often contain hair follicles (“Pilosebaceous unit”)
- Complex, multifactorial etiology



Acne

- Sebaceous glands enlarge at **puberty**
 - **↑ androgens** → ↑ sebum
 - Adolescent acne: boys > girls
 - Men with androgen insensitivity: no acne
 - Women with excess androgens (PCOS): acne
- Increased **sebum and keratin**
 - Keratinocytes line hair shafts → keratin
 - Blocks ducts
 - Bacterial growth behind blockage

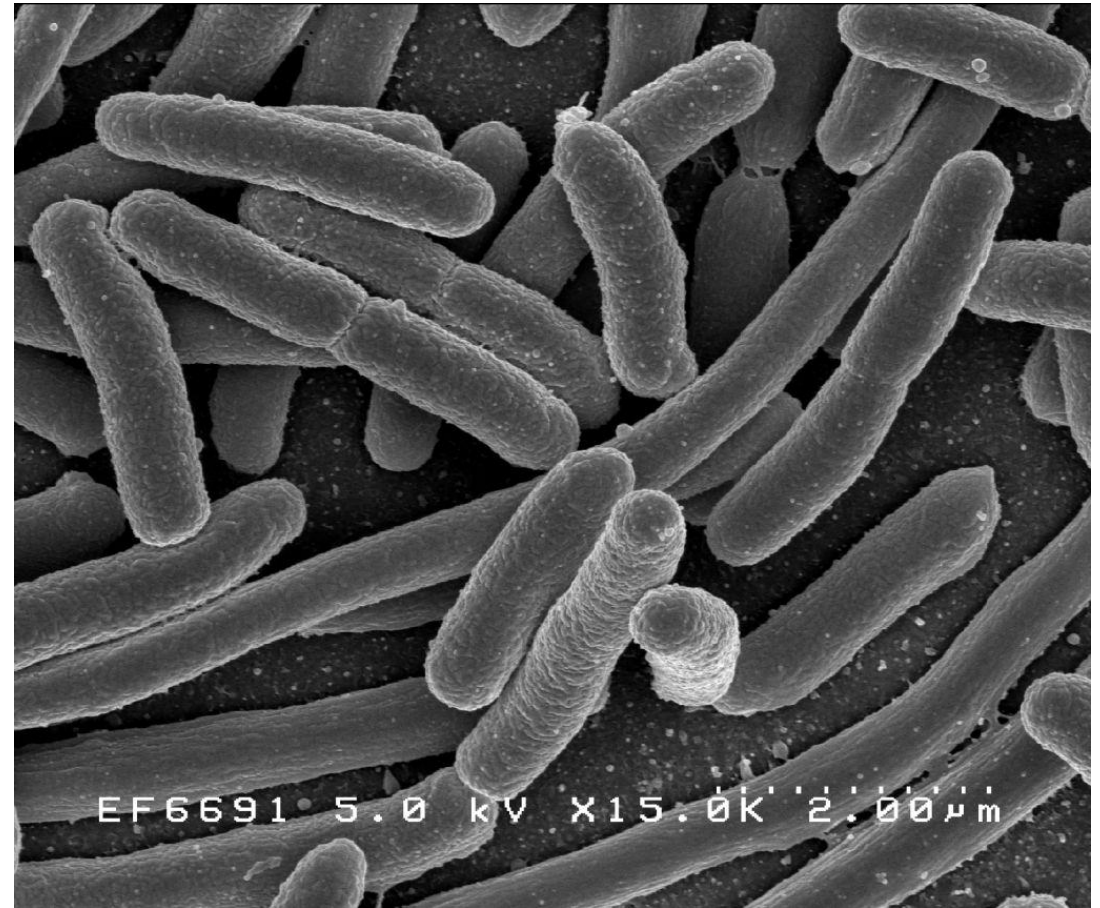


Dtresh71/Public Domain

Acne

- Sebum: growth medium for bacteria
- ***Propionibacterium acnes***
 - *Cutibacterium acnes*
- Anaerobic bacterium
- Normal skin flora

Propionibacterium acnes



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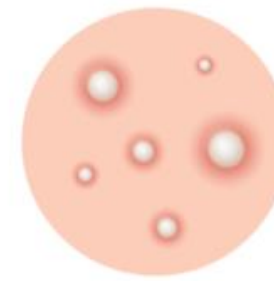
Acne

- **Comedones:** small, flesh-colored papules
 - Clogged pores
 - Open comedones: blackheads
 - Closed comedones (by skin): whiteheads
 - Inflammatory lesions (papules/pustules)
- Scarring and hyperpigmentation may occur

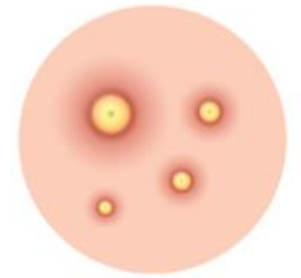
ACNE TYPES



BLACKHEAD



WHITEHEAD



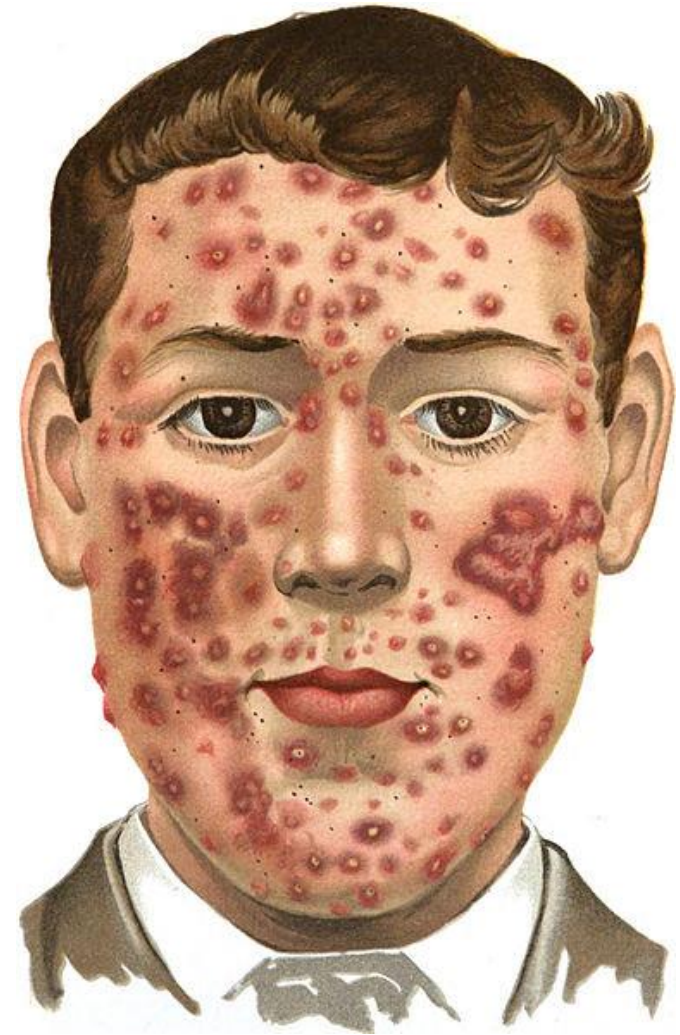
PUSTULE

Acne

- Affects most hormone-responsive glands
 - **Face**, neck, chest, upper back



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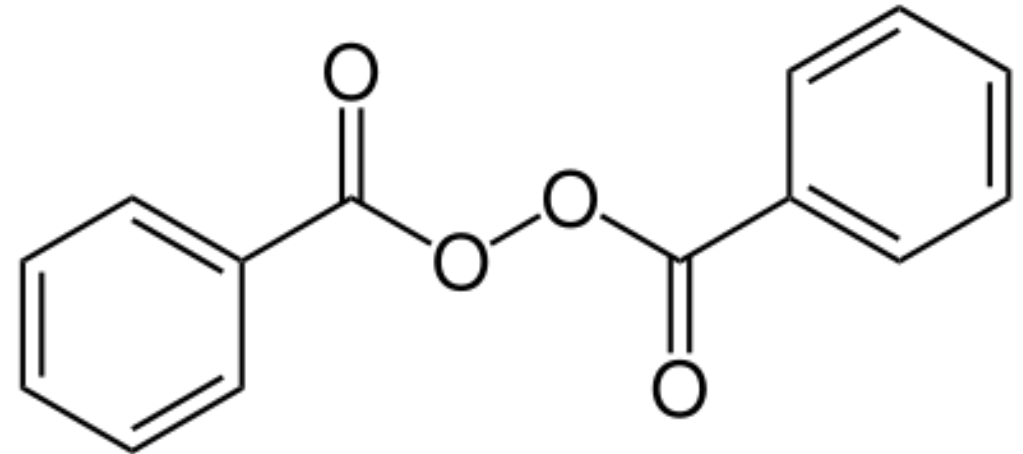


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Acne

Treatment

- Benzoyl peroxide (topical)
 - Breakdown keratin, unblocks pores (comedolytic)
 - Bactericidal to *P. acnes*
- Antibiotics
 - Decrease *P. acnes* colonization of skin
 - Clindamycin and erythromycin
- Oral contraceptive pills
 - Progestins: antiandrogen effects
- Retinoids (vitamin A derivatives)



Benzoyl Peroxide

Isotretinoin

Accutane

- 13-*cis*-retinoic acid
- **Decreases keratin production** in follicles
- Less follicular occlusion
- Highly ***teratogenic***
- OCP and/or pregnancy test prior to use
- Topical or oral forms

Before Isotretinoin



After Isotretinoin

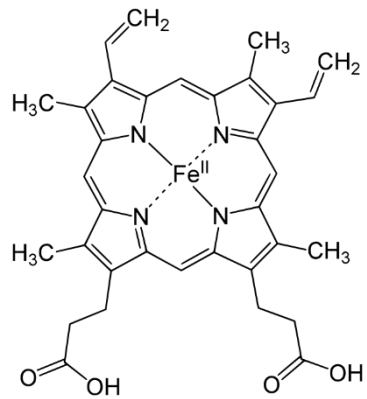


Newborn Hyperbilirubinemia

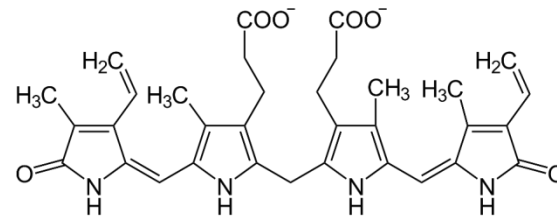
Jason Ryan, MD, MPH



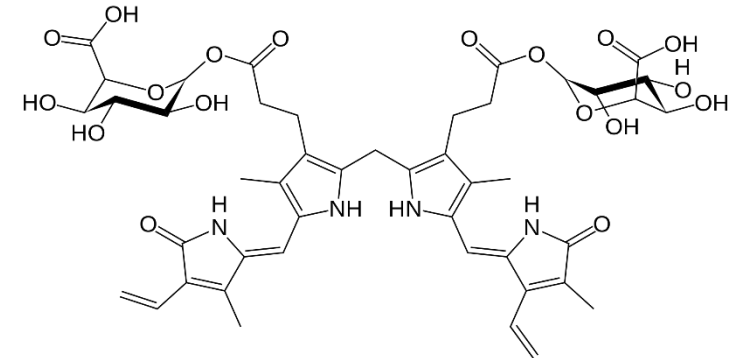
Bilirubin Metabolism



Heme



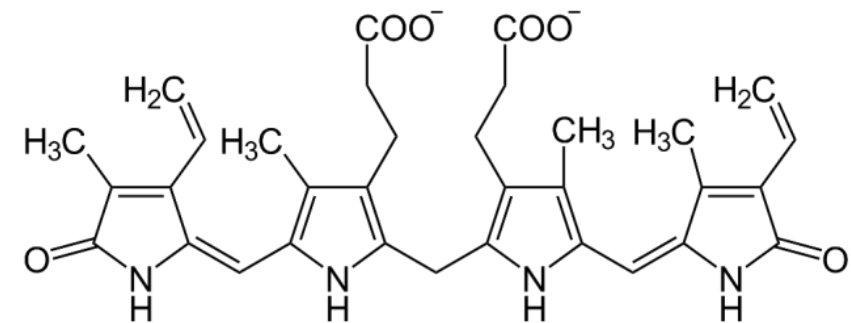
Unconjugated Bilirubin
(Indirect Bilirubin)



Conjugated Bilirubin
(Direct Bilirubin)

Neonatal Bilirubin

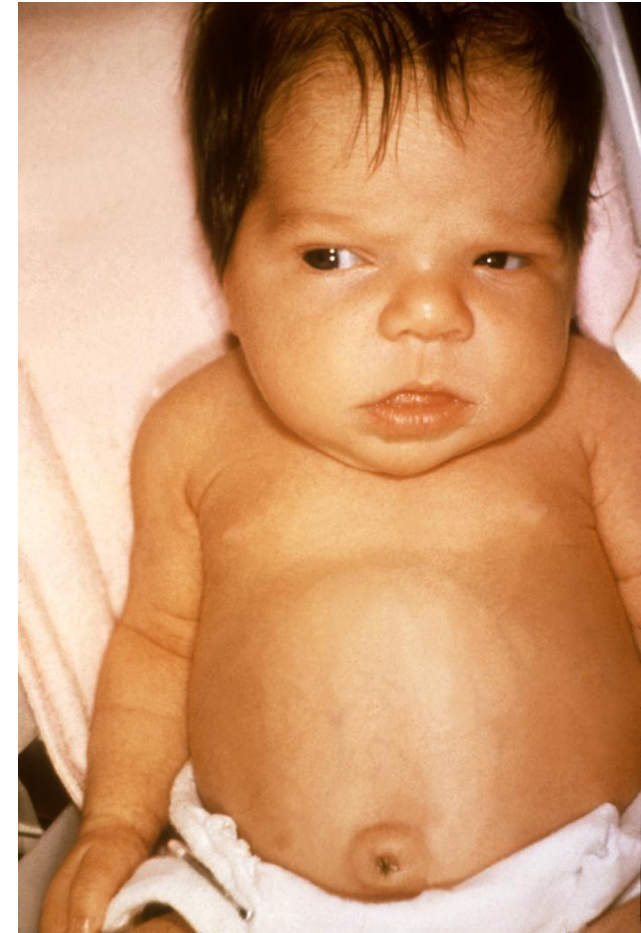
- Most newborns: **unconjugated (indirect) hyperbilirubinemia**
 - Fetal red cells have short lifespan
 - ↑ turnover of fetal red cells
 - Immature liver (↓ metabolism)
 - Low levels intestinal flora
- Levels peak 2 – 4 days after birth
- Normal adult total bilirubin < 1.0 mg/dL
- Normal infant peak ~ 8 mg/dL



Unconjugated Bilirubin
(Indirect Bilirubin)

Indirect Hyperbilirubinemia

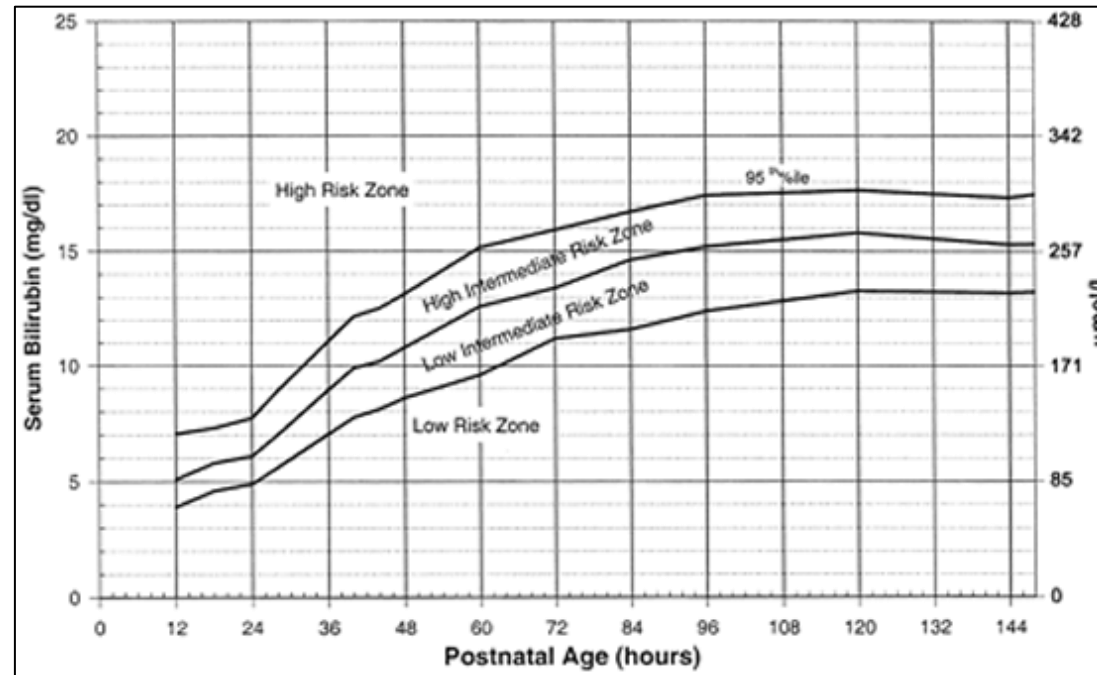
- Commonly causes **neonatal jaundice**
- Jaundice usually develops > 2 to 3 mg/dL
- Jaundice below umbilicus or icterus
 - Signs of markedly increased bilirubin
- Bilirubin measurement
 - Bilirubinometer (shines light on skin)
 - Blood test
- Neurologic damage: bilirubin level $> 25 \text{ mg/dl}$



Wikipedia/Public Domain

Bhutani Nomogram

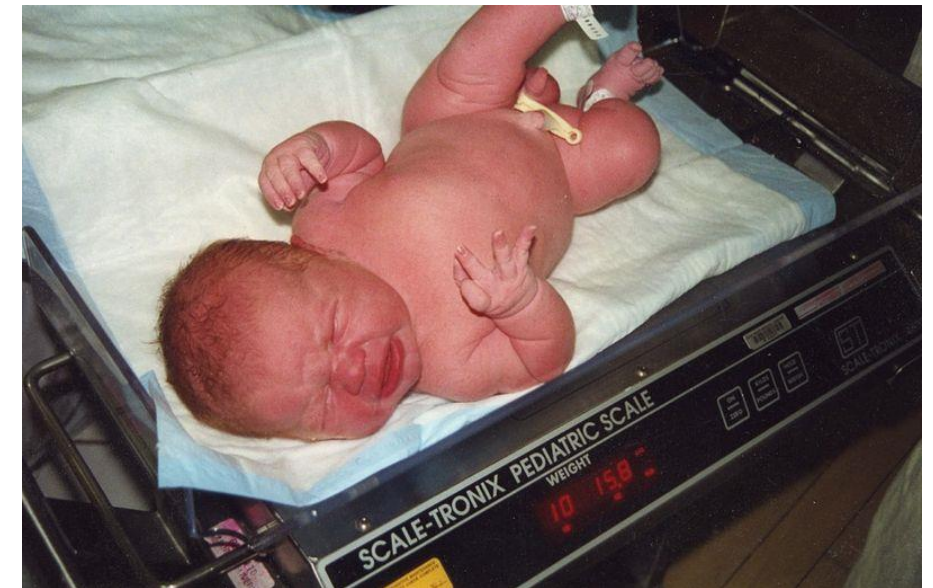
- Used to identify infants at risk of severe hyperbilirubinemia
- Interventions and follow-up testing based on risk zone



BIND

Bilirubin-Induced Neurologic Dysfunction

- Unconjugated bilirubin soluble in fats
- Crosses blood-brain barrier
- Acts as a neurotoxin
 - Basal ganglia; brain stem nuclei
- Bilirubin level $> 25\text{mg/dl}$
- Initially causes lethargy and hypotonia
- Untreated:
 - Coma and seizures
 - Opisthotonos/retrocollis

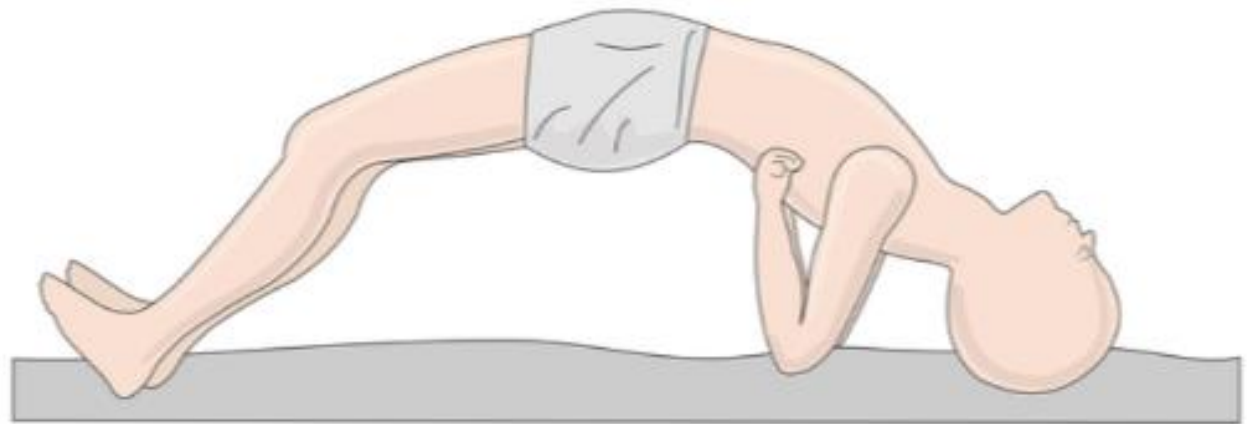


Andwhatsnext/Wikipedia

Opisthotonos and Retrocollis

- Opisthotonos
 - Spasm of back
 - Head and legs bend backward
 - Trunk arches forward
- Retrocollis
 - Backward arching of neck

Opisthotonos



Kernicterus

Chronic bilirubin encephalopathy (CBE)

- **Permanent** neurologic damage from hyperbilirubinemia
- Cerebral palsy
- Hearing loss
- Gaze abnormalities
- Dental hypoplasia

Indirect Hyperbilirubinemia

Treatment

- **Phototherapy**
- Exposes skin to light of specific wavelength
- Converts bilirubin to lumirubin
 - Isomerization (same chemical formula; different structure)
 - More water soluble
 - Allows excretion without conjugation



Indirect Hyperbilirubinemia

Causes

- Physiologic
- Breast milk jaundice
- Breast feeding jaundice
- Hemolysis
- Rare causes

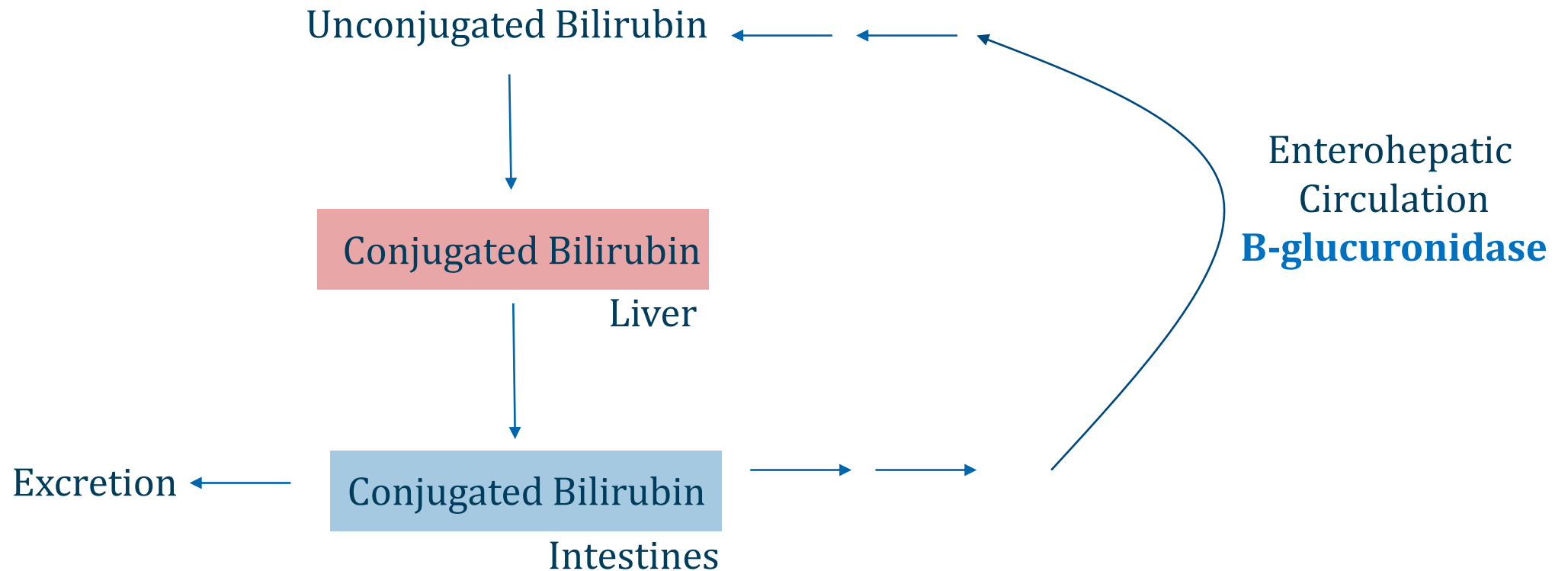
Breast Milk Jaundice

- Persistence of benign neonatal hyperbilirubinemia
- Occurs in breast-fed babies
- **Beta-glucuronidase** in breast milk
- Increase in GI absorption of unconjugated bilirubin
- Jaundice appears day 3 to 4
- Bilirubin peaks within **2 weeks**
- Declines to normal levels by 12 weeks
- **Baby will be feeding well and appear healthy**
- Usually mild and does not require treatment



Wikipedia/Public Domain

Breast Milk Jaundice



Breastfeeding Jaundice

- Inadequate lactation
- Inadequate intake of fluids and calories
- Increases enterohepatic circulation (↓ stool)
- Jaundice appears 1st week of life
- **Hypovolemia and weight loss**
- Signs of volume depletion on exam



Irene/Wikipedia

Hemolysis

- Often causes jaundice **first 24 hours of life**
- Feared cause: erythroblastosis fetalis
 - **Rh-negative mother**
 - Rh-positive baby
 - Maternal IgG crosses placenta



Indirect Hyperbilirubinemia

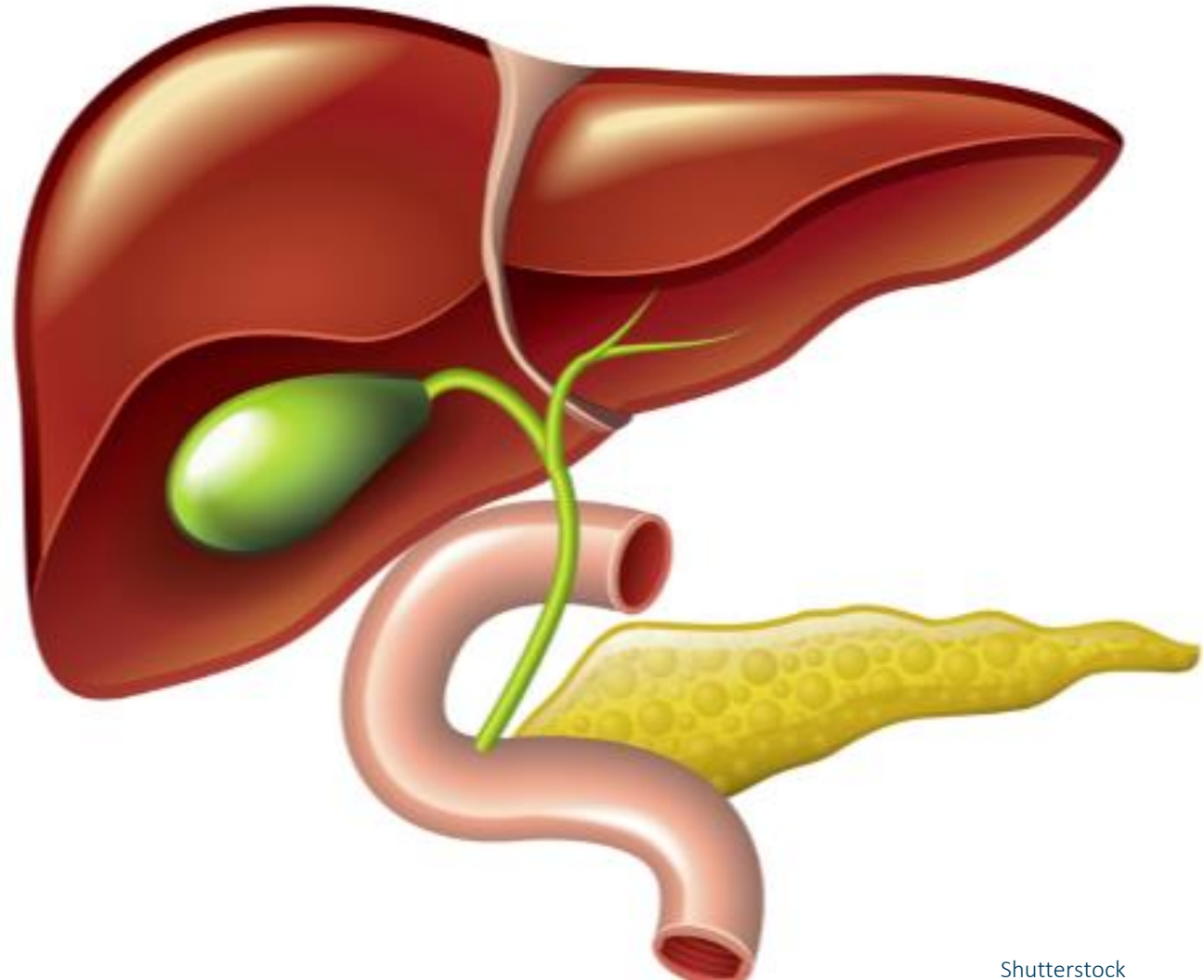
Rare Causes

- Crigler-Najjar
- Congenital hypothyroidism
- Galactosemia
- Spherocytosis
- Sepsis

Direct Hyperbilirubinemia

Conjugated Hyperbilirubinemia

- **Always pathologic**
- Biliary obstruction
 - Biliary atresia
- Liver disease



Delivery Room Care

Jason Ryan, MD, MPH



Delivery Room Care

- Dry and stimulate
- Clear airway if needed
- Provide warmth (blankets)
- Skin-to-skin contact with mother (warmth)
- Additional interventions after mother-child bonding
 - Vitamin K
 - Eye ointment
 - Hepatitis B vaccine



Apgar Scores

- Assigned to children at time of birth
- Assessed at **1 and 5 minutes** after birth
- Score of 0, 1, or 2 for each of the following:
 - **A**pppearance
 - **P**ulse
 - **G**rimace
 - **A**ctivity
 - **R**espiratory
- 90% newborns have scores 7 – 10
- Scores < 7 require further evaluation

Apgar Scores

	Sign	0	1	2
A	Appearance	All blue	Blue extremities	All pink
P	Pulse	Absent	< 100 bpm	> 100 bpm
G	Grimace	Absence	Weak grimace	Cough/cry
A	Activity	Limp	Some flexion	Fully active
R	Respiratory	Absent	Weak cry	Good cry

Neonatal Resuscitation

- **Normal newborn vitals:**
 - RR: 40 to 60/min
 - HR: 120 to 160/min
- **Bradycardia**
 - Marker of baby's respiratory efforts
 - Major cause in newborns: **hypoxia**
 - Primitive "diving reflex"



Neonatal Resuscitation

- **Apnea/gasping and heart rate < 100 bpm**
 - First step: positive pressure ventilation
 - Intubation
 - Chest compressions
 - Epinephrine via umbilical vein
- **Labored breathing or cyanosis with heart rate ≥ 100 bpm**
 - Clear airway
 - Use pulse oximetry to monitor O_2
 - Administer supplemental oxygen

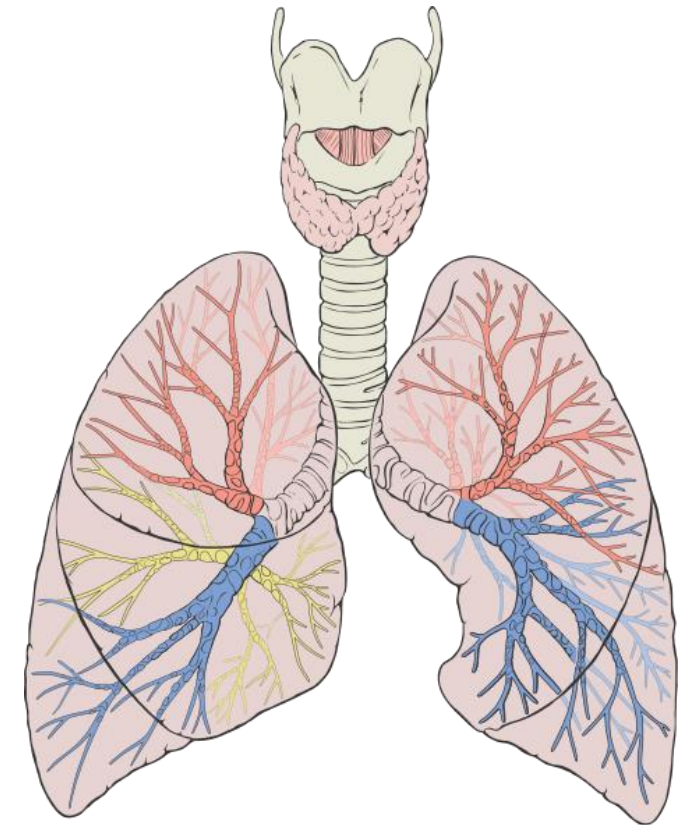


Neonatal Resuscitation Program

TTN

Transient Tachypnea of the Newborn

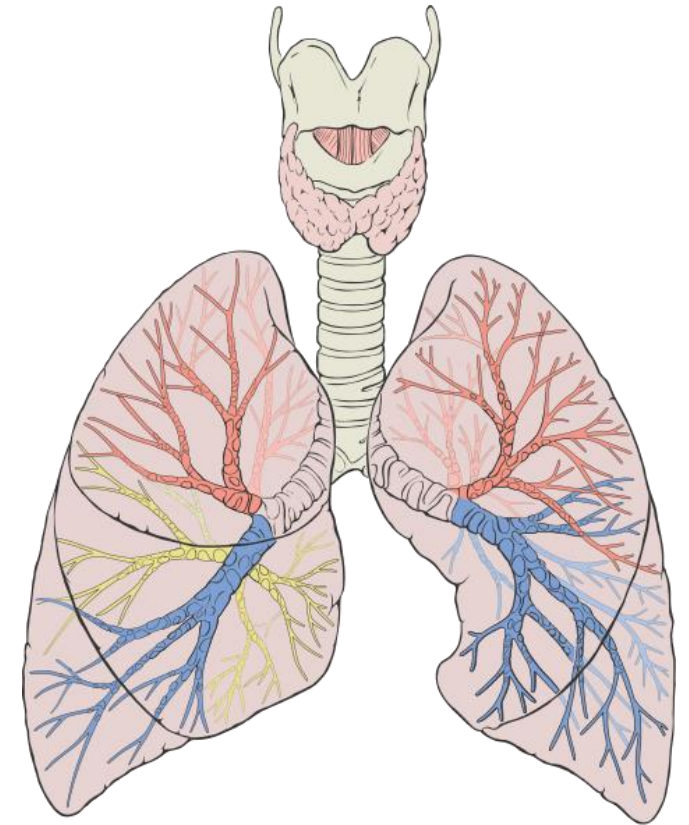
- Respiratory distress in immediate newborn period
 - Tachypnea (respiratory rate greater than 60/min)
 - Cyanosis
 - Increased work of breathing
- Slow clearance of fetal alveolar fluid (pulmonary edema)
- Common after **caesarean delivery without labor**
 - Lack of physiologic stimulation to clear lungs



TTN

Transient Tachypnea of the Newborn

- CXR: pulmonary edema
- Usually benign and self-limited condition
- Treatment: supportive
 - Oxygen/CPAP if needed
- **Rarely requires high oxygen (>40%)**
- Should resolve within 24 hours



Neonatal Hypoglycemia

- Transient low blood sugar: normal after birth
 - Maternal glucose lost → baby begins glycogen breakdown
 - Usually falls first 2 hours then recovers
- Persistent hypoglycemia can occur
 - Preterm infants or fetal growth restriction
 - Large for gestational age
 - Diabetic mothers
- May cause irritability, lethargy, rarely seizures
- Blood sugar not routinely checked unless symptoms
- Treatment: feedings



Pixabay

Polycythemia of the Newborn

- Newborns normally have increased red cell mass
 - Fetus in a relatively hypoxic environment in utero
 - Usual hematocrit healthy infants: 61%
 - Splenomegaly normal in newborns
- **Polycythemia: hematocrit > 65%**
 - Occurs in 1 to 5% of newborns
- Most common cause: **delayed cord clamping**
 - Delayed cord clamping (↑ cord RBCs)
- More likely with IUGR/placental insufficiency
 - Preeclampsia, SGA, post-term babies



Polycythemia of the Newborn

- Usually asymptomatic
- Increased viscosity can obstruct blood flow
- Rarely may cause symptoms
 - Hypoglycemia (excessive RBC glucose utilization)
 - Hyperbilirubinemia
 - Lethargy or poor feeding
- Treatment:
 - Observation
 - Hydration/glucose
 - Rarely partial exchange transfusion



Neonatal Sepsis

- Fever
- Irritability
- Risk factors:
 - Chorioamnionitis
 - Preterm delivery
 - Prolonged membrane rupture
 - Intrapartum fetal tachycardia
 - Meconium-stained amniotic fluid
 - Apgar < 6 (36x increased risk!)



Wikipedia/Public Domain

Neonatal Sepsis

- Diagnosis: **blood culture**
- Treatment: antibiotics
 - Usually ampicillin/gentamycin
 - Covers GBS, Listeria, Enterococcus, and most E. coli

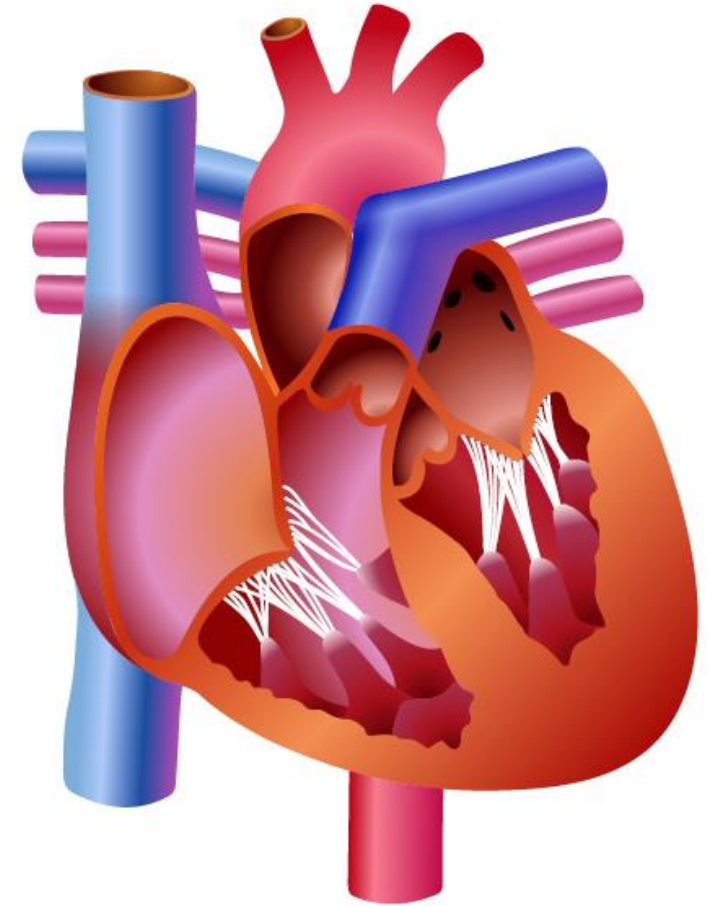


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PPHN

Persistent Pulmonary Hypertension of the Newborn

- Pulmonary vascular resistance should fall at birth
 - Oxygen to lungs → PVR falls
- **Persistent high PVR** → shunting → hypoxemia
 - Fetal shunts persist (foramen ovale, ductus arteriosus)
- Apparent during first 24 hours of life
- Respiratory distress and cyanosis
- Low Apgar scores
- Often co-occurs with **meconium-stained amniotic fluid**
- Usually occurs in term infants



PPHN

Persistent Pulmonary Hypertension of the Newborn

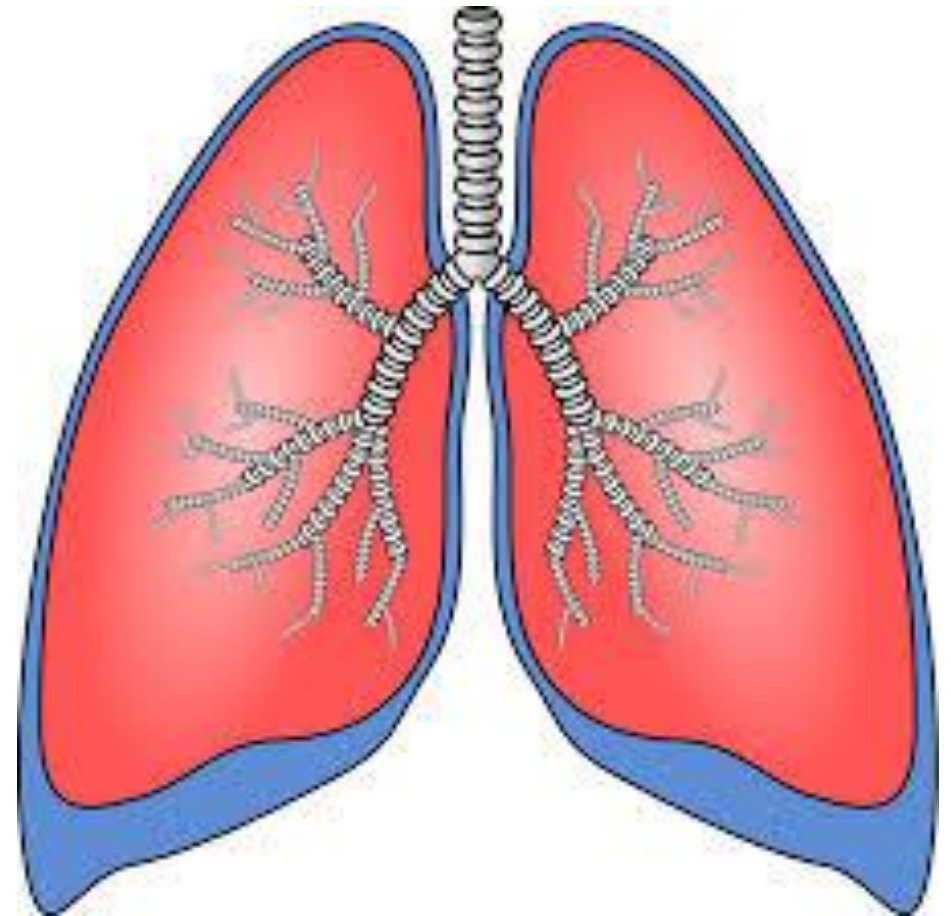
- CXR: usually clear lungs
- Diagnosis: **echocardiography**
- Treatment:
 - Supportive care
 - 100% oxygen (\downarrow PVR)
 - Inhaled nitric oxide
 - Intravenous sildenafil



Public Domain

Neonatal Respiratory Distress

- **Transient tachypnea of the newborn**
 - Caesarean delivery without labor
- **Respiratory distress syndrome**
 - Preterm infants
- **Persistent pulmonary hypertension**
 - Term infant
 - Meconium-stained amniotic fluid



Newborn Nursery

Jason Ryan, MD, MPH



Newborn Nursery

Eye Care

- **Erythromycin** ophthalmic ointment
- Prevents **gonococcal eye infection**
- Not effective against chlamydial conjunctivitis
 - Prevention is diagnosis/treatment of chlamydia in mother



Neonatal Conjunctivitis

Ophthalmia Neonatorum

Day	Cause	Treatment
0-1	Chemical irritation from eye ointment Classically caused by silver nitrate (not used in US)	Self-limited
2-5	Gonococcal; gram-negative diplococci Purulent exudates, eyelid swelling	IM Ceftriaxone
5-14	Chlamydial Watery, mucopurulent discharge	Oral erythromycin
5-14*	HSV Serous (pale-yellow transparent) discharge	Acyclovir

* Can occur up to 6 weeks after birth

Newborn Nursery

Vitamin K

- Single IM dose
- Prevents **vitamin-K deficient bleeding**
- Sterile GI tract at birth
- Insufficient vitamin K in breast milk
- Risk of neonatal hemorrhage



Ernest F/Wikipedia

Newborn Nursery

Hepatitis B Vaccine

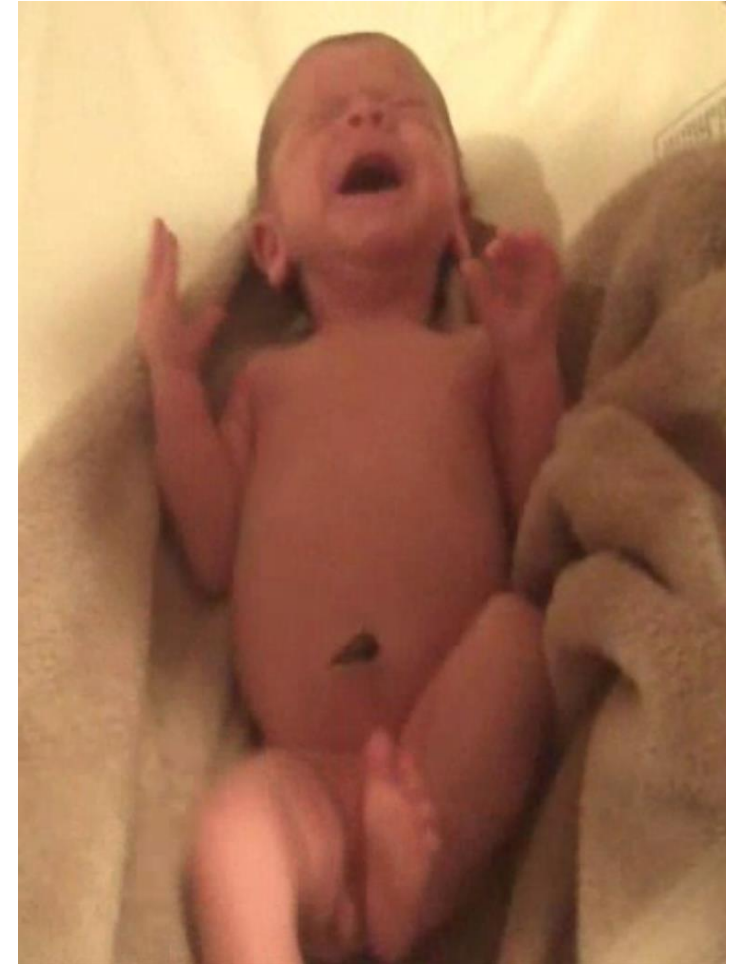
- Only vaccine given first 24 hours of life
- Infection can be passed mother to baby
- Newborn infection often leads to chronic disease

	0M	1M	2M	4M	6M	9M	12M	15M	18M	2Y	2.5Y	3Y	4Y	5Y	7-10Y	11-12Y	13-18Y
Hep B	#1	#2			#3												
DTaP			#1	#2	#3			#4					#5				
Hib			#1	#2	#3		#4										
PCV13			#1	#2	#3		#4										
IPV			#1	#2	#3								#4				
Rota			#1	#2	*3												
MMR							#1						#2				
Varicella							#1						#2				
Hep A							#1		#2								
Influenza					Yearly Vaccination (2 doses at first ever)												
MenACWY																#1	#2 (@16)
MenB																*: 2 Dose Series	
HPV																#: 2 Dose Series	
Tdap																#1	
# = Normal recommended vax. * = Special Circumstances																	

Newborn Nursery

Umbilical Cord

- Clamp and cut at birth
- **Keep stump dry**
 - No need to sterilize
 - Bacteria can help cord separate
- Omphalitis:
 - Infection of umbilicus/surrounding tissue
 - Polymicrobial
 - Risk of sepsis
 - Treatment: IV broad-spectrum antibiotics



Umbilical Granuloma

- Most common cause of an umbilical mass
- Soft, moist, and pink
- Treatment: topical **silver nitrate**



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Newborn Nursery

Screening

- Pulse oximetry
 - Screen for hypoxemia
 - Congenital heart disease
- Blood spot test
 - Many conditions
 - Congenital hypothyroidism
 - Congenital adrenal hyperplasia
 - Phenylketonuria
- Hearing



Shutterstock

Newborn Nursery

Feeding

- Frequent feeding to avoid hypoglycemia
- Full-term babies **lose weight** after birth
 - Up to 10 percent of birth weight
 - Occurs in first few days of life
 - Usually regained by 10 to 14 days
- Infants double birth weight by four months
- Triple birth weight by one year



Flickr/Public Domain

Newborn Nursery

Monitoring

- **Glucose**
 - Monitor for hypoglycemia in high-risk infants
 - Preterm
 - Large for gestational age
 - Small for gestational age
 - Infants of diabetic mothers
- **Bilirubin**
 - Bilirubin-induced neurologic dysfunction (BIND)
 - Visual assessment for jaundice
 - Transcutaneous bilirubin measurement
 - Total serum bilirubin measurement



Flickr/Public Domain

Newborn Nursery

Circumcision

- Elective procedure
- May reduce risks of:
 - Penile cancer
 - UTIs
 - Foreskin disorders (inflammation/fibrosis)
 - Transmission of HIV/HPV/HSV
- Procedural risks
 - Bleeding/infection
 - Glans injury
 - Urethrocutaneous fistulas (urine leakage)

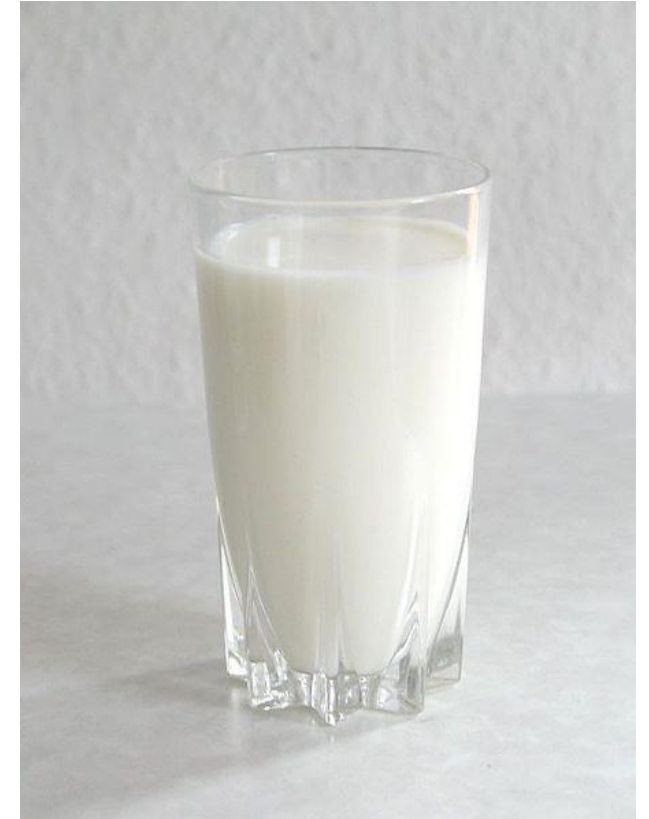


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Breastfeeding

Breast Milk Contents

- Lactose
- **Antimicrobial components**
 - Antibodies (mostly IgA – **passive immunization**)
 - Macrophages
 - Lymphocytes
 - Lactoferrin (anti-microbial)
 - Lysozymes (breaks down bacterial cell walls)
- Low vitamin D content
 - Vitamin D supplementation recommended for breast-fed babies



Public Domain

Breastfeeding

Benefits to Child

- **Lowers risk of infant infections** (GI, pulmonary)
- Possible long-term benefits
- Some studies show reduced allergies, diabetes, obesity



Achoubey/Wikipedia

Breastfeeding

Benefits to Mother

- **Decreased risk of breast and ovarian cancer**
- Possible decreased risk of cardiovascular disease
- Maternal-infant bonding
- Faster childbirth recovery
- Enhanced weight loss
- Longer postpartum anovulation
- Cost saving compared to formula



Wikipedia/Public Domain

Breastfeeding

Contraindications

- Herpetic breast lesions
- HIV or HTLV infections
- Chemotherapy or radiation
- Drug or alcohol use
- Galactosemia in infant



Ibrahimi O., et al. Acute Onset Vesicular Rash.
Am Fam Physician 2010 Oct 1; 82(7):815-816
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FPIES

Food Protein-Induced Enterocolitis Syndrome

- Food hypersensitivity reaction
- Most commonly due to protein in **cow's milk** or **soy**
 - Usually formula-fed infants
 - Rare in exclusively breastfed babies
- Starts shortly after birth
- **Vomiting and diarrhea**
- Dehydration and failure to thrive
- Diagnosis: clinical
- Treatment: elimination of trigger substance
- Usually resolves by 3 years old

Soy Beans and Soy Milk



FPIAP

Food Protein-Induced Proctocolitis

- Also food hypersensitivity reaction to protein
- Also starts shortly after birth
- Half of affected babies are **exclusively breast fed**
- Cow's milk: most common trigger
 - Consumed by mother or from formula
- **Infant appears well**
- Main clinical feature: **blood-streaked loose stools**
- May have other evidence of allergic disease (eczema)
- Diagnosis: clinical
- Treatment: elimination of trigger substance



Preterm and Postterm Infants

Jason Ryan, MD, MPH



Special Newborn Groups

- Prematurity
- Postterm pregnancy
- Small for gestational age
- Large for gestational age

Prematurity

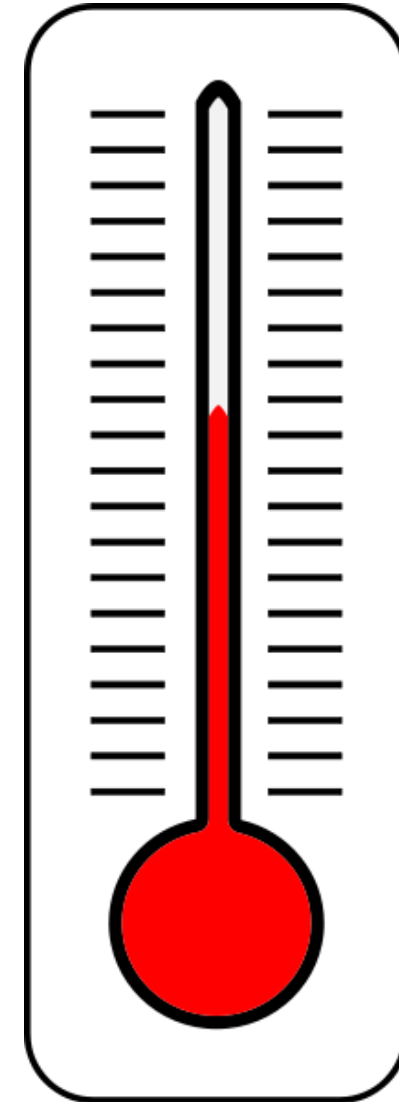
- Birth before 37-weeks gestation
 - Term: 38 weeks or more
 - “Late preterm:” 34 to 37 weeks
 - “Extremely preterm:” <28 weeks
- Associated with many newborn complications
- Milestones may be delayed during childhood
- Use corrected age for milestones until 2 years old

Corrected age: Actual age – weeks premature (before 40)

Prematurity

Immediate Newborn Complications

- **Hypothermia**
 - Less white adipose tissue (insulation)
 - Less brown adipose tissue (heat generation)
 - Large ratio surface area to weight (lose heat easily)
- **Hypoglycemia**
- **Hypotension**



Nevit Dilmen/Wikipedia

Prematurity

Immediate Newborn Complications

- **Hyperbilirubinemia**
 - ↑ unconjugated bilirubin
 - May lead to newborn jaundice
- **Hypocalcemia**
 - In utero calcium from mother
 - Newborn hypocalcemia common
 - Usually recovers over 24 hours
 - More common in premature babies

Neonatal RDS

Neonatal Respiratory Distress Syndrome

- Lungs “**mature**” when adequate surfactant present
- Occurs around **35 weeks**
- Lecithin–sphingomyelin ratio (L/S ratio)
- Both produced equally until ~35 weeks
- Ratio > 2.0 in amniotic fluid suggests lungs mature



Neonatal RDS

Neonatal Respiratory Distress Syndrome

- **Surfactant deficiency**
- High surface tension → atelectasis
- Decreased lung compliance
- Hypoxemia/ \uparrow pCO₂ (poor ventilation)
- Poorly responsive to O₂
 - Lungs collapsed (alveoli)
 - Intrapulmonary shunting
- Diagnosis: clinical plus CXR
 - CXR: diffuse ground glass appearance

Respiratory Distress Syndrome



Public Domain

Neonatal RDS

Risk Factors

- Prematurity
- Maternal diabetes
 - High insulin levels decrease surfactant production
- Cesarean delivery
 - Baby spared stress response at delivery
 - Reduced fetal cortisol
 - Reduction in surfactant

Cesarean Delivery



Neonatal RDS

Prevention and Treatment

- Preterm delivery: **betamethasone**
 - Corticosteroid
 - Given to mother to stimulate surfactant production
- Treatment: **surfactant**
 - Administered via endotracheal tube

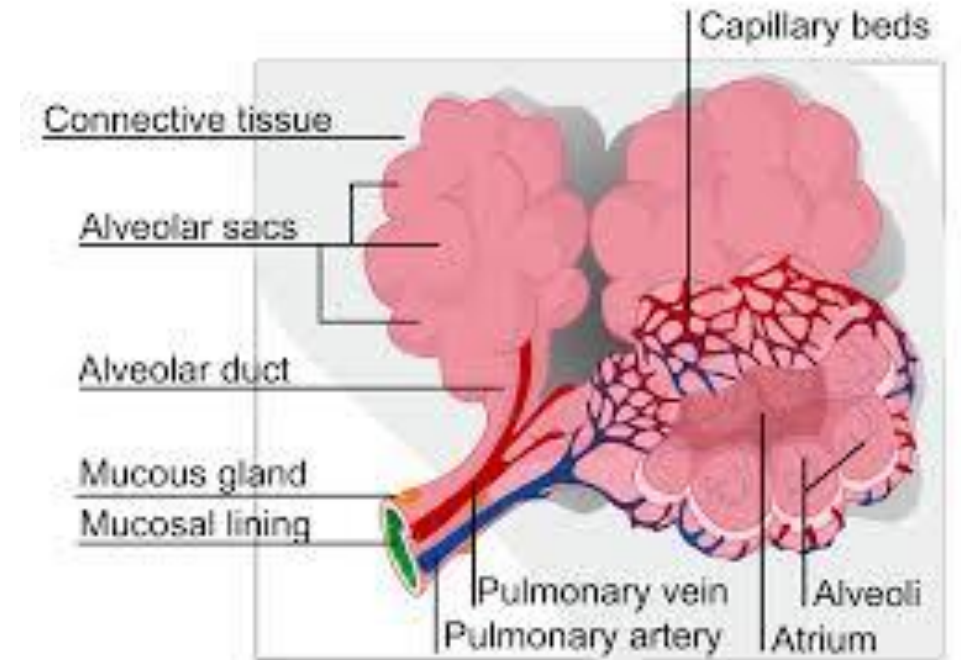


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Neonatal RDS

Complications

- **Patent ductus arteriosus**
 - Hypoxia keeps shunt open
- **Bronchopulmonary dysplasia**
 - Oxygen toxicity
 - Alveolarization does not progress normally
 - Respiratory problems during infancy
 - Often improves during childhood



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Retinopathy of Prematurity

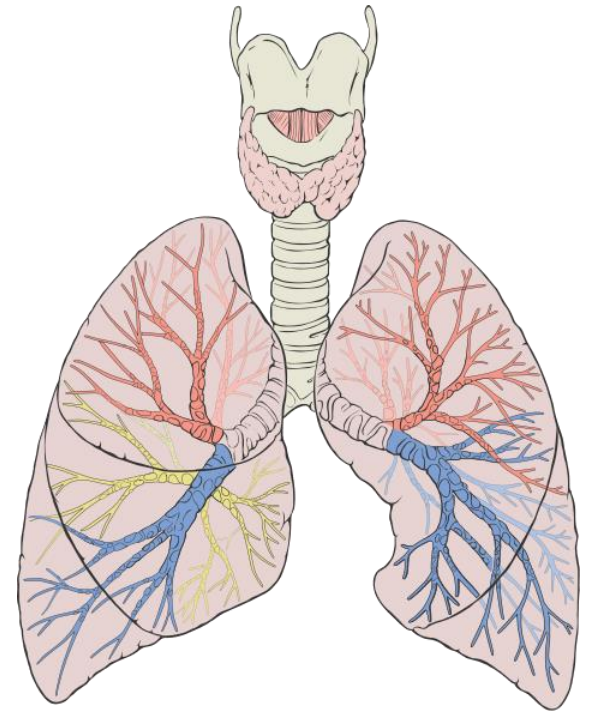
- Underdeveloped retinal vessels before birth
- Neovascularization in the retina
- Increased risk: exposure to high oxygen content
- **Retinal detachment** → blindness
- Diagnosis: retinal exam
- Treatment (severe cases):
 - Laser therapy
 - VEGF inhibitors



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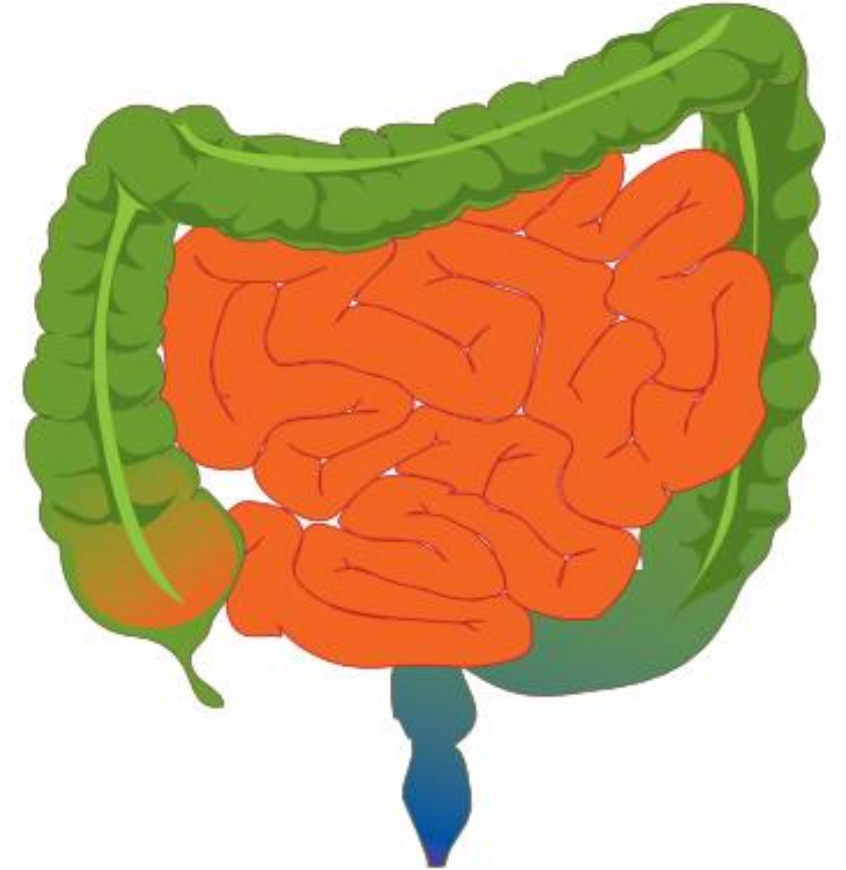
Apnea of Prematurity

- Immature respiratory control
- Cessation of breathing for at least 20 seconds
- Respiratory pauses with desaturation and/or bradycardia
- Treat with nasal continuous positive airway pressure (nCPAP)
- **Methylxanthine therapy**
 - Caffeine or theophylline
 - Blocks adenosine receptors
 - Adenosine inhibits respiratory drive
 - Treatment will cause tachycardia



Necrotizing Enterocolitis

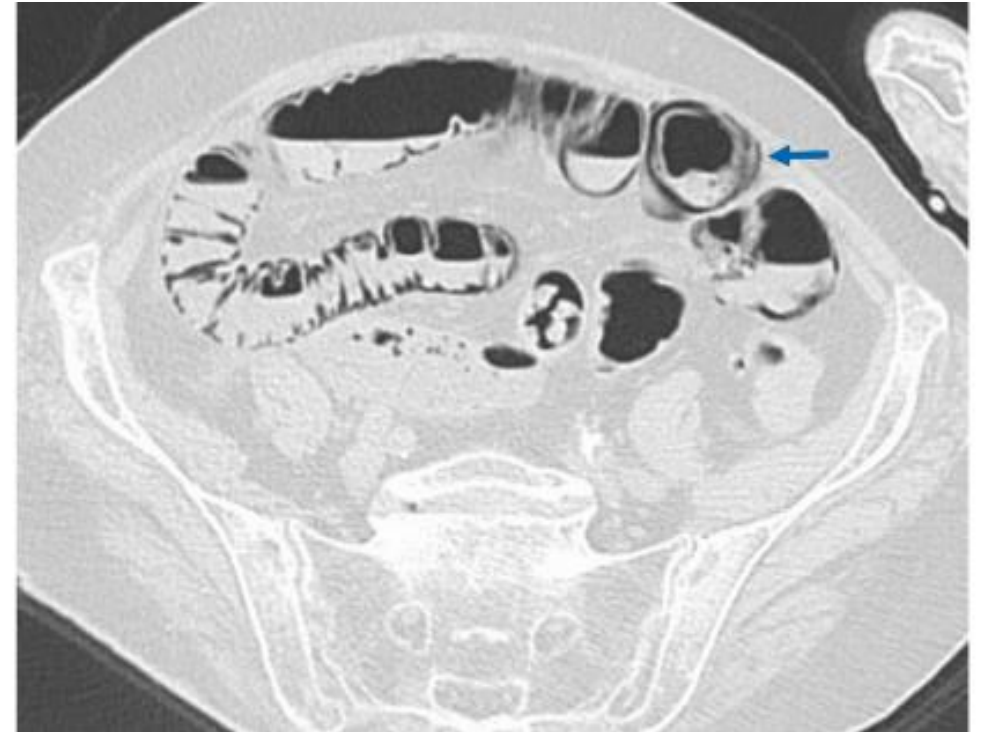
- Intestinal necrosis and obstruction
- Usually terminal ileum or colon
- Can lead to perforation and infection
- Most (90%) cases in **preterm infants**
- Associated with antibiotic therapy
- Often in **formula-fed babies**
 - Risk factor: Non-human milk



Necrotizing Enterocolitis

- Feeding intolerance
- Abdominal distention
- Diagnosis: X-ray (alternative: CT)
- **Pneumatosis intestinalis**
 - Gas in the bowel wall
 - Pathognomonic finding of NEC in newborns
- Treatment:
 - Supportive care
 - Antibiotics
 - Surgery

Pneumatosis Intestinalis



GERD

Gastroesophageal Reflux Disorder

- Can occur in any newborn
- More common in premature babies
- Multifactorial mechanisms
- Clinical manifestations
 - Nonspecific irritability
 - Vomiting
 - Failure to thrive
- Diagnosis: usually clinical suspicion (challenging)
- Treatment: diet, positioning, medications



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Intraventricular Hemorrhage

- Hemorrhage into **lateral ventricle**
- Hypotonia
- Loss of spontaneous movements
- Seizures, coma
- Germinal matrix problem
 - Highly vascular area near ventricles
 - Prematurity: poor autoregulation of blood flow here
 - Full-term infants: decreased vascularity
- Diagnosis: cranial ultrasound
- Treatment: supportive



www.mrineonatalbrain.com
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Intraventricular Hemorrhage



Intraventricular Hemorrhage

- Grades 1 through 4
- Hydrocephalus
- White matter injury
- Cerebral palsy
- Intellectual impairment

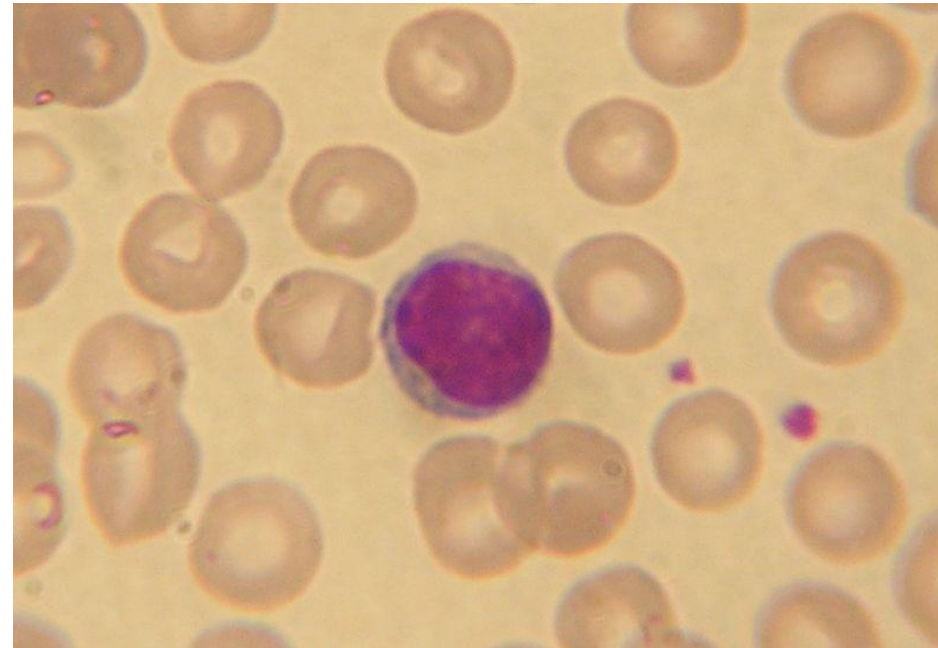


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Prematurity

Immune Function

- Cellular immunity impaired
- ↓ T-cells and B-cells at birth
- Some babies have neutropenia
- Risk of infection/sepsis



Mgiganteus/Wikipedia

Prematurity

Long-term Complications

- **Increased mortality and morbidity**
 - SIDS
 - Leading cause infant mortality 1 month to 1 year in US
 - Increased risk with preterm birth or low birth weight
- Increased risk of **neurocognitive problems**
 - Cognition
 - Social skills
 - Behavioral and emotional skills
- Growth impairment
- Impaired respiratory function

Postterm Pregnancy

- Delivery at ≥ 42 -weeks gestation
- \uparrow risk of short-term newborn complications
- Usually results in macrosomia (large baby)
- Fetal growth restriction may occur beyond 40 weeks
 - **Placental insufficiency**
 - Fetal malnourishment may occur
- Rarely causes **umbilical cord compression**
 - Leads to neonatal asphyxia
 - Possible neurologic damage



Dysmaturity Syndrome

- Occurs in babies with marked **intrauterine growth restriction (IUGR)**
 - Can occur in postterm pregnancies and SGA babies
 - Rarely seen in modern era due to elective delivery
- **Placenta insufficiency and malnourishment**
- Characteristic appearance at birth:
 - Long, thin arms and legs
 - Dry, “parchment-like” skin
 - Peeling, loose skin
 - Long toenails and fingernails
 - Baby alert with “wide-eyed” look
 - Decreased/absent vernix

Newborn Vernix



Wikipedia/Public Domain

Meconium Aspiration Syndrome

- Respiratory distress
- Meconium-stained amniotic fluid (MSAF) at birth
- Tachypnea and cyanosis
- More common if pregnancy lasts **beyond 40 weeks**
- Treatment: supportive
 - Maintenance oxygenation and ventilation
 - Empirical antibiotics

Meconium



Wikipedia/Public Domain

Small for Gestational Age

Low Birth Weight

- Less than 2500 grams (5.5lbs) or 10th percentile
- Occurs in ~10% of term babies
- Caused by IUGR
- Increased risk of:
 - Neonatal mortality
 - Newborn complications
- Lower birth weight → greater risk complications

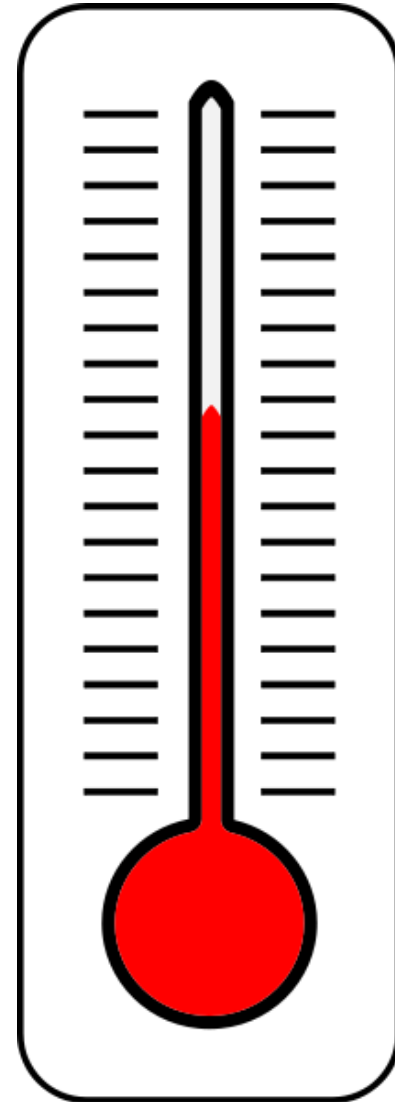


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Small for Gestational Age

Newborn Complications

- Perinatal asphyxia
 - Chronic undernourishment from placenta
 - Contractions at birth → hypoxia
- Hypothermia
- Hypoglycemia
- Impaired immune function
- Hypocalcemia
- Polycythemia



Nevit Dilmen/Wikipedia

Large for Gestational Age

- Greater than 4000 grams (8.8lbs) or 90th percentile
- Associations:
 - Maternal diabetes (gestational or preexisting)
 - Maternal pre-pregnancy weight
 - Excessive maternal weight gain



Øyvind Holmstad/Wikipedia

Large for Gestational Age

Complications

- Macrosomia associated with **birth injuries**
- Maternal complications
 - Vaginal lacerations
 - Severe postpartum hemorrhage
 - Increased likelihood of cesarean delivery
- Infant complications
 - Shoulder dystocia
 - Brachial plexus injury
 - Clavicular fracture

Shoulder Dystocia



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Child Abuse

Jason Ryan, MD, MPH



Child Maltreatment

- Child (physical) abuse
- Sexual abuse
- Emotional abuse
- Child neglect

Child Abuse

- Injury to a child by parent or caregiver
- Commonly affects **children under 1 year of age**
- Perpetrator usually closest family member (mother)
- Often identified by healthcare providers

Child Abuse Injuries

History

- Reported minor trauma → major injury
- Caregiver history changes over time
- Severe injury blamed on siblings/pets

Child Abuse Injuries

Bruising

- **Most common abuse injury**
- Multiple bruises
- Buttocks, trunk, ear, neck



Thirteen Of Clubs/Flickr

Child Abuse Injuries

Fractures

- Often identified by skeletal survey
 - X-rays of all bones
- **Multiple fractures** in **different healing stages**
- Rib fractures
- Long bone fractures in baby



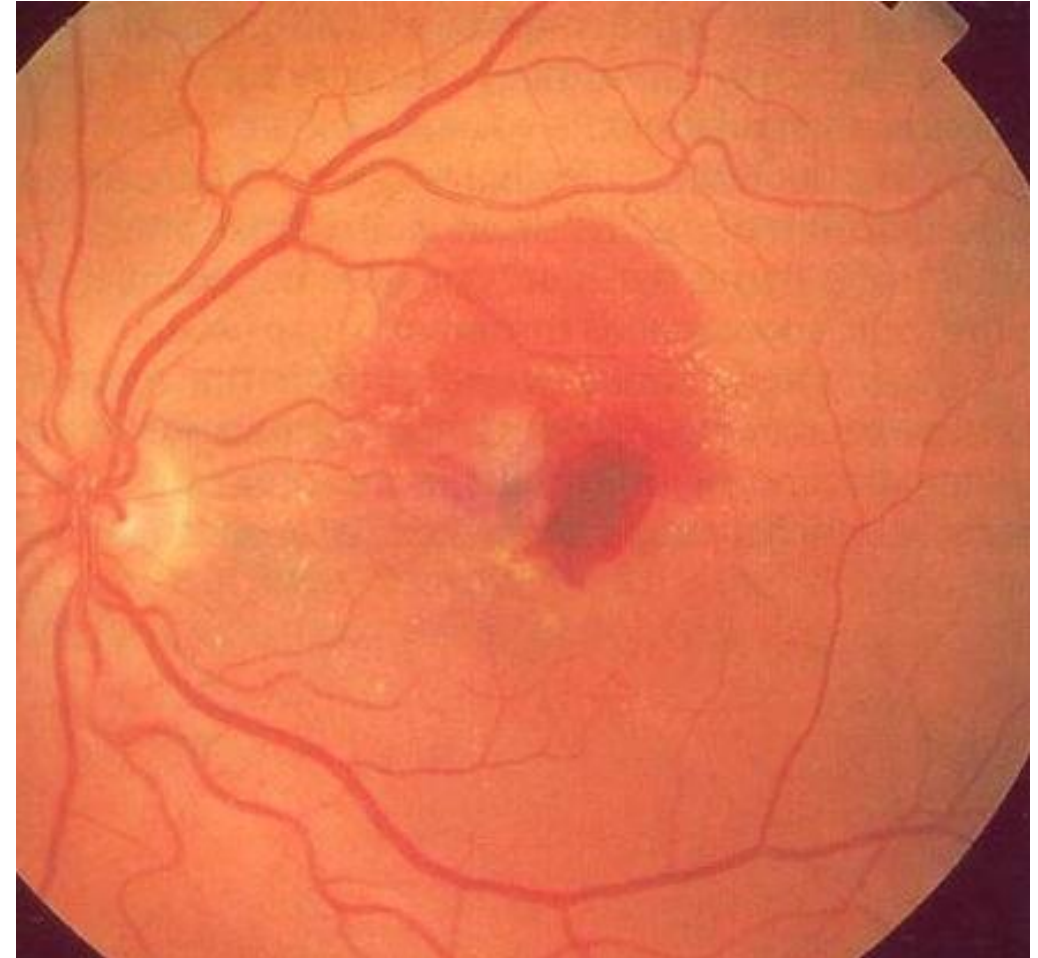
Gilo1969/Wikipedia

Child Abuse Injuries

Head Trauma

- “Abusive head trauma”
- “Shaken baby syndrome”
- Retinal hemorrhages
- Subdural hematoma

Retinal Hemorrhage



Public Domain

Child Abuse

Selected Risk Factors

- Parent factors
 - Single, young parents
 - Lower parental level of education
 - Parental substance or alcohol abuse
 - Parental psychiatric illness
- Child factors
 - Unplanned pregnancy
 - Unwanted child
 - Learning disabilities, behavioral problems

Child Abuse

Diagnosis and Management

- Standard imaging tool: **skeletal survey**
 - X-rays of all bones in the body
- Head CT if head trauma suspected
- Ensure child safety
- Remove child from caregiver
- Contact authorities
- Treat injuries

Child Sexual Abuse

- Most common **pre-puberty (9-12 years old)**
- Perpetrator usually **male** known to child
- Trauma to mouth, anus, genitals
- Sexually transmitted infection

Emotional Abuse

Psychological Abuse

- Child feels worthless, unloved
- Verbal abuse
- Criticism
- Intimidation (scaring child)
- Humiliation
- Confinement for prolonged periods as punishment

Child Neglect

- Common form of child maltreatment
- 50% cases reported to child protection services
- Inadequate food, shelter, supervision, affection
- Poor clothing and hygiene
- Underweight or malnourished
- **Must be reported to protective services**
- All 50 states have laws requiring physician reporting

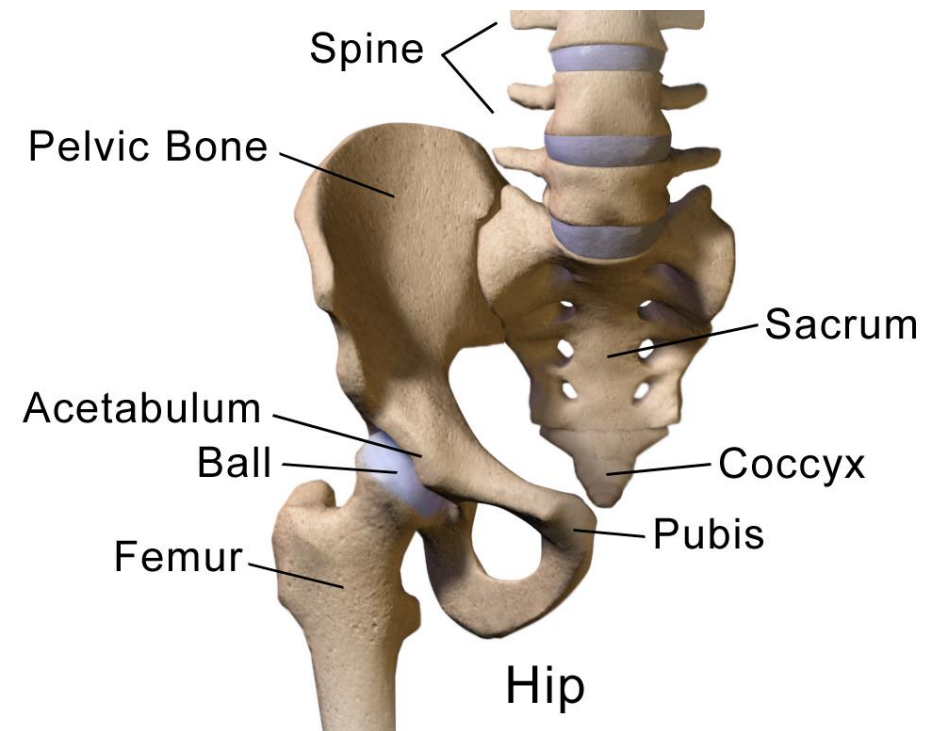
Pediatric Orthopedics

Jason Ryan, MD, MPH



Developmental Dysplasia of the Hip

- Abnormal development of acetabulum and proximal femur
 - Hip laxity common in newborns
 - Most will outgrow this
 - Persistent laxity may require treatment
- Mechanical instability of hip
- Often detected in 1st months of life
- Leg length discrepancy
- Asymmetric inguinal folds
- **Hip instability on exam**
- Can lead to early osteoarthritis in adulthood



Public Domain

Developmental Dysplasia of the Hip

- **Ortolani**
 - Hip abducted while pushing trochanter anteriorly
 - Dislocated hip: palpable clunk
- **Barlow**
 - Hip adducted
 - Unstable hip: palpable clunk
- American Academy of Pediatrics:
 - Screen infants up to three months of age



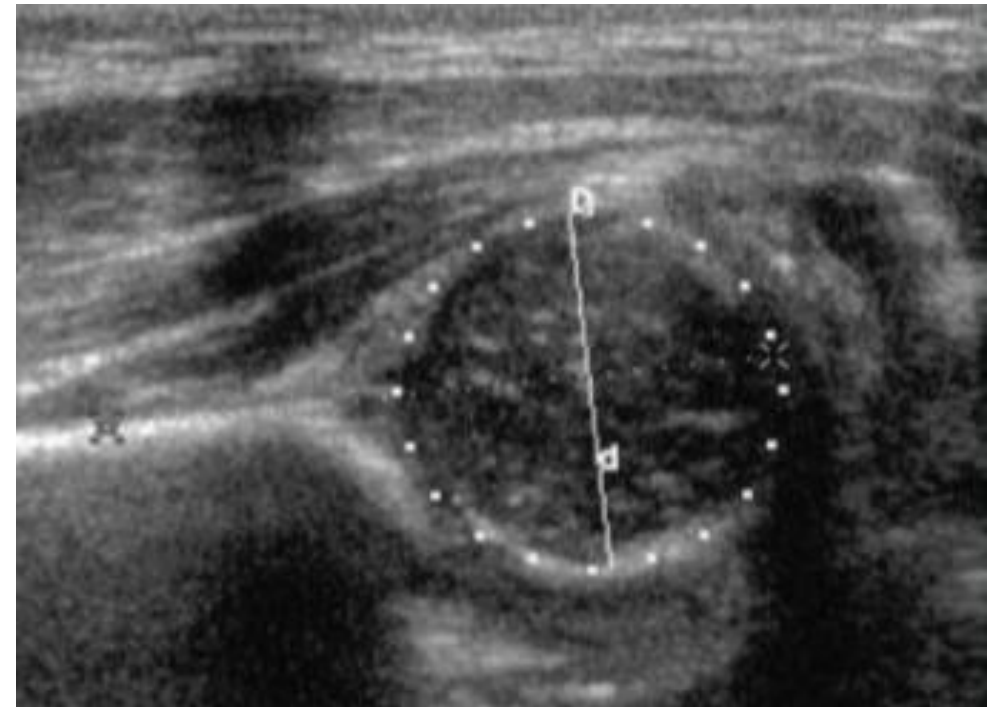
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Developmental Dysplasia of the Hip

Diagnosis

- Often runs in families
- Clinical diagnosis with imaging confirmation
- Less than 4 months: **ultrasound of hip**
 - X-rays have limited value
 - Bones are cartilaginous and not ossified
- More than 4 months: X-ray

Hip Ultrasound



Developmental Dysplasia of the Hip

Treatment

- **Abduction splint (Pavlik harness)**
- Reduction
- Surgery
- Complications:
 - Early osteoarthritis
 - Avascular necrosis



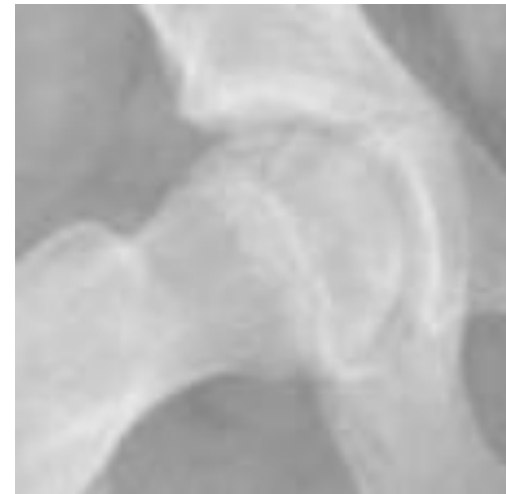
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SCFE

Slipped Capital Femoral Epiphysis

- Slippage of overlying end of femur
 - Epiphysis slips posteriorly
- Most common hip disorder in adolescence (~13 yrs)
 - Periods of rapid growth shortly after puberty onset
- **Groin pain and limp** on affected side
- Limited hip motion
- **Orthopedic emergency**
- Diagnosis: X-ray (ice cream falling off cone)
- Treatment: surgical femoral head pinning

Normal



SCFE



Legg-Calvé-Perthes Disease

- Idiopathic avascular necrosis
- Hip disorder in children (~6 years)
- **Abnormal blood flow** to femoral head
- Often presents as a **painless limp**
 - Contrast with SCFE
- Subacute/insidious onset
 - Usually over 1 month
 - Contrast with other hip disorders

Legg-Calvé-Perthes Disease



James Heilman, MD/Wikipedia

Legg-Calvé-Perthes Disease

Diagnosis and Treatment

- X-ray
 - Insensitive
 - May be normal in early disease
- MRI: very sensitive
- Treatment:
 - Avoid weight bearing
 - Splinting
 - Rarely requires surgery (controversial)
 - Often resolves (bone heals)
- Can lead to early osteoarthritis

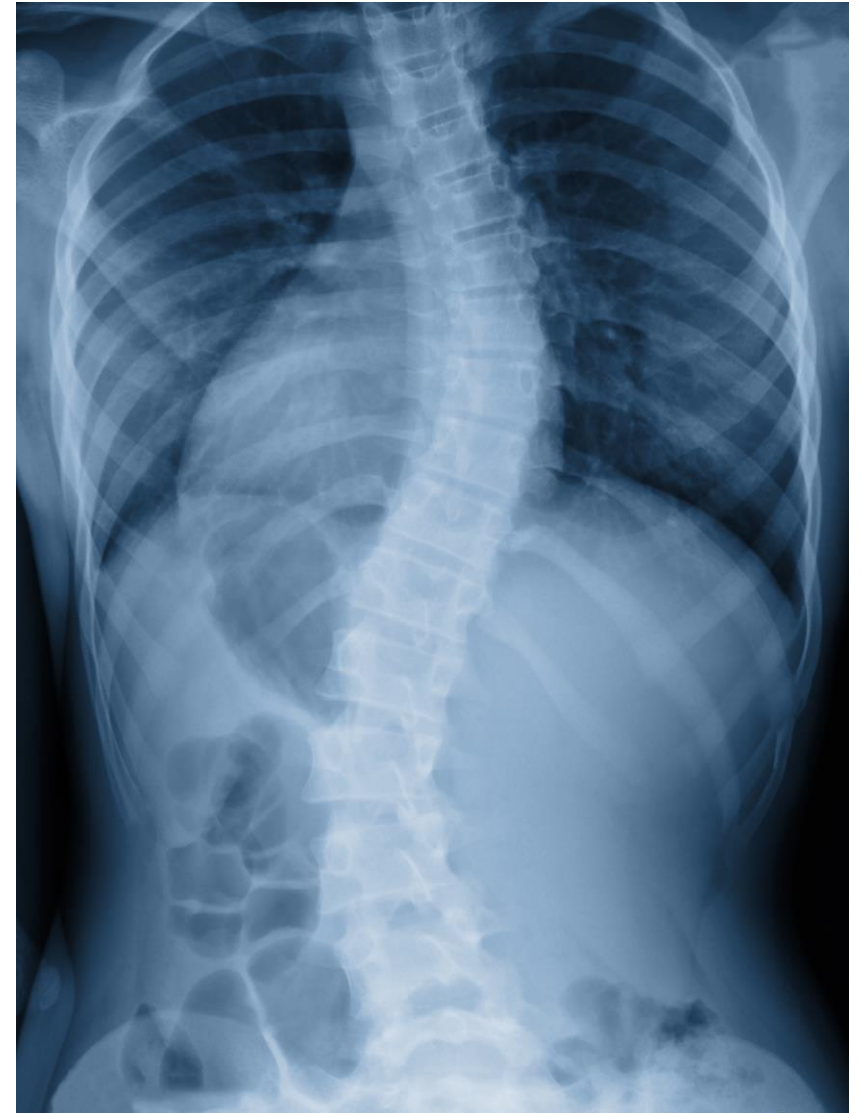
Legg-Calvé-Perthes Disease



James Heilman, MD/Wikipedia

Scoliosis

- Lateral curvature of the spine
- Common in adolescents (> 10 years old)
 - “Early onset” scoliosis occurs before this age (rare)
- Common in females in thoracic spine
- May lead to chronic back pain and deformity
- Severe cases: restrictive lung disease
- Diagnosis:
 - Inspection
 - Adams forward bend test
 - X-ray



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Adams Forward Bend Test

- Patient bends forward at waist until spine parallel ground
- Patient observed from the back

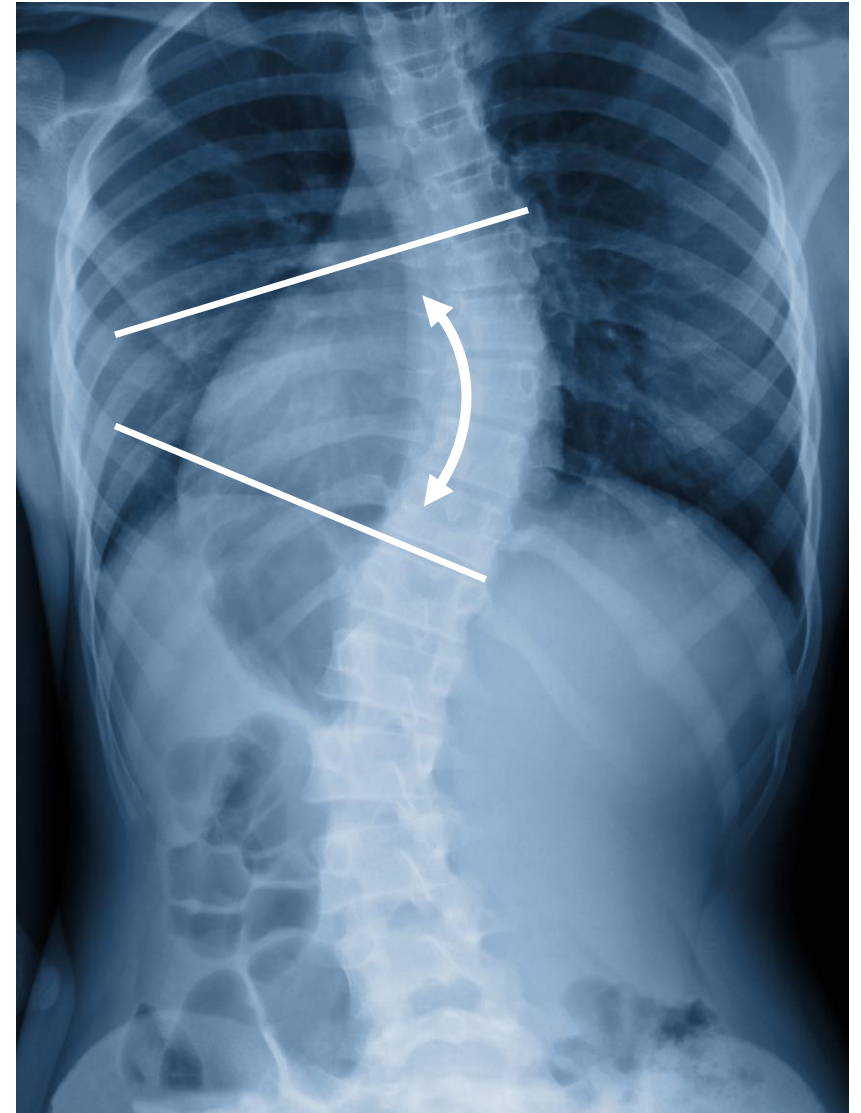


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Scoliosis

Treatment

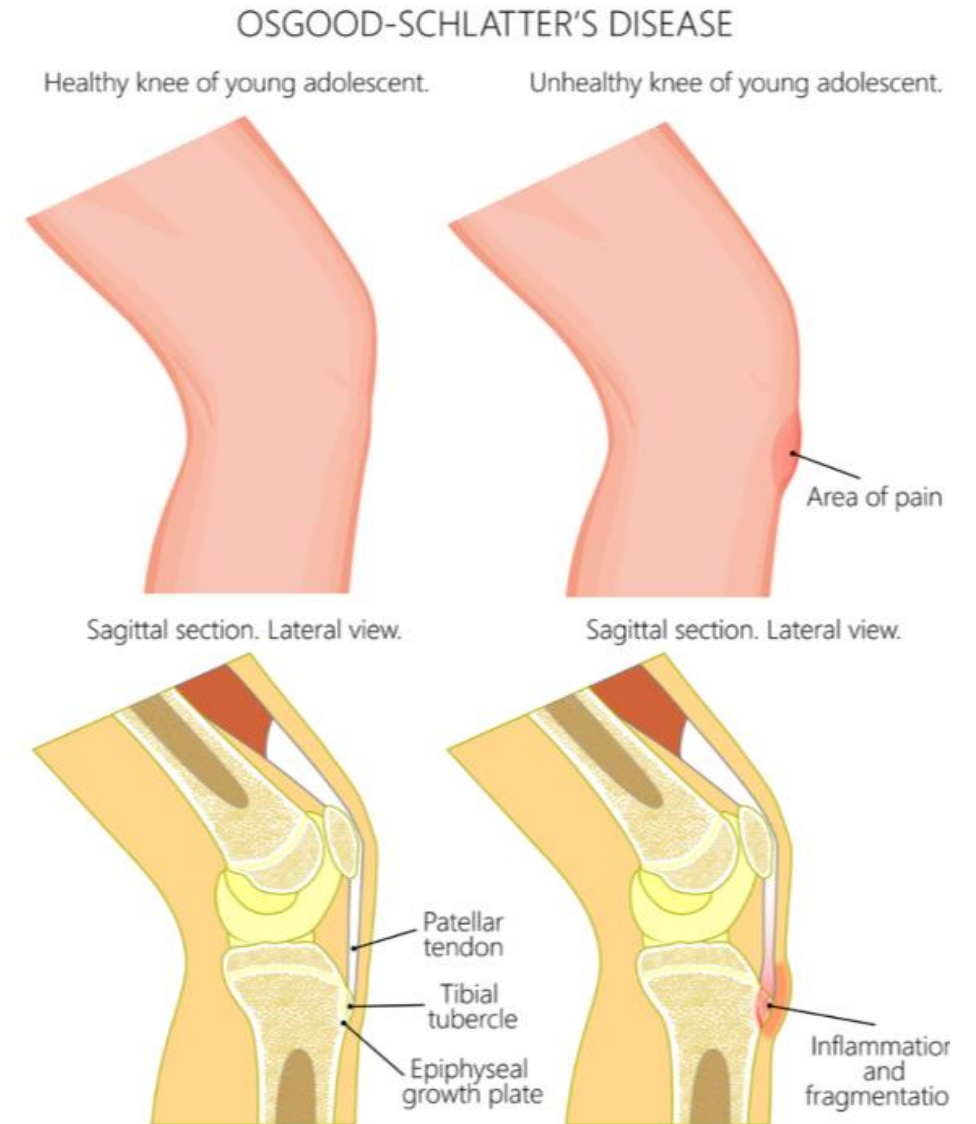
- Based on **Cobb angle** and skeletal maturity
 - Smaller angles may not progress
 - Skeletally immature patients may outgrow scoliosis
- Observation
 - Smaller angles ($< 20^\circ$)
- Bracing
- Surgery
 - Larger angles ($> 50^\circ$)



Osgood-Schlatter Disease

Tibial tuberosity avulsion

- Overuse injury in children (usually 9 to 14)
- Pain and swelling at tibial tubercle
 - Insertion point of patellar tendon
 - Secondary ossification center of tibia
- Chronic avulsion (pulling)
- Diagnosis: clinical
- Usually benign, self-limited condition



Metatarsus Adductus

- Most common congenital foot deformity
- Medial deviation of forefoot (“C shape”)
- Toes point inward
- Usually resolves spontaneously



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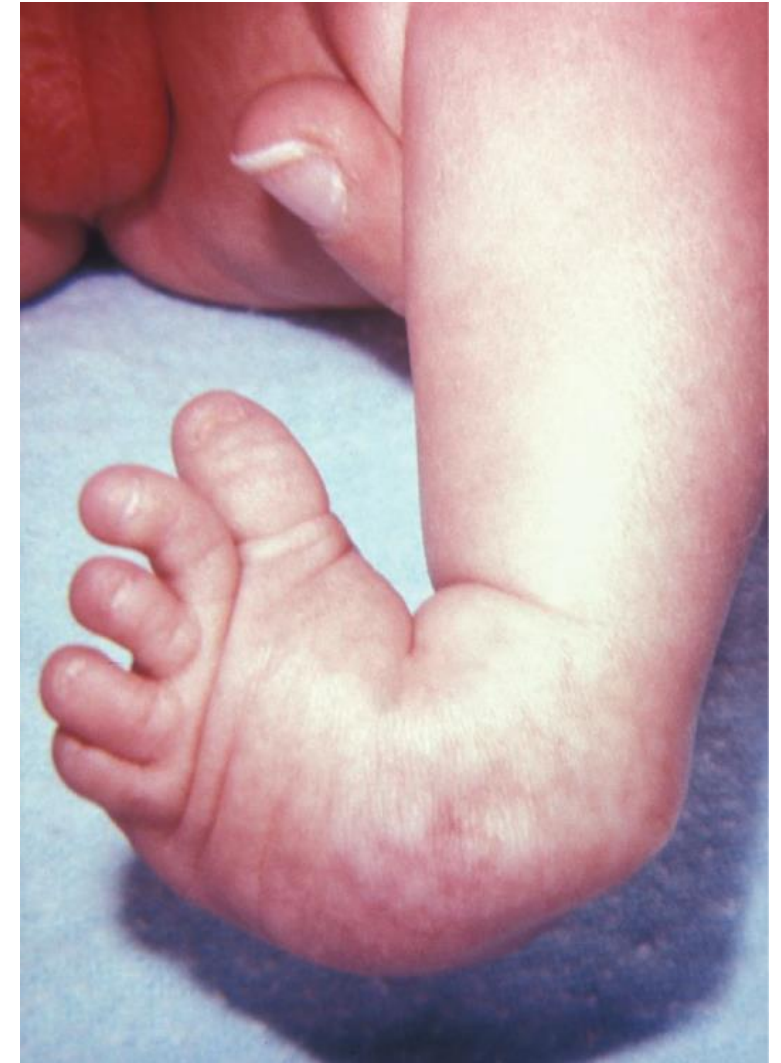
Talipes equinovarus

Club Foot

- Evident at birth
- Caused by deformity of talus
- Medial deviation of forefoot
- Foot supination
- Plantar surface turned inward
- Usually isolated (80% cases)
- Non-isolated cases:
 - Trisomy 18
 - Spina Bifida
 - Other disorders



Talus Bone



Public Domain

Talipes equinovarus

Treatment

- Stretching
- Casting and bracing
 - Ponseti method
- Achilles tenotomy
 - Done after casting
 - Releases tightness in Achilles tendon

Ponseti Method Casting

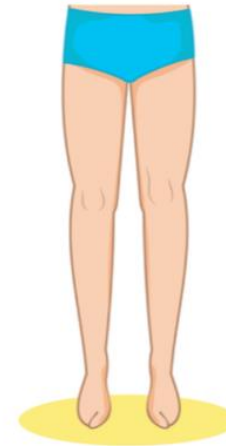


Madilyn Seely/Slideplayer

Lower Extremity Alignment

- Varus: bow-legged
- Valgus: knock-kneed
- At birth varus alignment is normal
- Standing/walking: amount of varus increases
 - Early walkers have more varus alignment
- By 24 months: alignment usually neutral

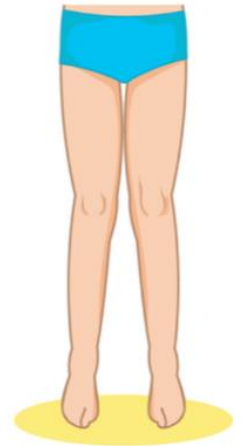
VARUS AND VALGUS KNEE DEFORMITY



NORMAL
Neutral stance



VARUS
Bow-legged

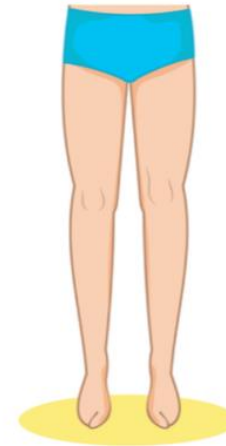


VALGUS
Knock-kneed

Lower Extremity Alignment

- After 24 months: alignment becomes valgus
- Maximum valgus at 4 years
- After 4 years valgus alignment decreases
- By 7 years: permanent slight valgus

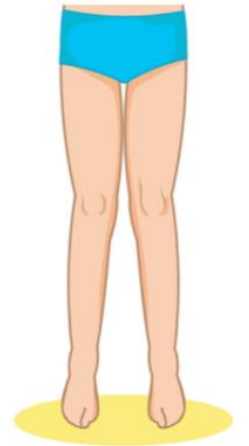
VARUS AND VALGUS KNEE DEFORMITY



NORMAL
Neutral stance



VARUS
Bow-legged



VALGUS
Knock-kneed

Genu Varum

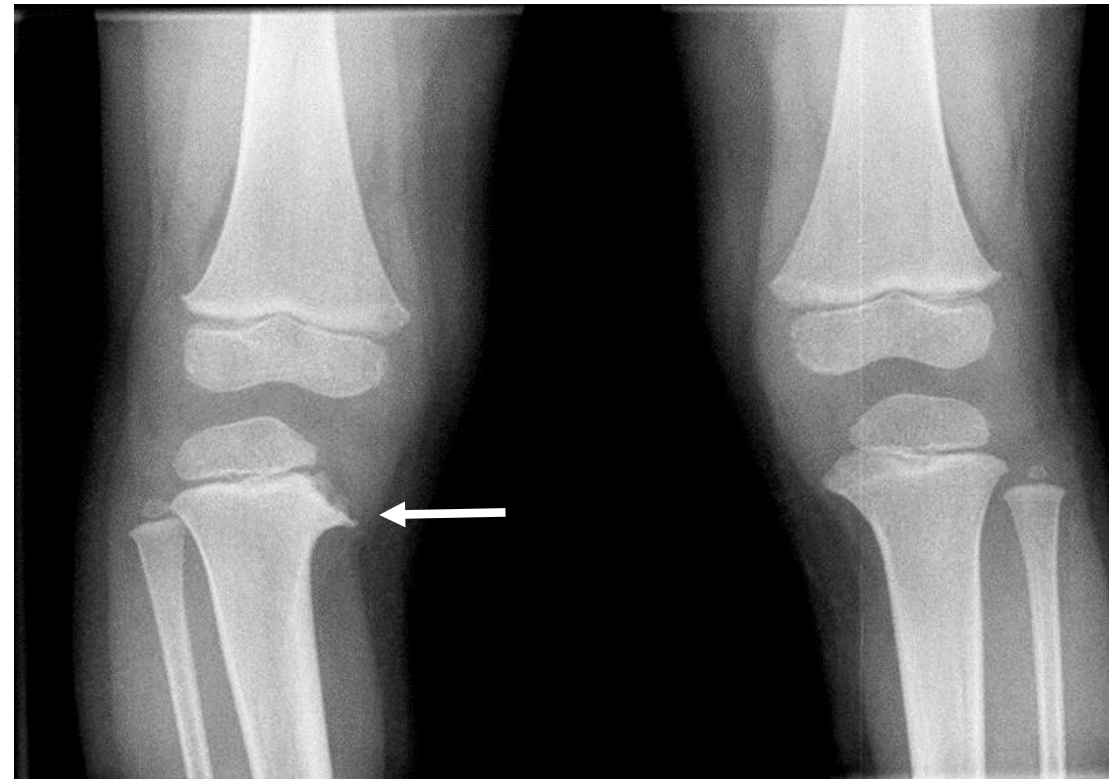
- Genu = knee
- Genu varum normal from birth until ~ 3 years
- Pathologic after 3 years
 - Blount disease (most common cause)
 - Skeletal dysplasia
 - Rickets
 - Systemic diseases affecting bone



VARUS
Bow-legged

Blount Disease

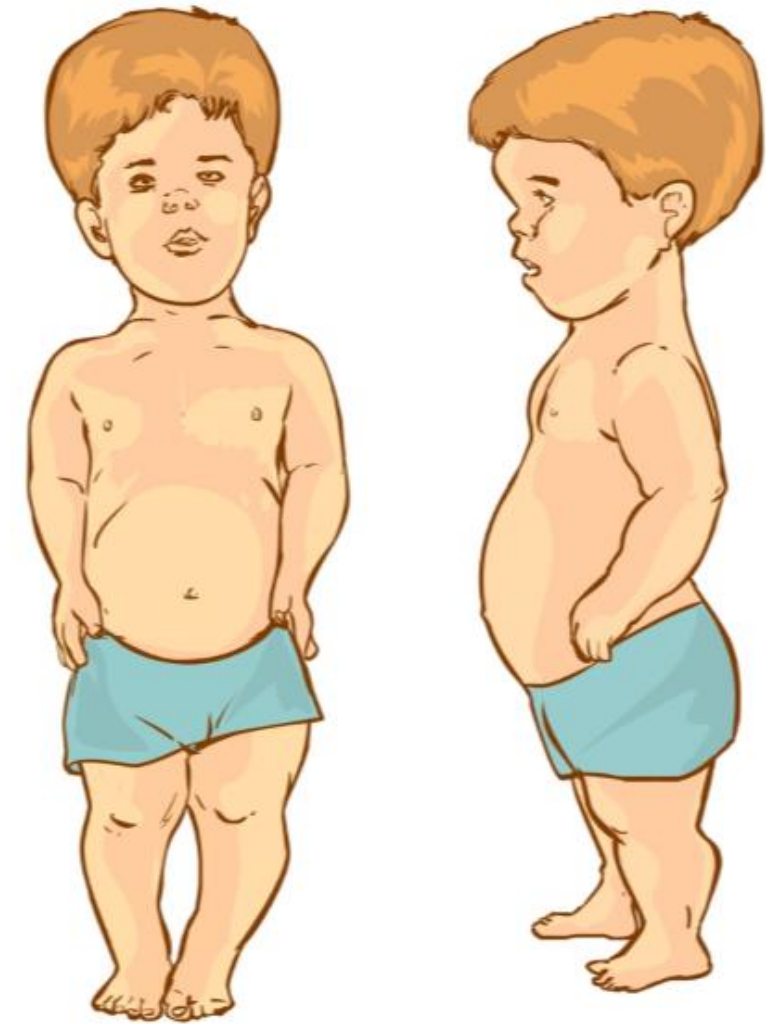
- Abnormal growth plates near medial tibia
- Etiology poorly understood
- Diagnosis: clinical plus X-ray
- Treatment: bracing or surgery



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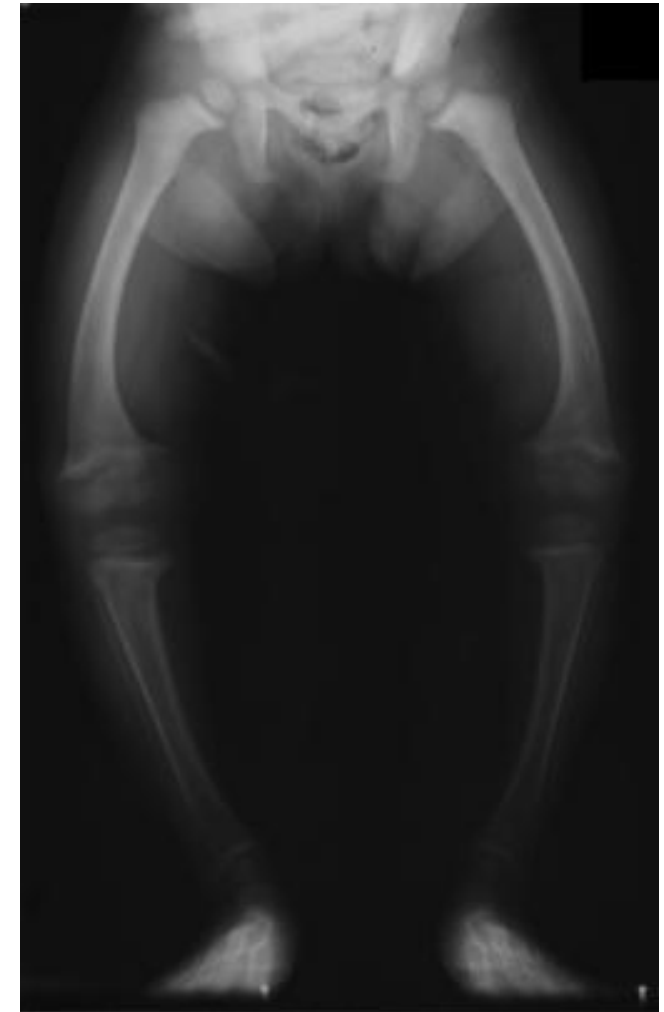
Skeletal Dysplasias

- Disorders of skeletal development
- Achondroplasia
- Pseudoachondroplasia
- Metaphyseal chondrodysplasia



Rickets

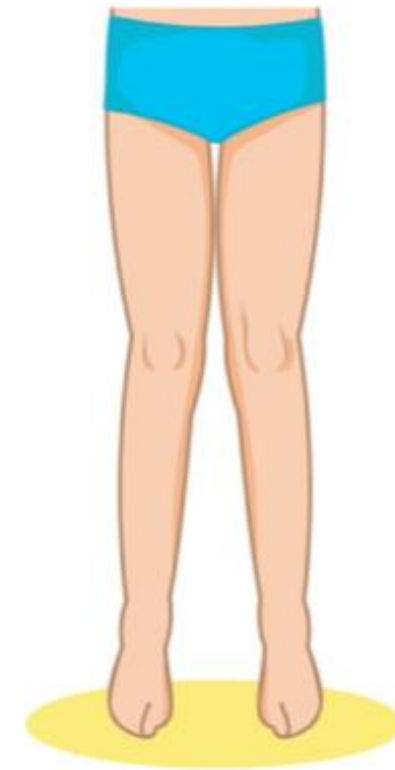
- Calcium, phosphate or vitamin-D deficiency
- Poor mineralization of bone in children
- Bowed legs is a classic finding



Michael L. Richardson, M.D./Wikipedia

Genu Valgum

- After 24 months: alignment becomes valgus
- Maximum valgus at 4 years
- After 4 years valgus alignment decreases
- By 7 years: permanent slight valgus
- Pathologic valgus (rare) after 7 years:
 - Often posttraumatic
 - Other rare causes



VALGUS
Knock-kneed

Flat Feet

Pes Planus

- Normal in babies
- Does not cause pain
- Requires evaluation only if limited range of motion



Child Psychiatry

Jason Ryan, MD, MPH



Autism Spectrum Disorder

- Neurodevelopmental disorder
- Exact cause unknown
- Associated with TORCH infections
 - Rubella, CMV
- Abnormal social skills
 - Communication/interaction
- Repetitive behavior patterns
- Limited interests and activities



Autism Spectrum Disorder

Diagnostic Criteria

- Clinical diagnosis
- Deficits in social interaction in **multiple settings**
- Failure of back-and-forth conversation
- Reduced sharing of interests, emotions
- Abnormal eye contact or body language
- Difficulty making friends
- Lack of interest in peers

Autism Spectrum Disorder

Diagnostic Criteria

- Restricted, repetitive patterns
 - Repetitive movements, use of objects
 - Insistence on sameness, unwavering adherence to routines
 - Preoccupation with certain objects
- Symptoms must impair function
- Symptoms must be present in early development
 - Often diagnosed about 2 years of age
 - Symptoms sometimes present earlier but unnoticed
- Symptoms not accounted for by other causes
 - Intellectual disability, learning disorder, deafness

Autism Spectrum Disorder

Other Features

- Intellectual impairment
 - Variable
 - Some skills weak (i.e. verbal communication, reasoning)
- **Savants**
 - Some patients have special skills in one area
 - Memory, music, art, math
 - Classic example: determining day of week for given date

Autism Spectrum Disorder

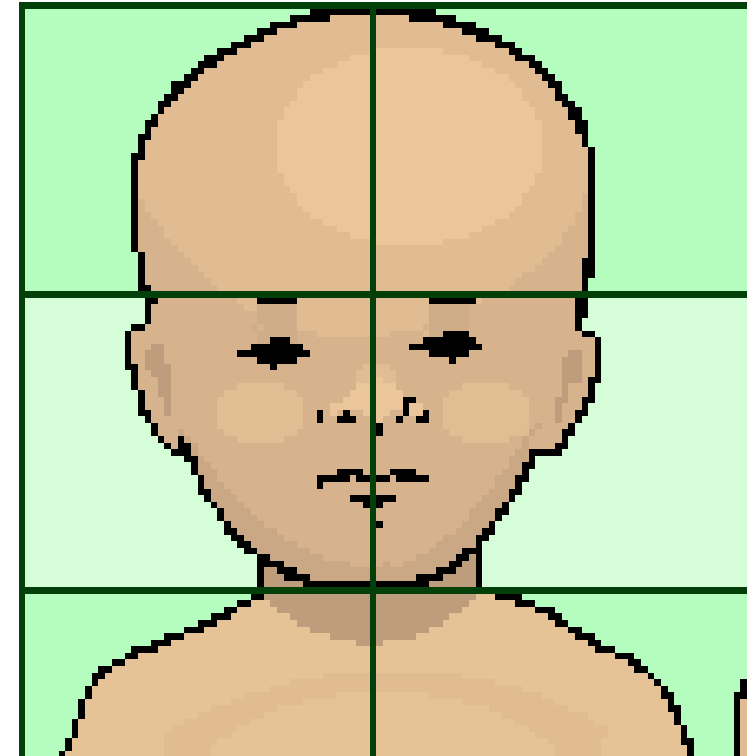
Clinical Features

- Often identified by pediatrician
- Issues with behavior, language, socialization
- Failure to reach developmental milestones
 - Not gesturing or babbling by 12 months
 - No two-word phrases at 2 years
- Referral to ASD specialists for diagnosis

Autism Spectrum Disorder

Clinical Features

- More common among **males**
 - Four times > females
- Increased head circumference
 - 25% of cases: greater than the 97th percentile



Ephert/Wikipedia

Autism Spectrum Disorder

Associated Disorders

- **Fragile X syndrome**
 - X-linked trinucleotide repeat disorder
 - Long face, big ears, large testes
- **Down's syndrome**
- **Rett's syndrome**
 - Neurodevelopmental disorder of girls
 - Initially normal development
 - Regression of cognitive/motor skills
 - Repetitive hand movements

Autism Spectrum Disorder

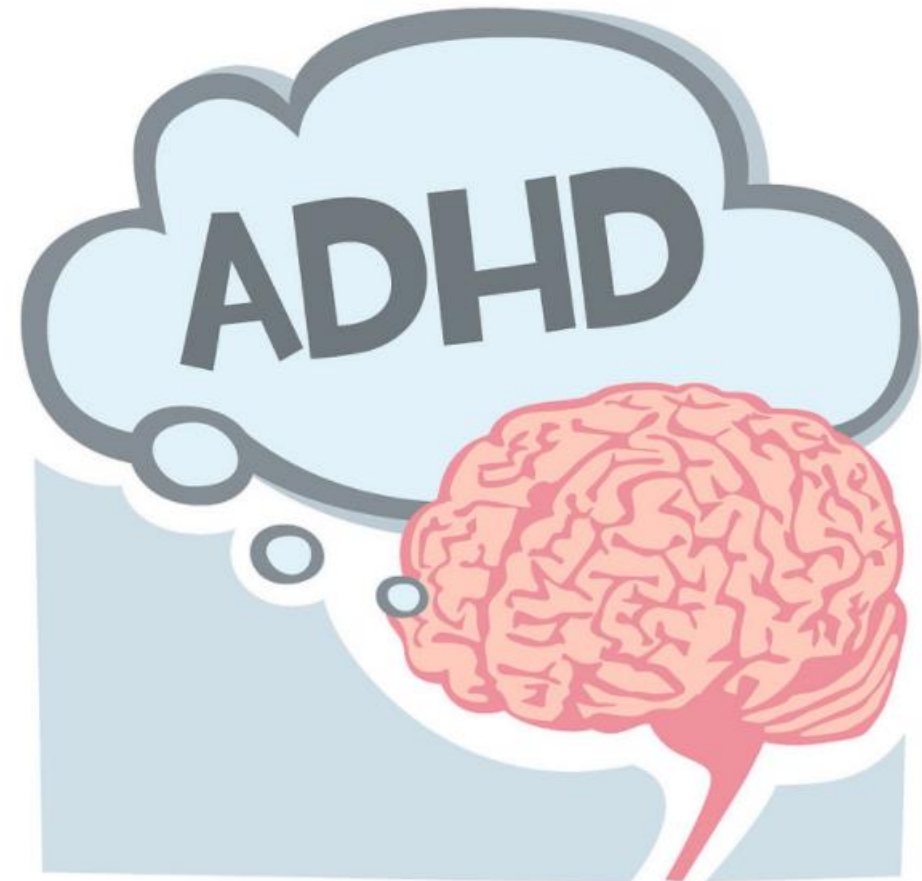
Treatment

- **Early behavioral intervention**
 - Behavioral management
 - Occupational therapy (teaching skills for daily activity)
 - Speech therapy
- No specific effective medical therapy
- Medications only for symptoms
 - Hyperactivity
 - Depression
- Two FDA-approved medications (antipsychotics)
 - Risperidone
 - Aripiprazole

ADHD

Attention deficit hyperactivity disorder

- Exact cause unknown
- Limited attention
- Hyperactivity
- Poor impulse control
- Normal intelligence on testing
 - But may have difficulty in school



amenclinicsphotos ac/Flickr

ADHD

Diagnostic Criteria

- Frequent symptoms of hyperactivity/impulsivity
- **Present in more than one setting (school/home)**
- Persist for **at least six months**
- **Present before age of 12**
- Impairs social/school functioning
- Excessive for developmental level of the child

ADHD

Diagnostic Criteria

DSM-5: Symptoms > 6 months and present in at least two settings, onset before age 12
- At least 6 inattentive symptoms and or 6 hyperactive symptoms

Inattentive	Hyperactive
- Difficulty sustaining attention	- Difficulty remaining seated
- Does not appear to listen	- Fidgets/squirms
- Difficulty organizing	- Runs about or climbs excessively
- Loses things	- Talks excessively
- Easily distracted	- Blurts out answers
- Careless mistakes	- Interrupts others
- Struggles following instructions	- Difficulty taking turns

ADHD

Epidemiology

- Four times more common in **males**
- Most cases among children 6 to 12 years old
- Symptoms persist to adulthood up to 2/3 of cases



marviikad/Flickr

ADHD

Treatment

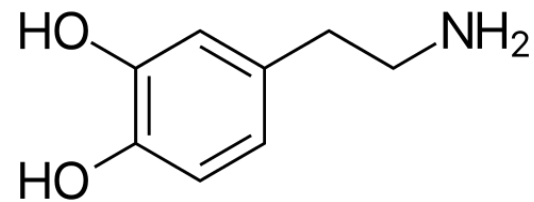
- Behavioral interventions (rewards, time out)
- Behavioral therapy
- Stimulants
- Atomoxetine
- Alpha-2 agonists
- Best treatment: **therapy plus medication**
 - Better than either alone



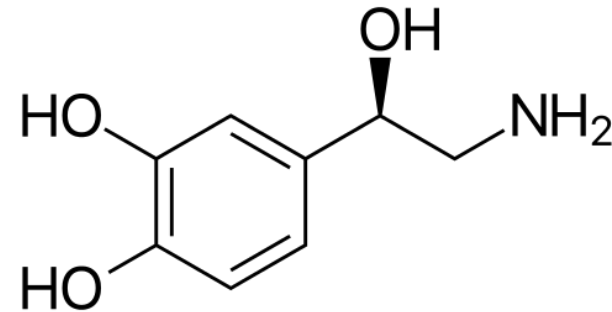
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Stimulants

- ADHD associated with **decreased CNS dopamine activity**
- Increase CNS dopamine and norepinephrine activity
- Increase CNS levels in synapses
- Improve ADHD symptoms
 - ADHD children stimulated by activity
 - Drugs relieve need to self-stimulate



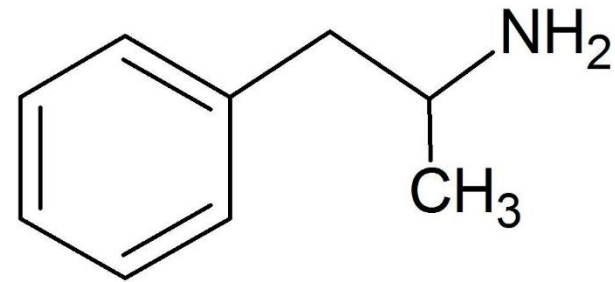
Dopamine



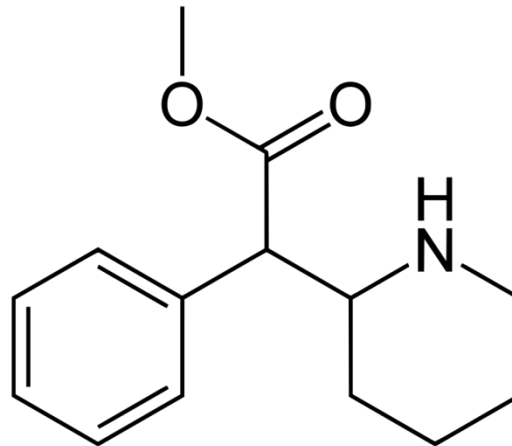
Norepinephrine

Stimulants

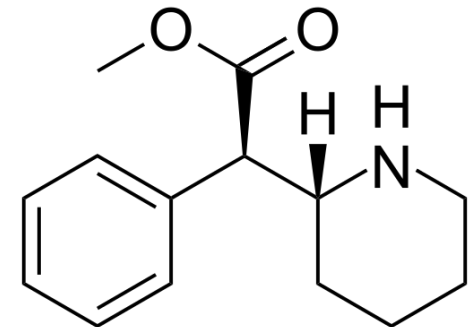
- Methylphenidate (Ritalin)
- Amphetamine (Adderall)
- Dexmethylphenidate (Focalin)



Amphetamine



Methylphenidate



Dexmethylphenidate

Stimulants

Adverse Effects

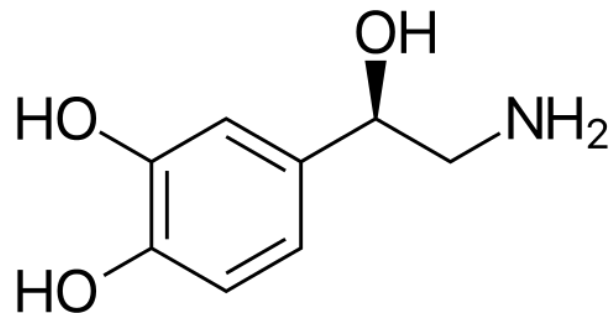
- Loss of appetite
- Weight loss
- Insomnia
- Abuse potential



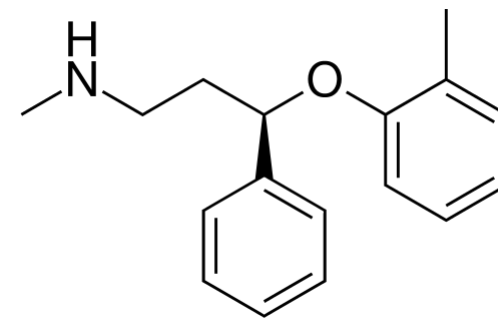
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Atomoxetine

- Considered a **non-stimulant** treatment for ADHD
- Selective **norepinephrine** re-uptake inhibitor
- No direct effects on dopamine systems in CNS
 - Dopamine effects may cause euphoria
 - **Less abuse potential**
- May have less insomnia, loss of appetite



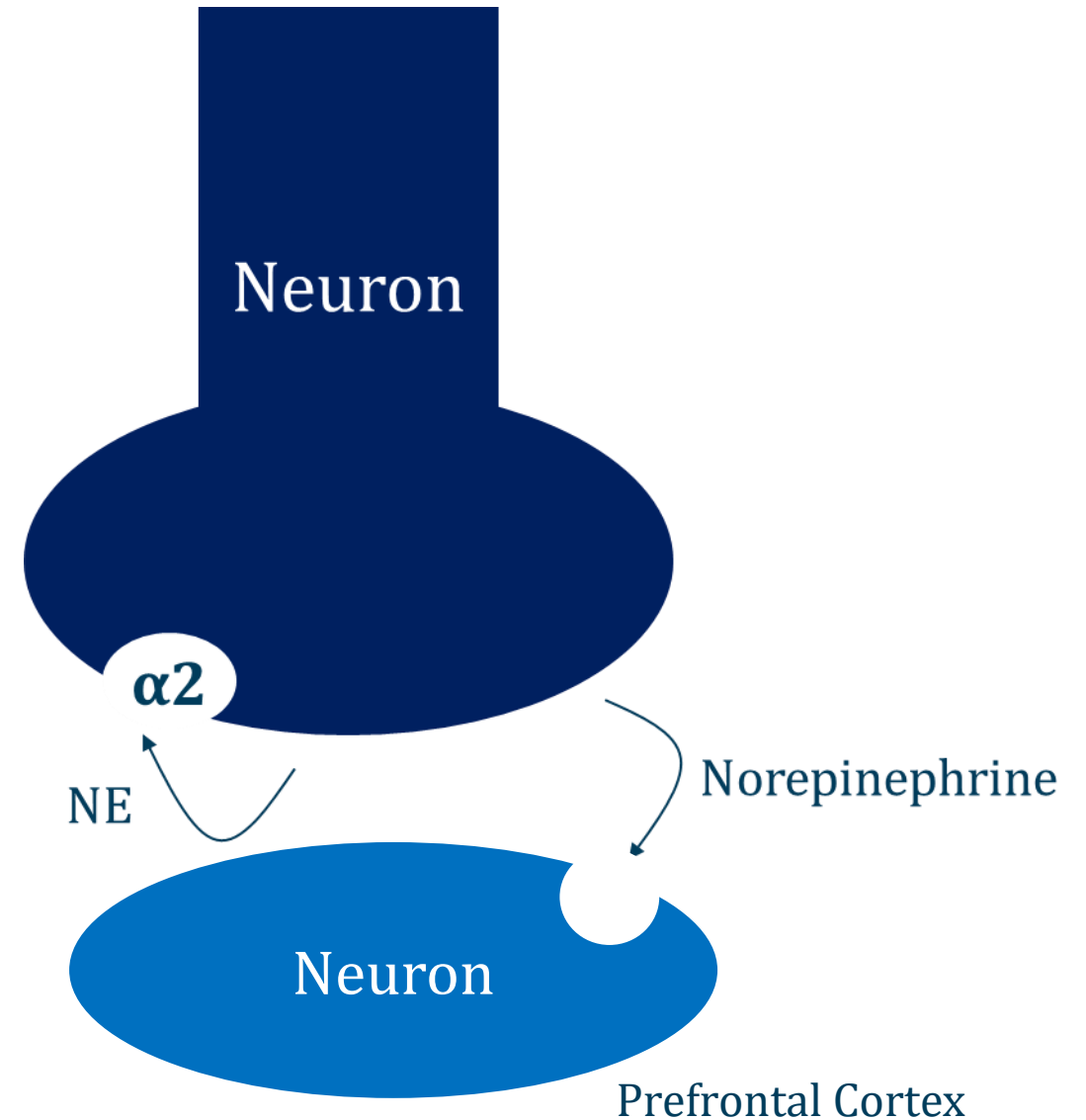
Norepinephrine



Atomoxetine

Alpha-2 Agonists

- **Clonidine**
- **Guanfacine**
- Decrease norepinephrine release
- Sedating and calming



Tourette Syndrome

Tic Disorder

- Neurologic disorder
- Occurs in children
- Hallmark: **recurrent tics**
- Sudden, quick repetitive movements or speech
- Commonly co-occurs with **other disorders**
 - Attention deficit hyperactivity disorder (ADHD) – 60%
 - Obsessive-compulsive disorder (OCD) – 30%

Tourette Syndrome

- Motor tics
 - Sudden, quick movements
 - Eye blink
 - Head jerk
 - Grimace
- Speech (phonic) tics
 - Sudden, quick speech, usually few words
 - Coprolalia: obscene language

Tourette Syndrome

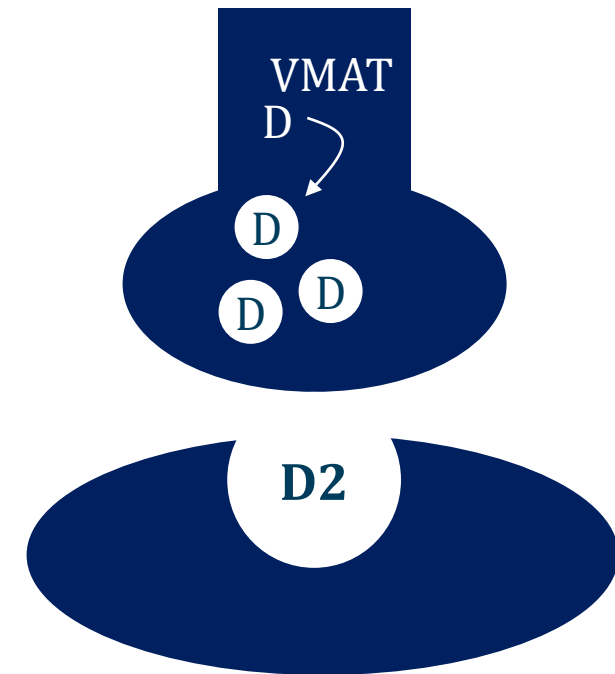
Diagnostic Criteria

- Based on clinical criteria
- **Tics for at least one year**
- Onset before 18 years (DSM-5 criteria)
- Multiple motor tics
- One or more phonic tics
- Tics occur many times a day
- Tics not be explained by another cause

Tourette Syndrome

Treatment

- Behavioral therapy (especially if OCD, ADHD)
- **Antipsychotics**
 - Haloperidol, pimozide, and aripiprazole
 - Fluphenazine, Risperidone
 - May cause tardive dyskinesia
- **Tetrabenazine** (“dopamine depletion”)
 - Inhibits VMAT-2 (vesicular monoamine transporter type 2)
 - Blocks uptake of dopamine synaptic vesicles (pre-synapse)
 - Less dopamine storage/release



Oppositional Defiant Disorder

- Angry, irritable child
- Argues with authority figures
- Defiant
- Vindictive toward parents/teachers



Gerry Thomasen/Flickr

Oppositional Defiant Disorder

Diagnostic Criteria and Treatment

- Occurs with at least one individual who is not a sibling
- Causes problems at work, school or home
- Not caused by substance use, depression or bipolar
- Lasts at least six months
- Treatment: Cognitive behavioral therapy
- Resolves in most children

DMDD

Disruptive mood dysregulation disorder

- New disorder
- Added to DSM-V in 2013
- Controversial
- Some symptoms common (irritability)
- Similarities to ODD
- Few established treatments

DMDD

Disruptive mood dysregulation disorder

- Childhood mood disorder
 - Must occur before age 10
- Excessively irritable or angry behavior
- Frequent **temper outbursts**
 - At least three times per week
 - At least two settings (home, school, etc.)
- Behavior out of proportion to situation

DMDD

Disruptive mood dysregulation disorder

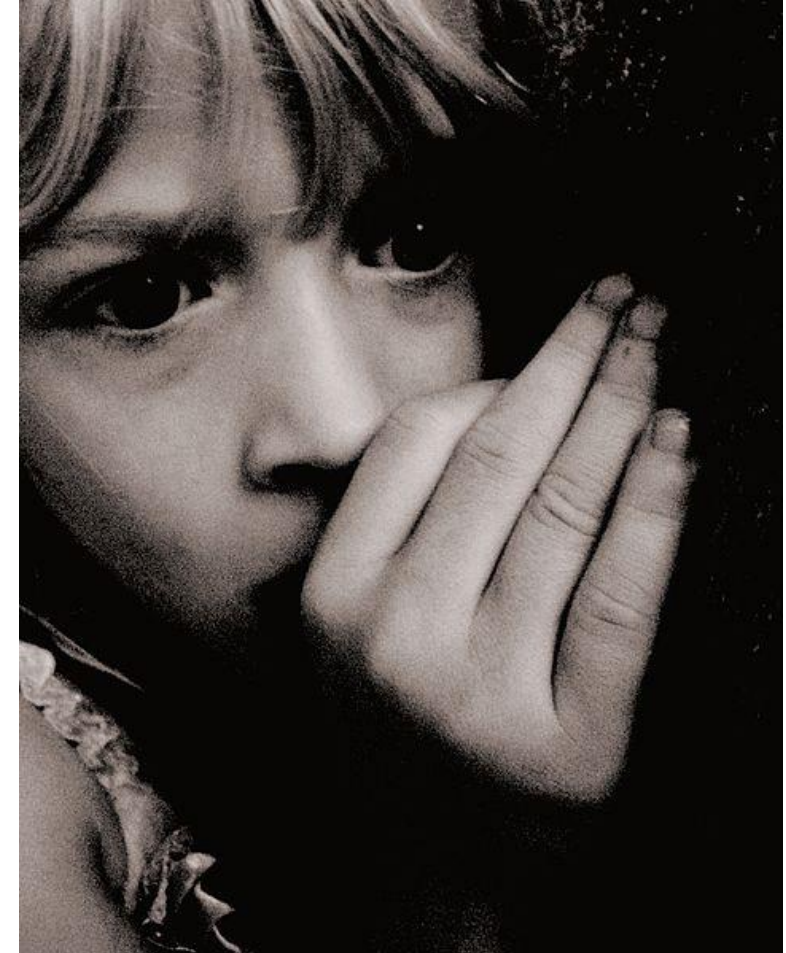
- Cognitive behavioral therapy
- Anti-psychotics
- Anti-depressants
- Stimulants

Separation Anxiety Disorder

- Childhood anxiety disorder
- Distress when separating home/parents
 - Refusal to leave home
 - Refusal to go to school
- Worry about losing major attachment figures
- Persistent reluctance/refusal to go out

Separation Anxiety Disorder

- Nightmares about separation
- Repeated complaints of **physical symptoms**
 - Headaches, upset stomach, nausea
 - Occurs with separation or in anticipation
- Treatment: **psychotherapy**
 - Goal: teach children coping skills
 - Cognitive behavioral therapy
 - Parent-child interaction therapy



D Sharon Pruitt/Wikipedia

Conduct Disorder

- Childhood behavioral disorder
- Repeated pattern of violating rights of others
- **Aggression** to people/animals
- **Destruction** of property
- Lying or stealing
- Adult version: Antisocial personality disorder



Bad Behavior

ADHD
Poor attention
Hyperactivity

ODD
Argues
Defiant

DMDD
Temper tantrums

Conduct Disorder
Property destruction
Aggression to animals

Congenital Gastroenterology I

Jason Ryan, MD, MPH



Meconium

- **First stool of newborn**
- Dark, thick, and sticky
- Should pass within 24 hours
- **Meconium aspiration syndrome**
 - Meconium passes in utero
 - Baby born through meconium-stained amniotic fluid
 - Causes newborn respiratory distress
 - Treatment: maintenance oxygenation and ventilation
 - Empirical antibiotics

Meconium



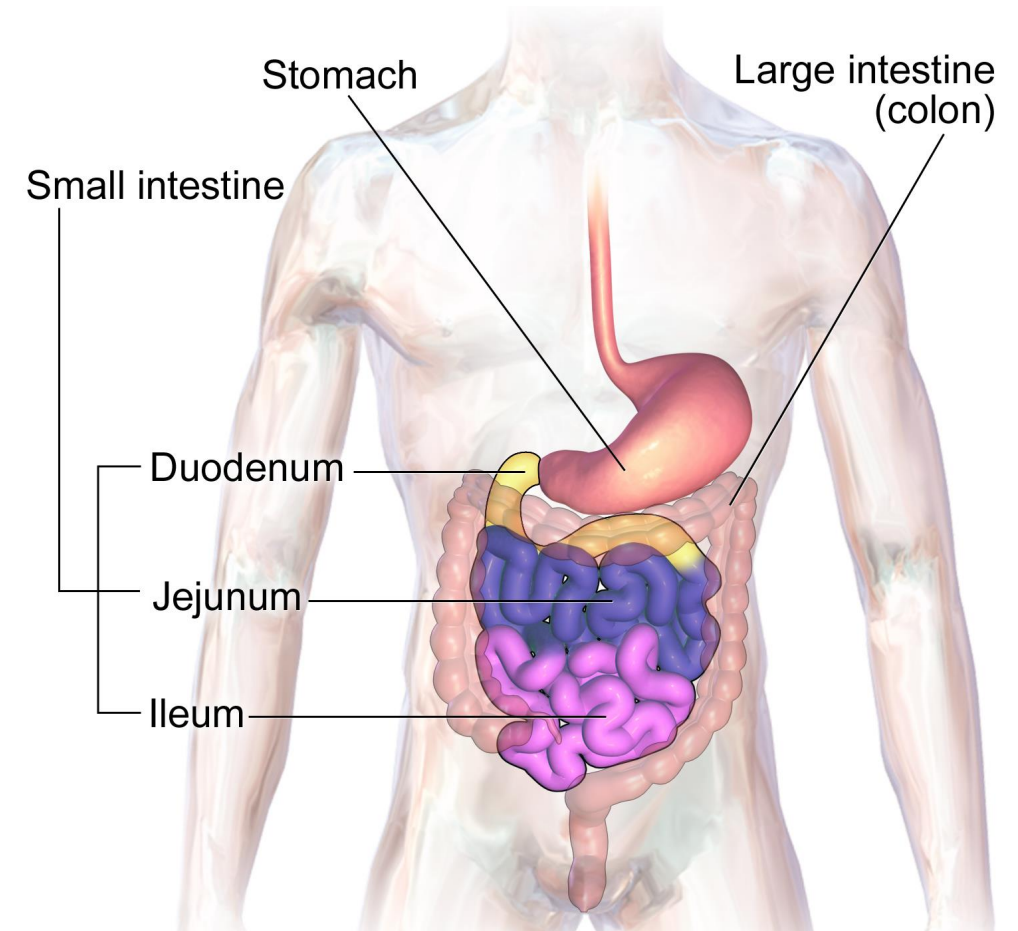
Delayed Meconium Passage

- May indicate intestinal obstruction
- Many potential causes
- Must consider **meconium ileus** and **Hirschsprung's**



Meconium ileus

- **Small bowel obstruction** due to meconium
- Meconium too thick/sticky (“ inspissated ”)
- Meconium plug forms
- Abdominal distension
- Bilious vomiting (green-yellow color)
- Almost all cases associated with **cystic fibrosis**

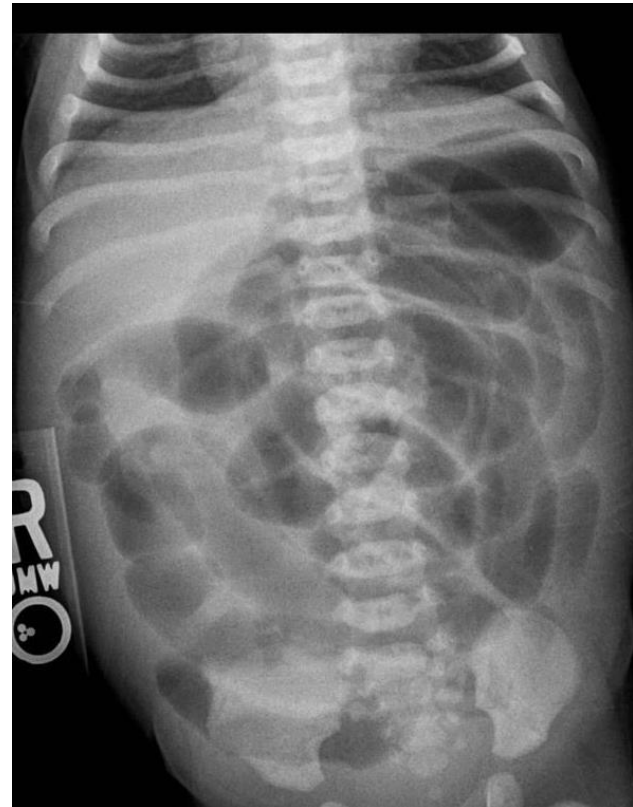


Meconium ileus

Diagnosis

- **Abdominal x-ray**
 - Identifies dilated bowel loops
 - “Soap-bubble” sign
 - Meconium mixed with air
 - Excludes perforation
- **Contrast enema x-ray**
 - Small colon (“microcolon” - unused)
 - Partial small bowel filling
 - Pellets of meconium

Plain X-ray



medpix.nlm.nih.gov

Contrast Enema

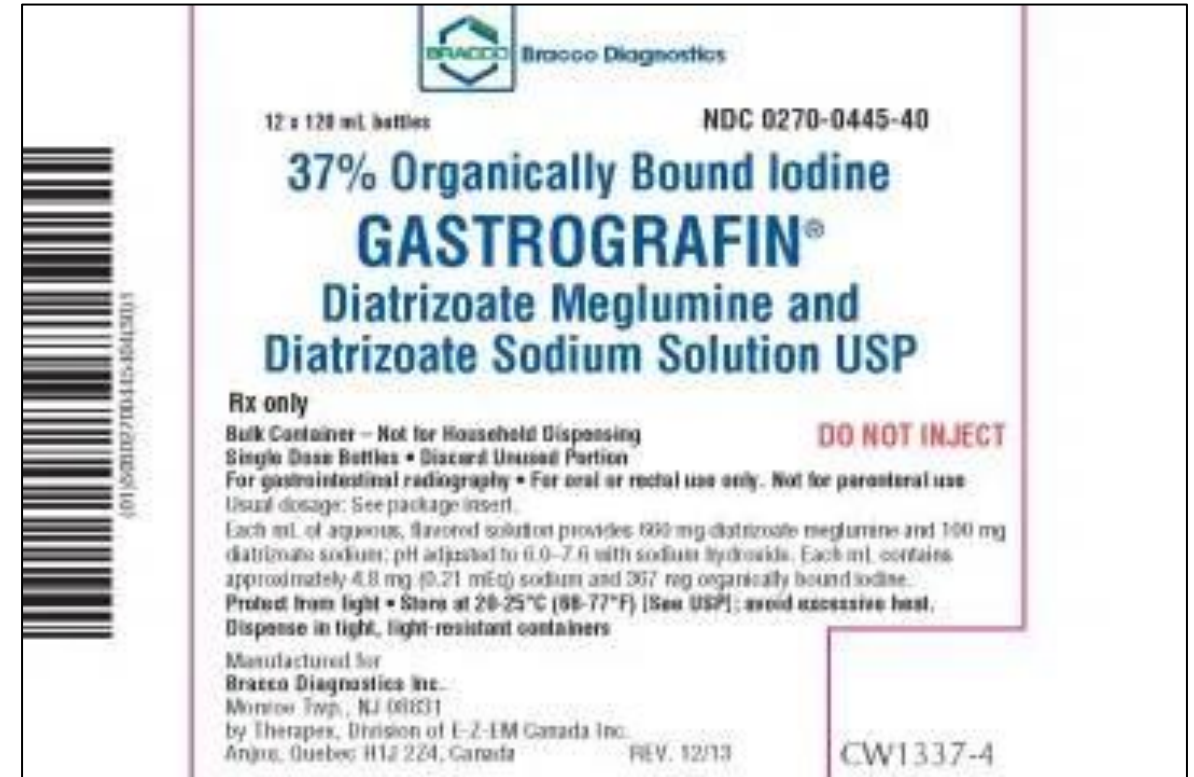


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Meconium ileus

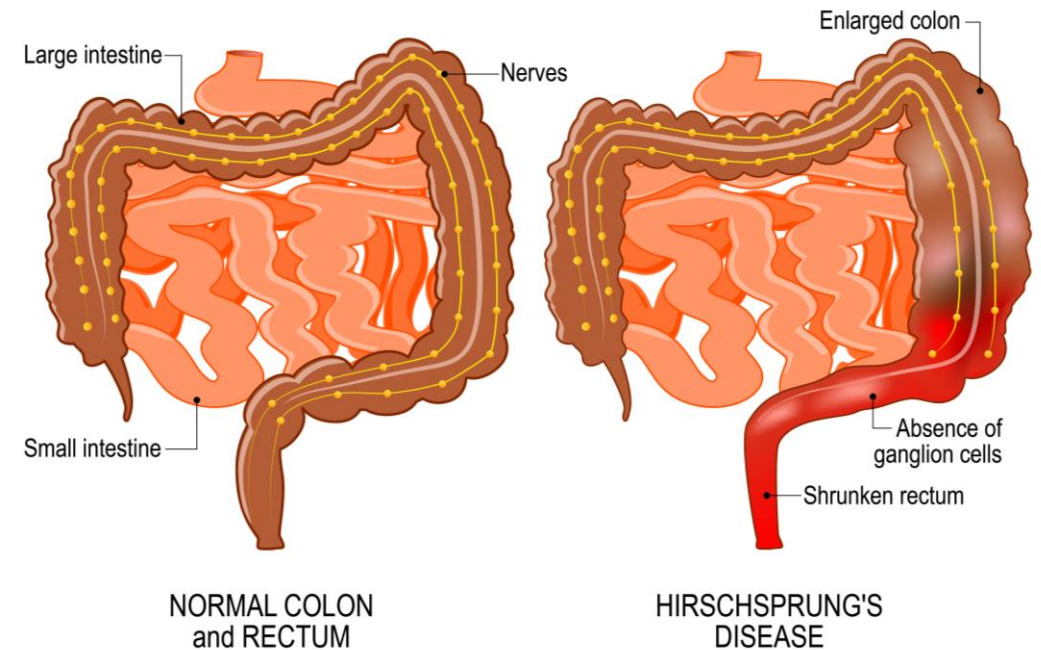
Management

- Nasogastric decompression
- **Gastrografin enema**
 - Done after diagnostic enema
 - Hyperosmolar enema
 - Draws fluid into bowel
 - Breaks up meconium
- Surgery for hemodynamic instability



Hirschsprung's Disease

- Congenital motor disease of colon
- Abnormal peristalsis of colon
- **Absent ganglion cells**
 - Derived from neural crest cells
 - Fail to migrate properly in Hirschsprung's disease
- Result: obstruction (no peristalsis)
- Often associated with other anomalies
 - Vision, hearing, genitourinary, cardiac
- Associated with **Down syndrome**



Hirschsprung's Disease

Clinical Features

- **Failure to pass meconium**
- Abdominal distention
- Bilious vomiting
- Examination: no stool in rectal vault
- **Squirt or blast sign**
 - Rectal exam → temporary obstruction relief
 - Rapid emptying of bowels
- Less severe disease (uncommon): chronic constipation

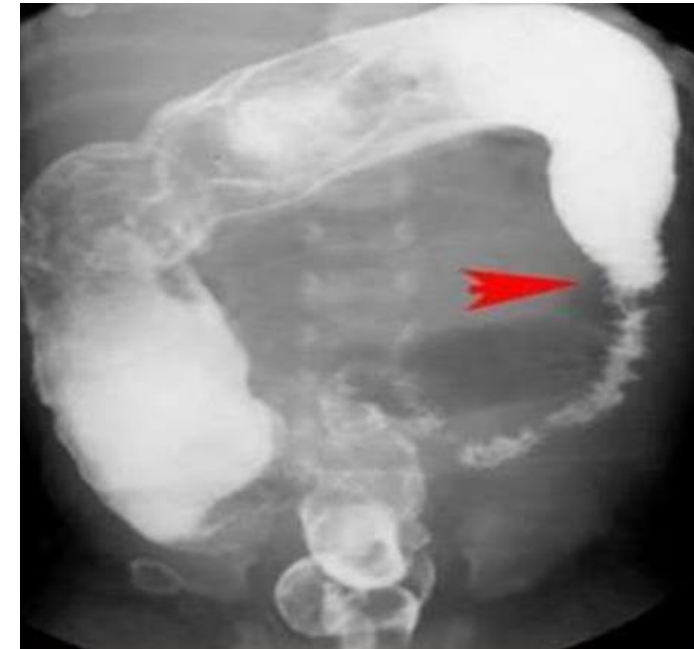
Hirschsprung's Disease

Diagnosis and Treatment

- **Abdominal x-ray**
 - Dilated bowel
 - No air in rectum
- **Contrast enema: “transition zone”**
 - Done after x-ray showing no perforation
 - Proximal distended bowel (normal)
 - Distal bowel small (abnormal)



Dr Hani Salam/Radiopedia

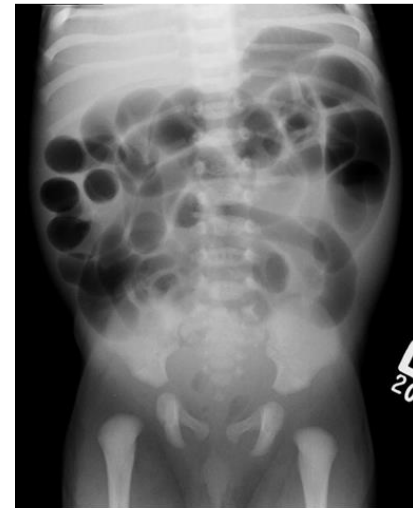


Dr. Abd Allah Nazeer, MD/Slideshare

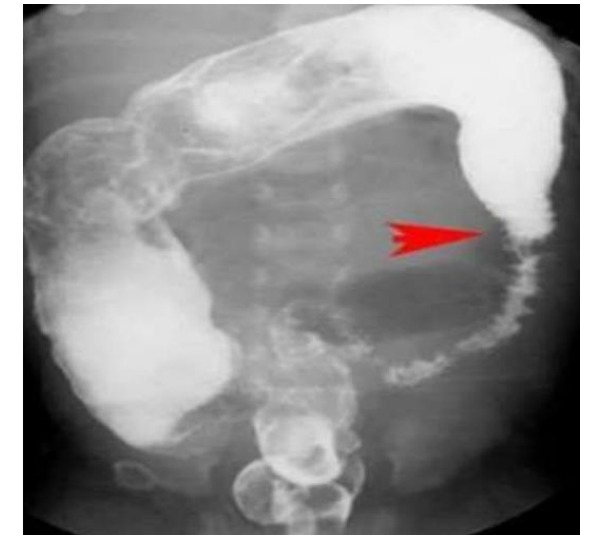
Hirschsprung's Disease

Diagnosis and Treatment

- **Rectal “suction” biopsy**
 - Rectum ALWAYS involved (other areas variable)
 - Standard biopsy may only show mucosa
 - Need to biopsy full thickness including submucosa
 - Diagnosis confirmed by showing absence of ganglion cells
- Treatment: colon resection
 - Removal of colon without ganglion cells



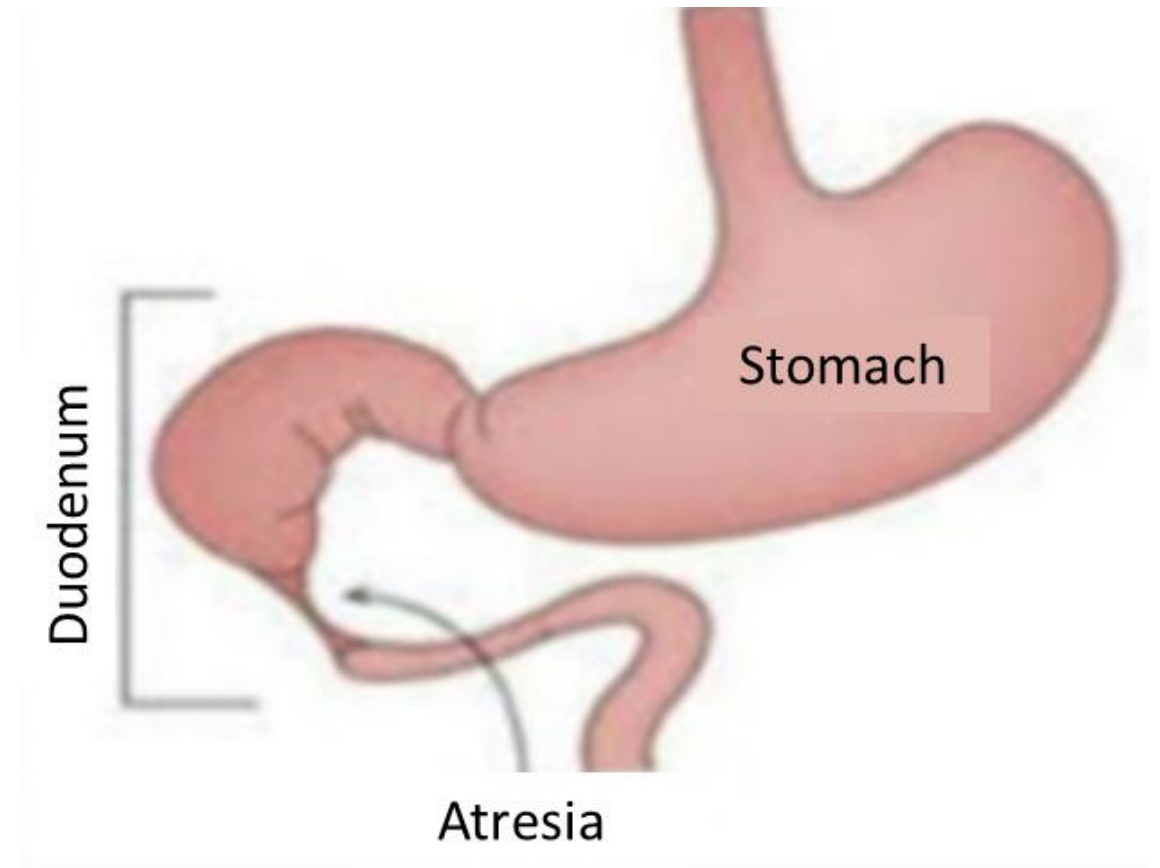
Dr Hani Salam/Radiopedia



Dr. Abd Allah Nazeer, MD/Slideshare

Intestinal Atresia

- Atresia = closed/absent opening
- Can occur anywhere in GI tract
- **Duodenum is most common**
- Colon rare
- Associated with **polyhydramnios**
- Bilious vomiting in newborn
- Abdominal distension



Duodenal Atresia

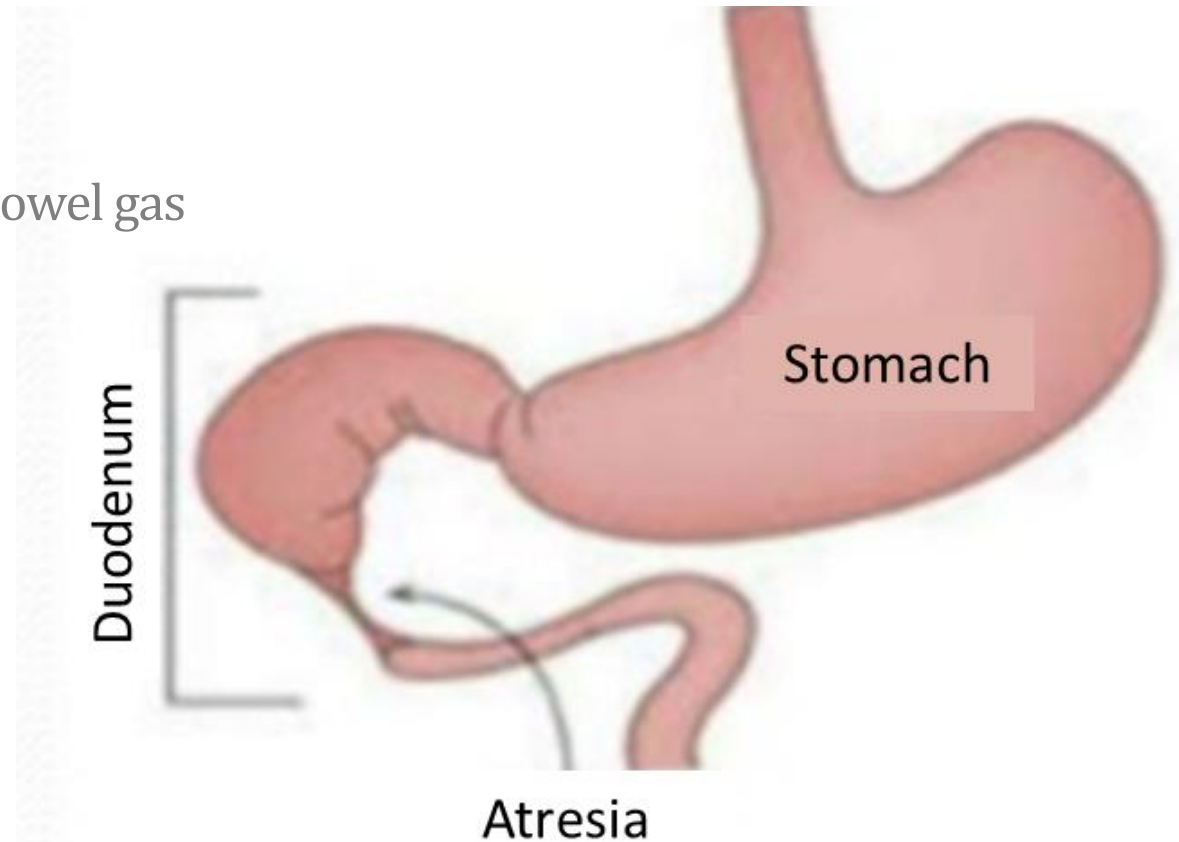
- Associated with failure of “**recanalization**”
 - In early development, duodenum occludes
 - Patency restored by recanalization
- Associated with Down syndrome
- Diagnosis: x-ray
 - **Double bubble sign**
 - Distention of duodenal stump and stomach
 - Tight pylorus in middle
 - No distal gas

Double Bubble Sign



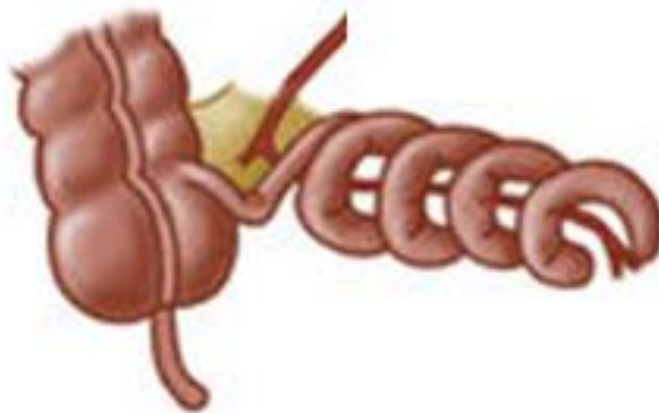
Duodenal Atresia

- Double bubble + no distal gas = duodenal atresia
- Upper GI series
 - Contrast x-ray
 - Rules out malrotation with midgut volvulus
 - Shows dilated stomach/duodenum, no distal bowel gas
- Definitive treatment: surgery
 - After stabilization with NG tube and fluids



Jejunal-Ileal Atresia

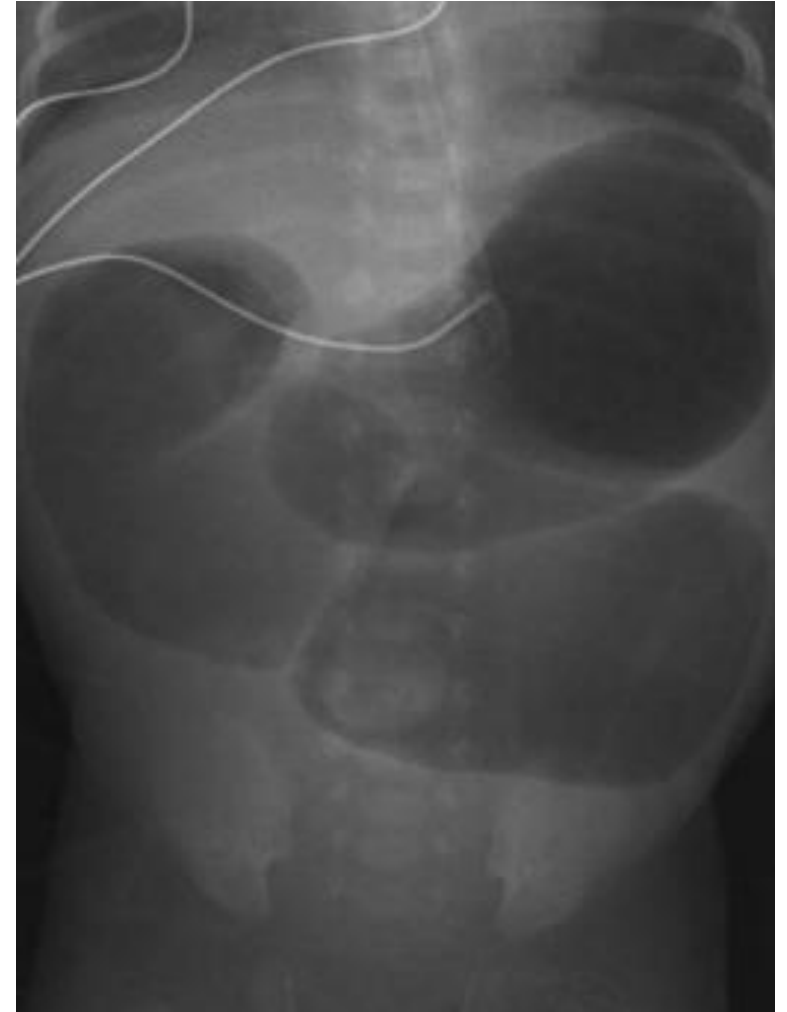
- Vascular disruption → **ischemic necrosis of intestine**
 - Necrotic tissue resorbed
 - Leaves blind ends of bowel
- Bowel distal to blind end may be curled
 - “Apple-peel atresia”



Jejunal-Ileal Atresia

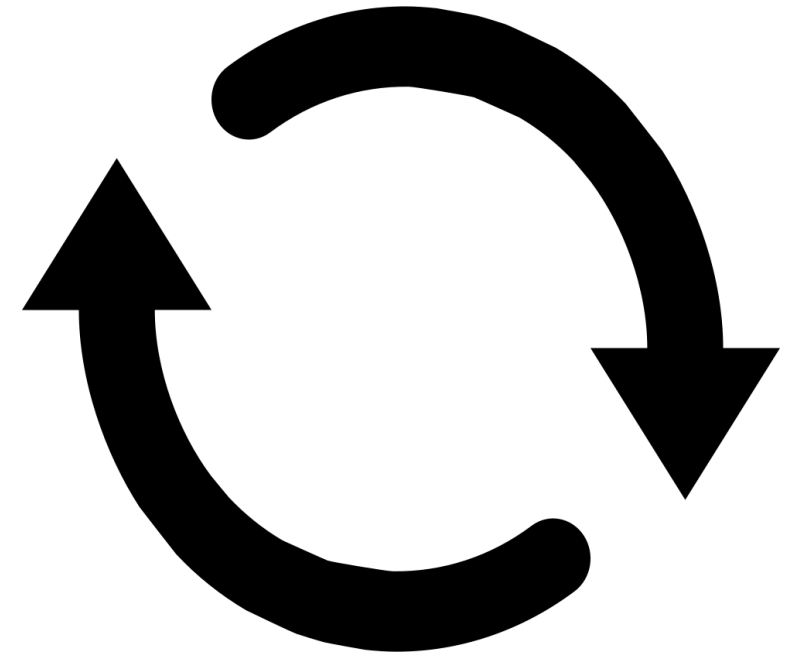
- X-ray: **triple bubble sign**
 - Classic finding in jejunal atresia
 - Double bubble plus 3rd bubble for jejunal distension
- Treatment: surgery

Triple Bubble Sign



Malrotation

- Failure of embryonic gut to rotate normally
- Improper positioning of the bowel
- Fibrous adhesions of peritoneum (Ladd Bands)
- Can cause **duodenal obstruction** from bands
- May be **asymptomatic throughout life**
 - Sometimes incidentally discovered
- Most common presentation in babies: **midgut volvulus**



Midgut Volvulus

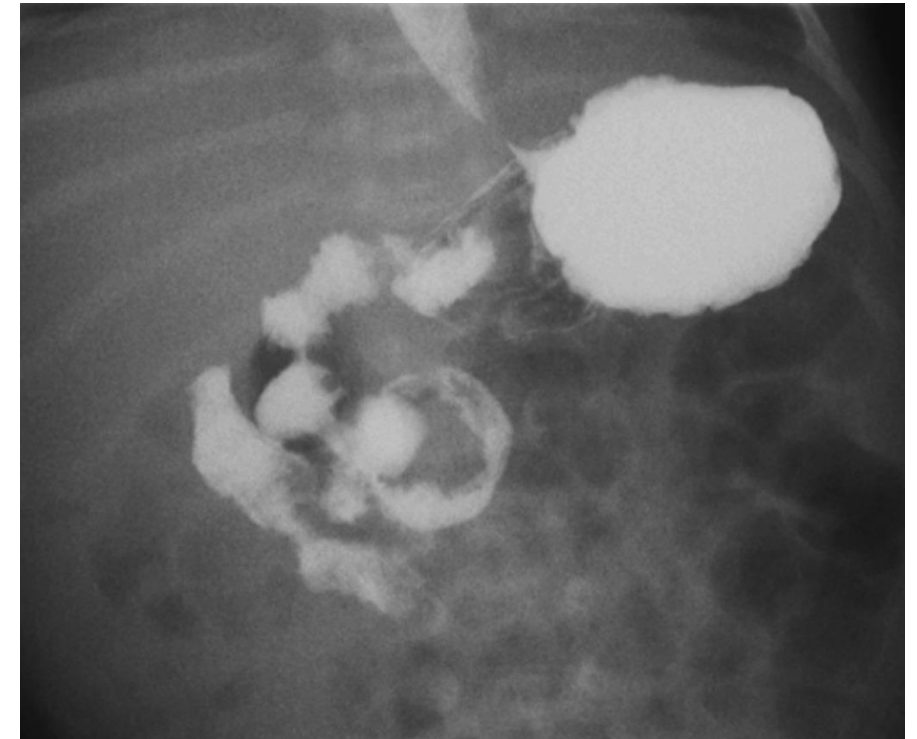
- Small bowel (usually ileum) **twists around SMA**
- Causes small bowel obstruction
- Vascular compromise → ischemia
- **Usually presents 3 to 7 days of life**
- Bilious vomiting
- Mild abdominal distention
- Blood in stool
- **Sepsis (bowel necrosis)**
 - Fever
 - Signs of peritonitis or shock possible



Midgut Volvulus

- Best initial test: **abdominal x-ray**
 - Can be normal in early stages
 - May show dilated bowel loops
 - Excludes perforation
- US: dilated duodenum
 - Normal US does not exclude diagnosis
- Diagnosis: **upper GI series with contrast**
 - “Corkscrew” appearance of proximal small bowel

Malrotation with Midgut Volvulus

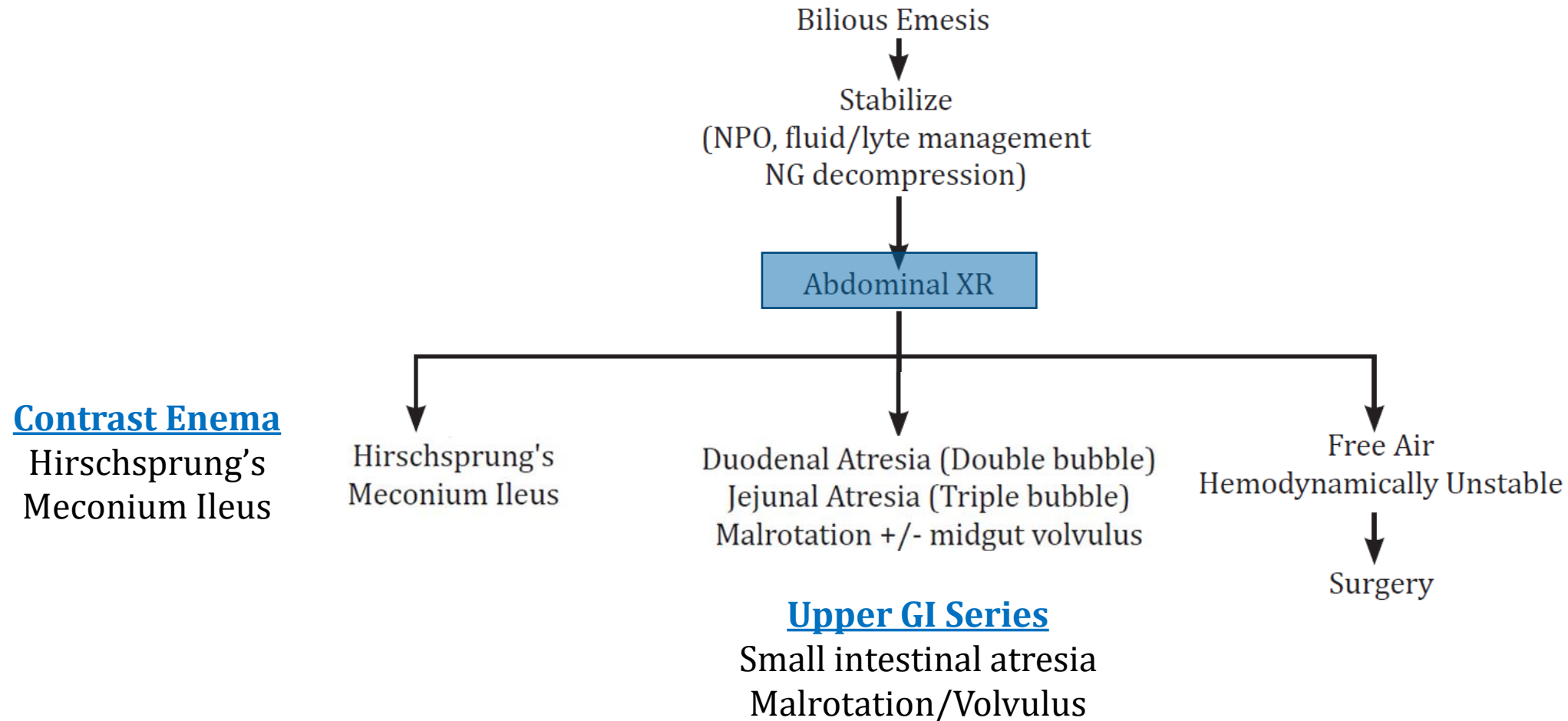


Midgut Volvulus

- Treatment: urgent surgery
- Ladd's procedure
- Remove adhesions and appendix
- Put small bowel on right, colon on left



Bilious Emesis in Newborns



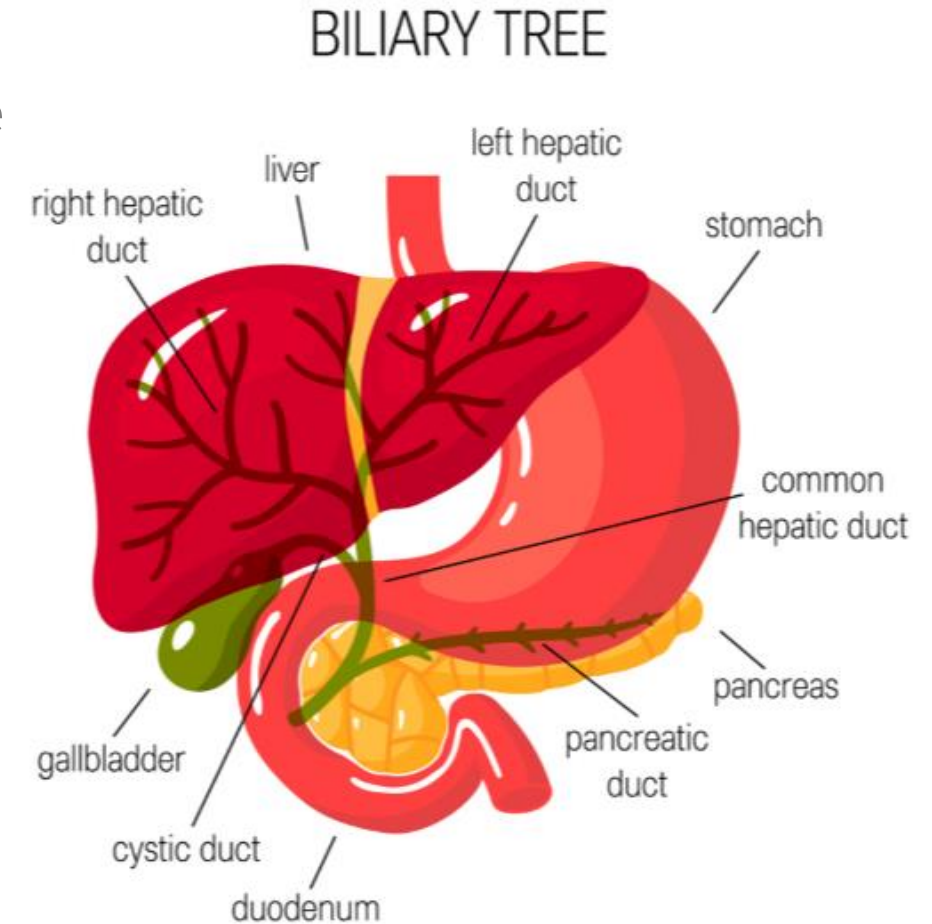
Congenital Gastroenterology II

Jason Ryan, MD, MPH



Biliary Atresia

- **Biliary obstruction** in newborns
- Biliary ducts do not form or degenerate early in life
- Presents 2 to 8 weeks after birth
- Jaundice
- **Conjugated hyperbilirubinemia**
- Dark urine
- Pale stools (“acholic”)
- Elevated AST/ALT



Biliary Atresia

Diagnosis and Management

- Initial diagnosis: **ultrasound**
 - Gallbladder absent or abnormal
 - Absence of common bile duct
 - No other causes of obstruction
- Treatment: **surgery (Kasai procedure)**
 - Hepatoportoenterostomy (HPE)
 - Create conduit for bile drainage using small intestine
 - Followed by treatment with ursodeoxycholic acid
 - Modifies balance of bile acids to protect conduit
- Most children eventually need liver transplant

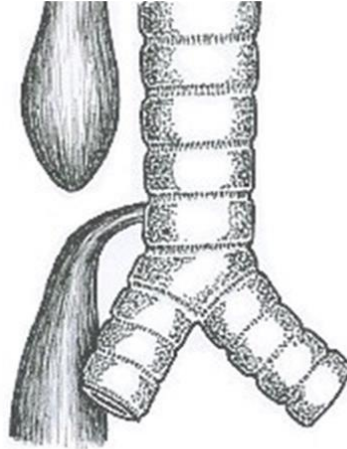
Small, Irregular Gallbladder



Esophageal Atresia

- Esophageal narrowing or interruption
- Most commonly occurs with **tracheoesophageal fistula**

EA with TEF
Most Common

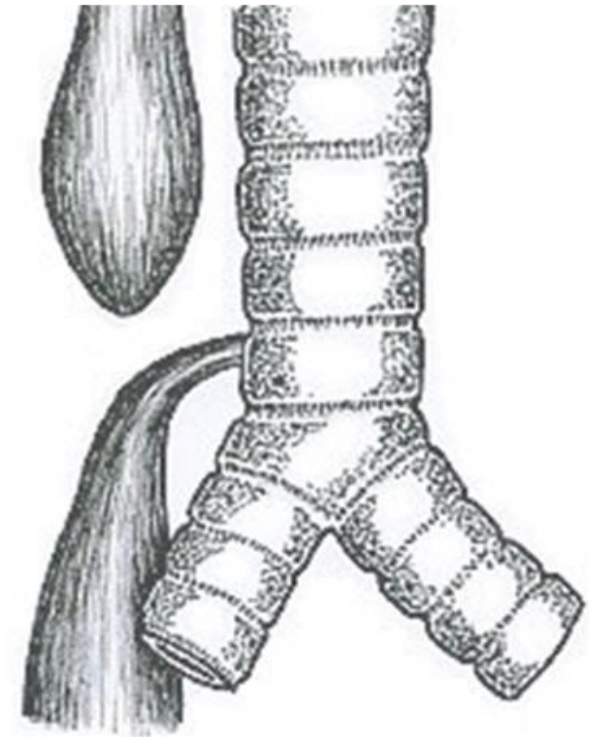


Esophageal Atresia

Clinical Features

- Esophagus does not connect to stomach
 - Polyhydramnios (baby cannot swallow fluid)
 - **Drooling, choking, vomiting** (accumulation secretions)
 - Symptoms occur with feeds
 - Cannot pass NG tube into stomach
- Fistula esophagus → trachea
 - Gastric distension (air in stomach on CXR)
 - Reflux → aspiration pneumonia → **respiratory distress**

EA with TEF Most Common



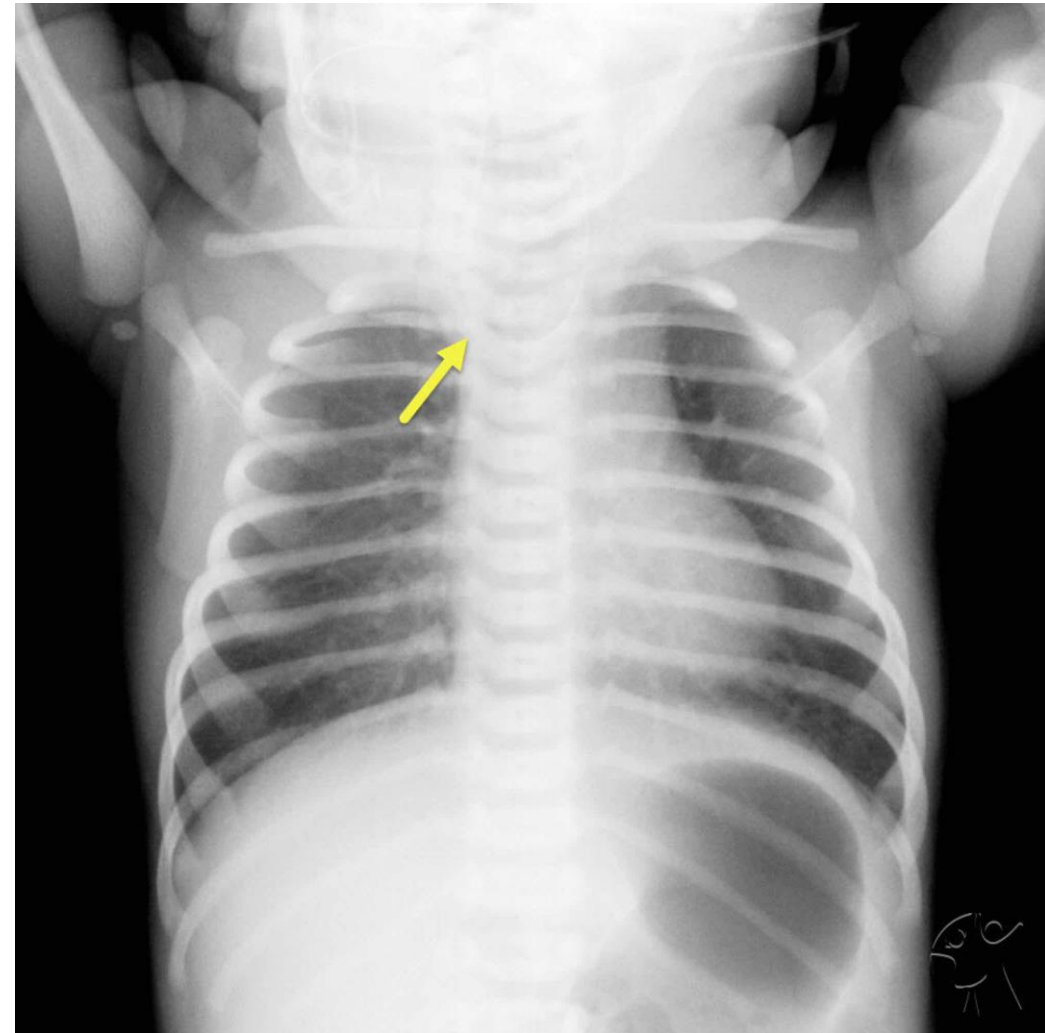
Esophageal Atresia

Clinical Features

- Best initial test: **chest x-ray**
- NG tube curled
- Gas-filled gastrointestinal tract
- Treatment: surgical repair
- Prognosis:
 - Sometimes residual dysmotility
 - GERD

Tracheoesophageal Fistula

(Air in stomach; NG tube coiling)



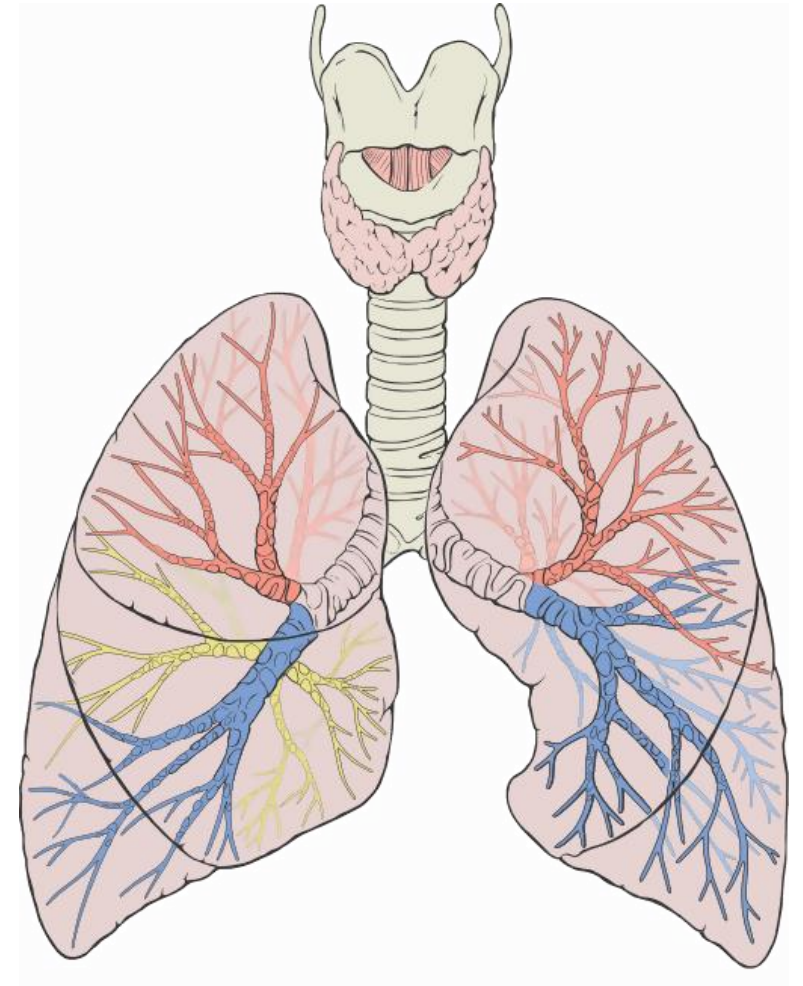
VACTERL Association

- **V**ertebral defects
- **A**nal atresia
- **C**ardiac defects
- **T**racheoesophageal fistula
- **R**enal anomalies
- **L**imb abnormalities
- Anomalies that commonly occur together
- Babies with VACTERL have at least three
- Diagnosis of one → screen for others

CDH

Congenital diaphragmatic hernia

- Developmental defect of diaphragm
- Defective formation **pleuroperitoneal membrane**
- Abdominal organs herniate into chest
- In utero herniation → **pulmonary hypoplasia**
- Can lead to fetal demise



CDH

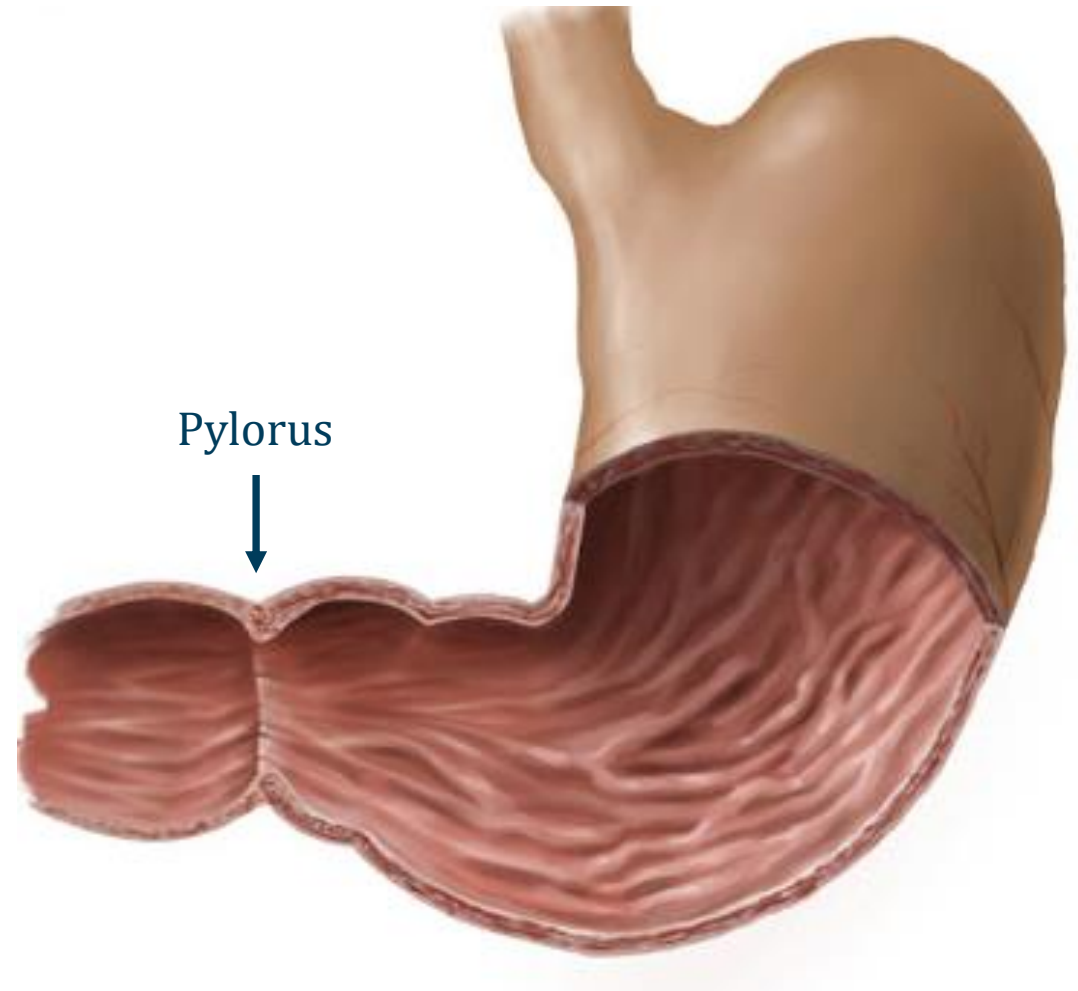
Congenital diaphragmatic hernia

- Diagnosis in utero: ultrasound
- At birth: **chest x-ray**
 - Abdominal contents in chest
- Initial stabilization and ventilation
- Definitive treatment: surgery



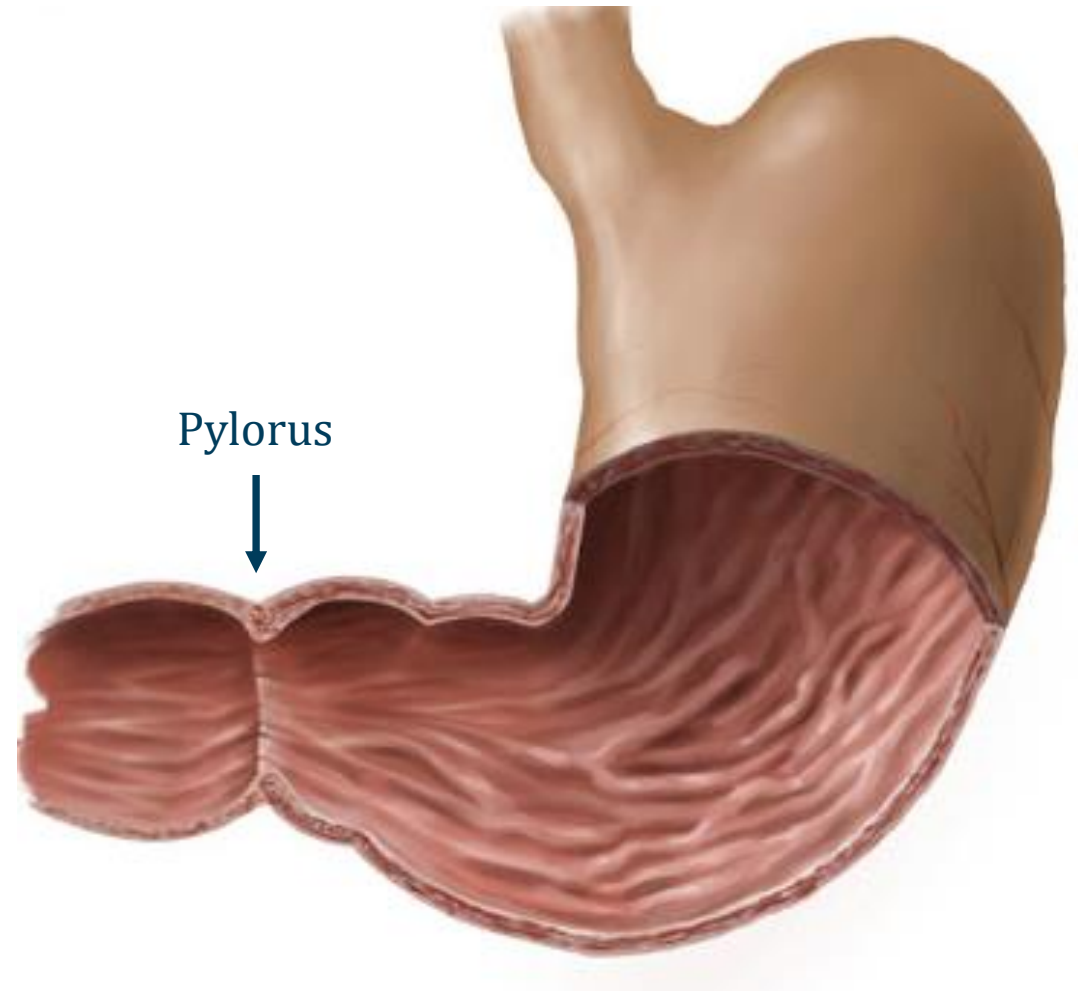
Hypertrophic Pyloric Stenosis

- Hypertrophy of pylorus
- Gastric outlet obstruction
 - “Projectile,” non-bilious vomiting (clear/yellow)
- Palpable mass – **“olive sign”**
 - Feels like olive
- Metabolic alkalosis from vomiting
- Usually presents three to six weeks of age
- “Hungry vomiting”



Hypertrophic Pyloric Stenosis

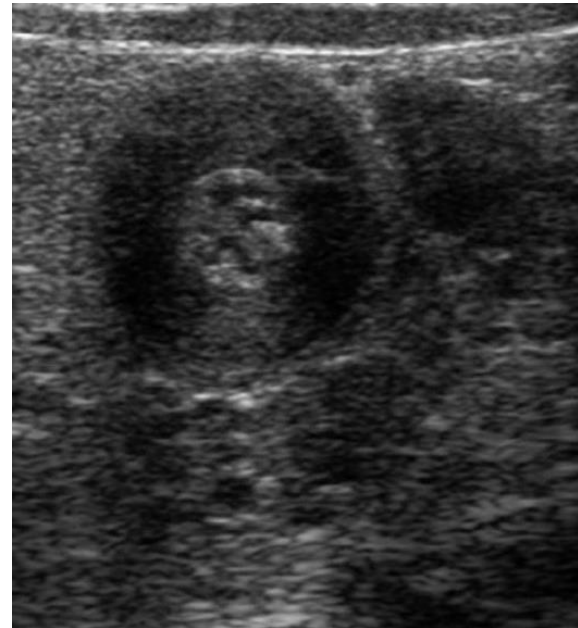
- 30% are first-born children
- More common in males
- Macrolide antibiotics
 - Erythromycin and azithromycin
 - Increased risk when used before 2 weeks of age



Hypertrophic Pyloric Stenosis

- Diagnosis: **ultrasound**
 - “Target sign” or “Donut sign”
 - Hypertrophied hypoechoic muscle
 - Surrounds mucosa
- Upper GI contrast X-ray
 - Done if US equivocal
 - String sign
 - Elongated pyloric canal
- Treatment:
 - Volume resuscitation
 - Surgery

Target or Donut Sign
(ultrasound)



String Sign
(contrast X-ray)



Omphalocele

- Persistence of normal herniation
- Intestines covered by peritoneal membrane
- Usually herniate through umbilical cord
- Easily identified on fetal ultrasound
- Rarely involves liver
 - Liver does not normally herniate



Omphalocele

- Many associated genetic defects
 - Trisomy 21 (Down syndrome)
 - Trisomy 18 (Edwards syndrome)
 - Trisomy 13
- Many associated conditions
 - Congenital heart defects (up to 50% babies)
 - Orofacial clefts
 - Neural tube defects
- Treatment: surgical closure



Gastroschisis

- Extrusion of bowel through **abdominal wall defect**
- **Not covered by peritoneum**
- Free-floating bowel in amniotic sac on US
- **Elevated maternal AFP**
- Incomplete closure of abdominal wall
- Paraumbilical abdominal wall defect
- Usually on right side of umbilical cord
- Bowel ischemia and necrosis may occur



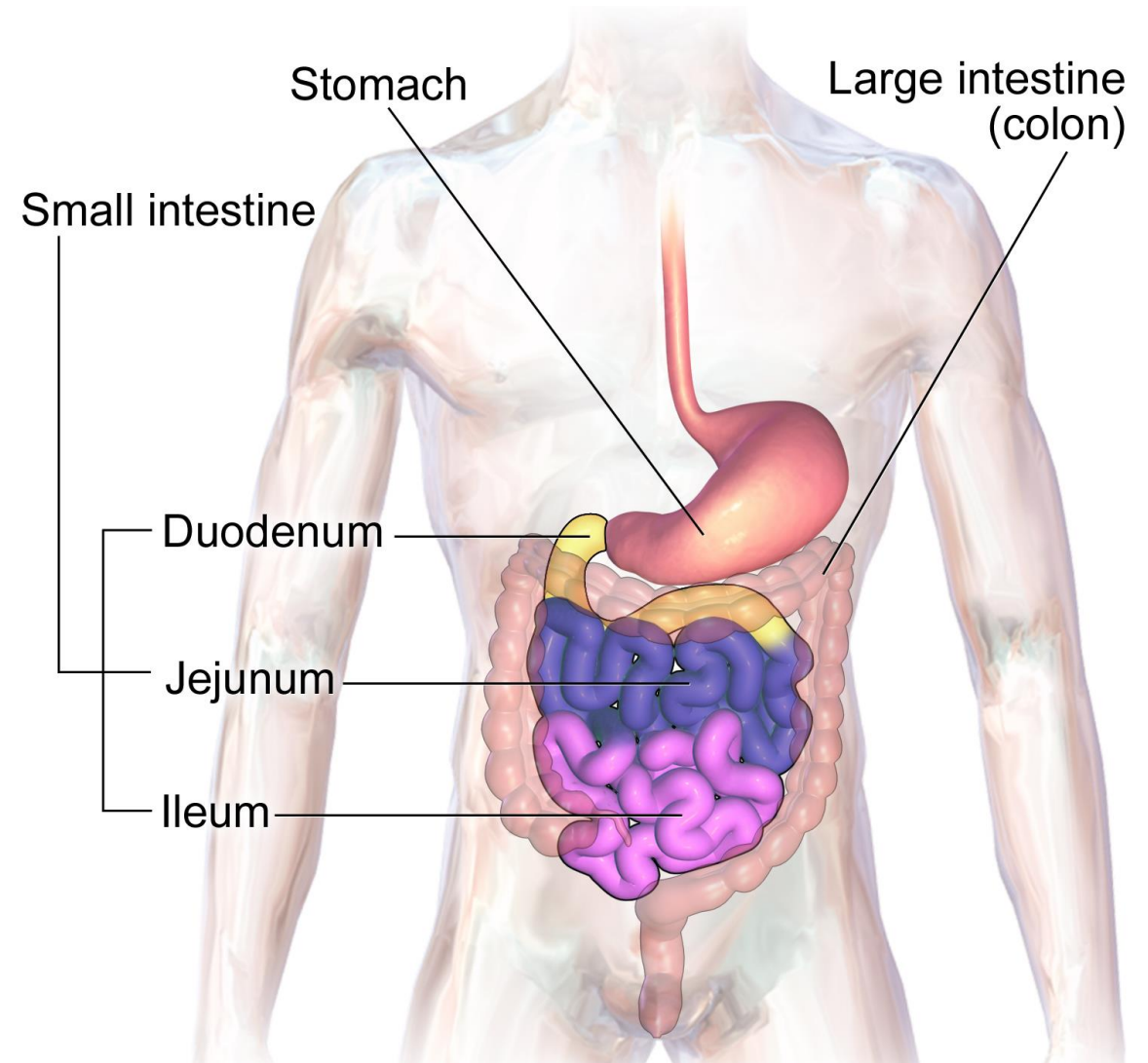
Gastroschisis

- Usually an **isolated defect**
 - Contrast with omphalocele
 - Usually no trisomy or other defects
- Treatment: surgery



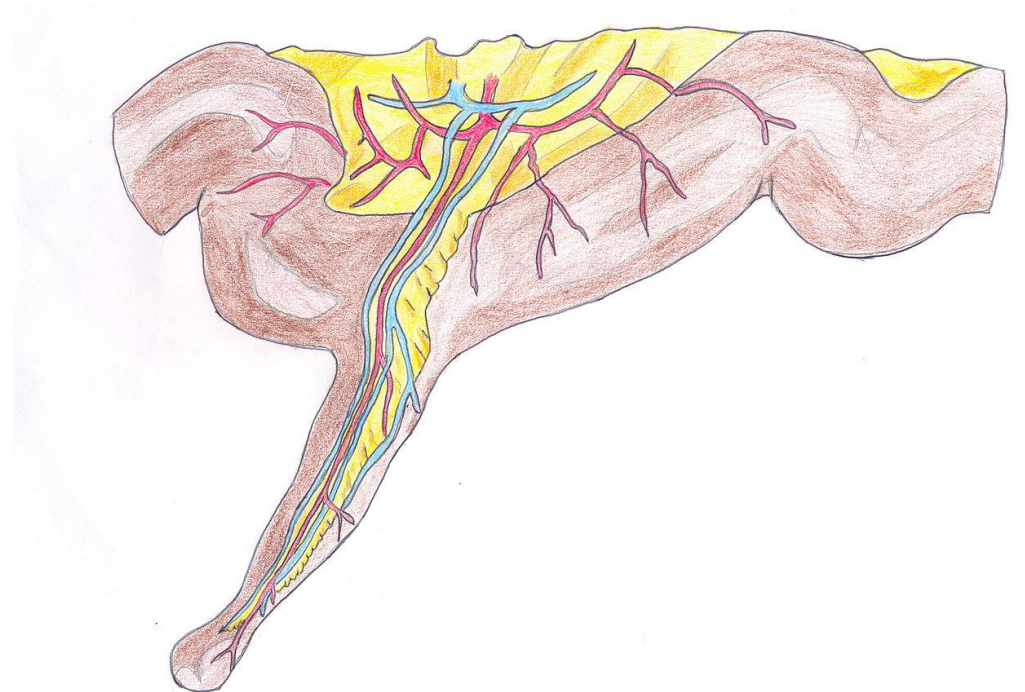
Meckel's Diverticulum

- Most common congenital GI anomaly
- Diverticulum of **small bowel (ileum)**
- Persistent remnant of **vitelline duct**



Meckel's Diverticulum

- “True diverticulum”
 - Contains **all layers of bowel wall**: mucosa, submucosa, muscular
 - Contrast with colonic diverticula
- Often contains **stomach tissue**
 - “Ectopic gastric tissue”
 - Origin unclear
 - Sometimes pancreatic tissue also



Meckel's Diverticulum

Clinical Features

- Usually no symptoms
- Often incidental discovery on imaging or at surgery
- Can present at any age but 50% < 10 years
- Ectopic gastric tissue may secrete acid
 - Ulceration
 - Pain
 - Bleeding
- Most common symptom: **painless bleeding**
- Potential cause of obstruction, diverticulitis

Meckel's Diverticulum

Rule of 2's

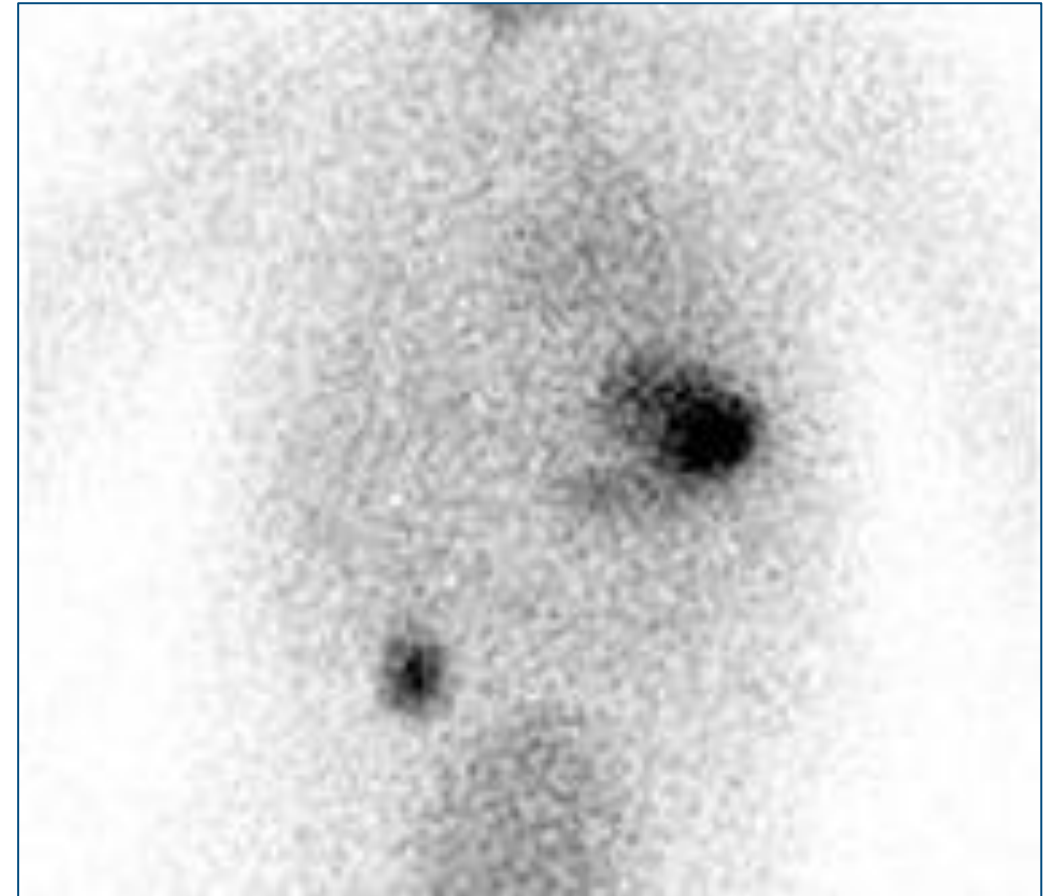
- 2 percent of population
- Male-to-female ratio 2:1
- Within 2 feet from the ileocecal valve
- Usually 2 inches in size

Meckel's Diverticulum

Diagnosis and Treatment

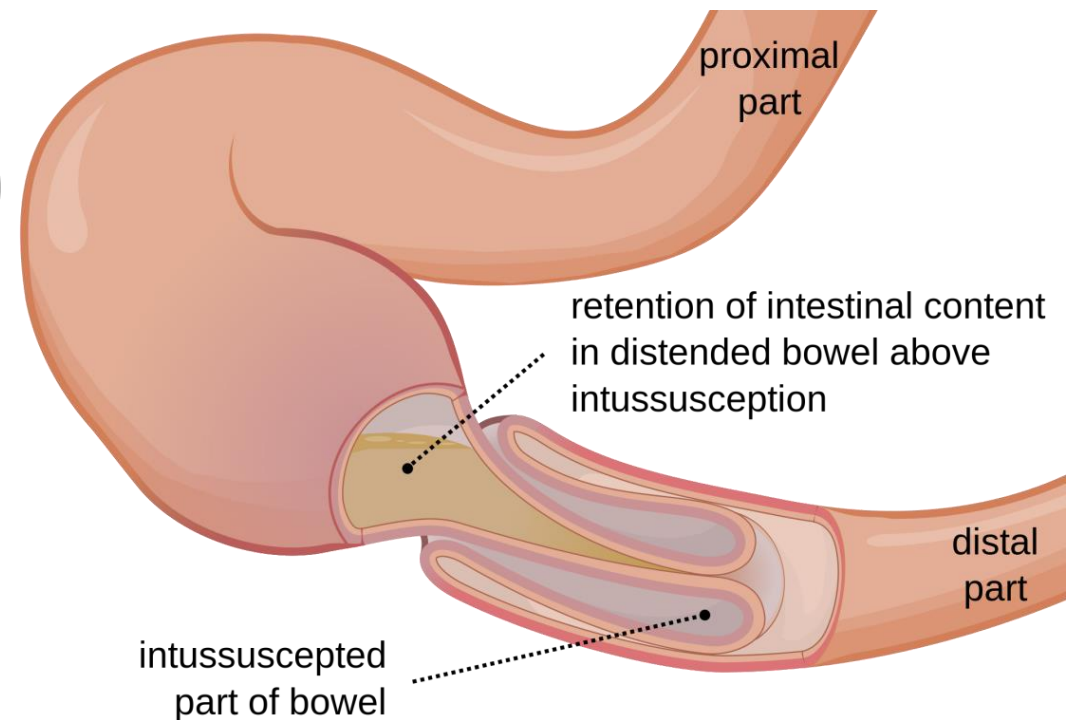
- **Technetium scan**
 - Also called a “Meckel’s scan”
 - Tracer taken up by gastric cells in diverticulum
- Treatment (symptomatic): surgery

Meckel's Diverticulum
(technetium scan)



Intussusception

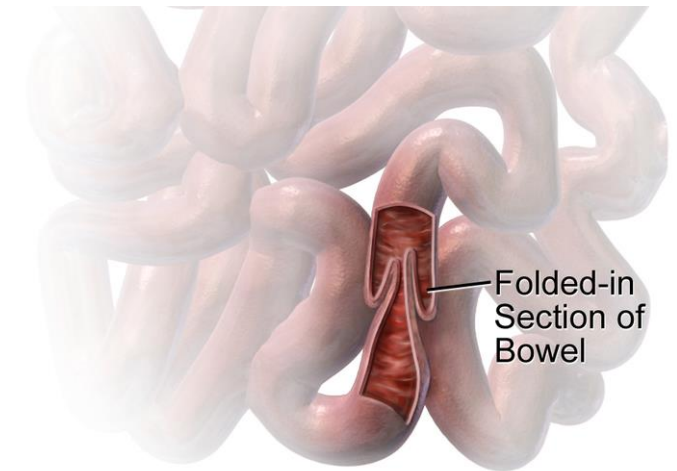
- “Telescoping” of intestine
- Intestine folds into lumen
- Often near the ileocecal junction
- Common in children (often < 2 years old)
- **Abdominal pain**
- **GI bleeding: “currant jelly” (rare)**
 - Mixture of blood and mucous



Intussusception

Lead Point

- **Underlying lesions** often lead to intussusception
- Intestine trapped and dragged by peristalsis
- Meckel's diverticulum
- Lymphoid hyperplasia (viral gastroenteritis)
- Strong association with enteric adenovirus infection
- In adults: tumors



Intussusception of the Bowel

Intussusception

Diagnosis and Management

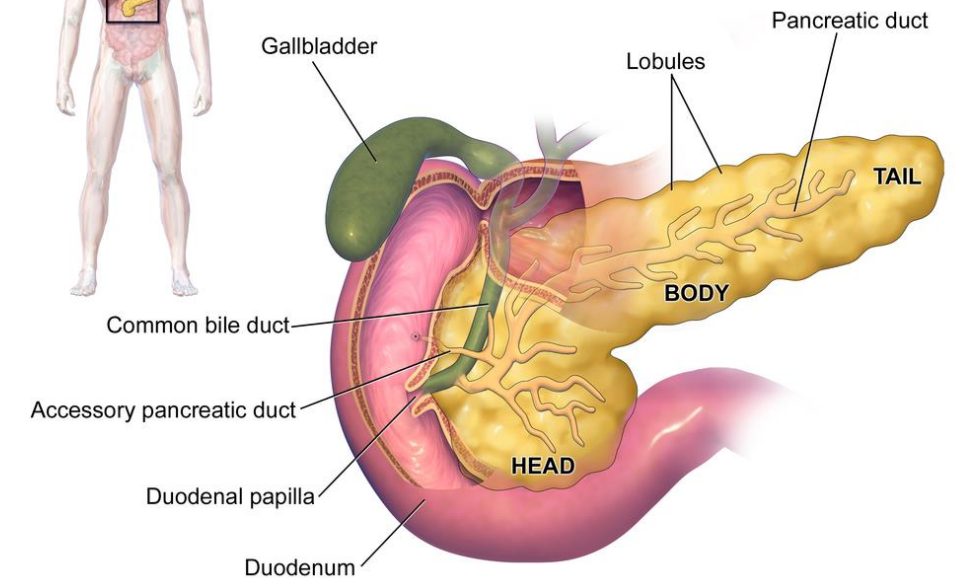
- Diagnosis: **abdominal ultrasound**
 - “Bull’s Eye” sign or “Target” sign
- Treatment: **air enema**
 - Resolves in-folding of intestine
- Surgery in severe, refractory cases

Target Sign



Annular Pancreas

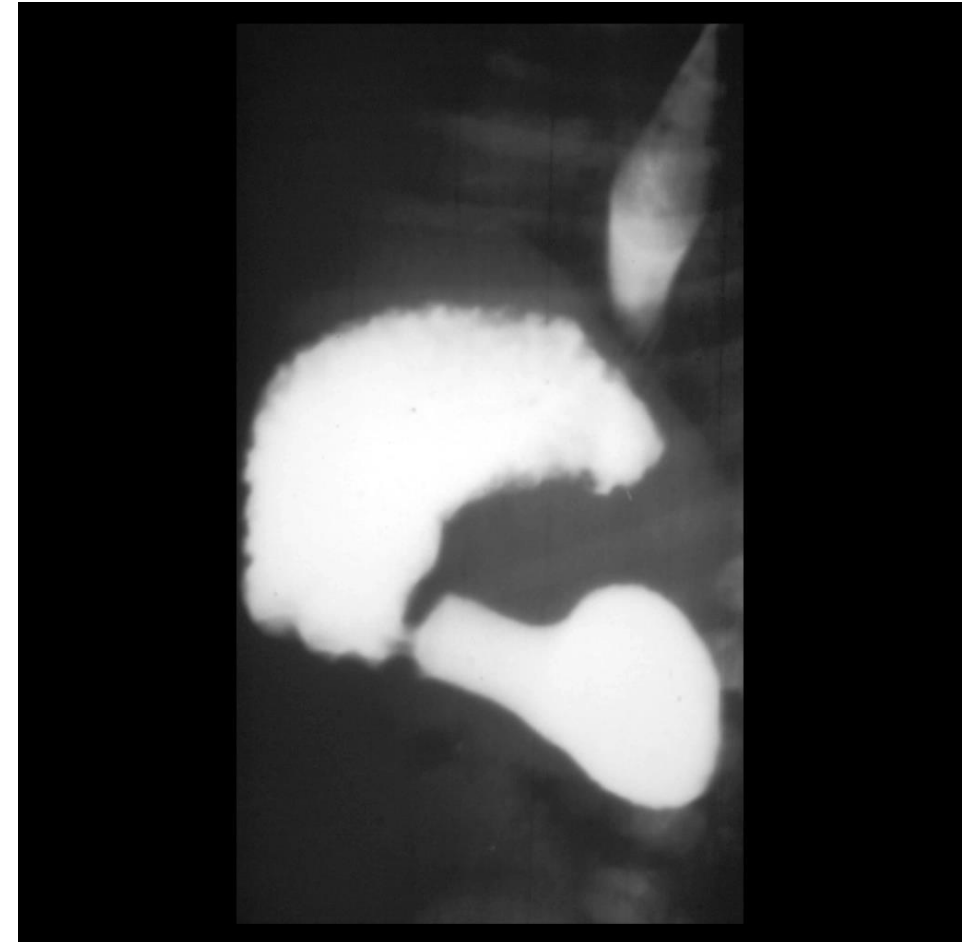
- Congenital anomaly of ventral pancreatic bud
- Fuses around duodenum
- Ring of pancreatic tissue that surrounds duodenum
- Usually asymptomatic
- Can cause **small bowel obstruction**
- Rarely leads to recurrent **pancreatitis**



Annular Pancreas

- Diagnosis: upper GI series or CT scan
- Treatment: **duodenoduodenostomy**
 - Bypass annulus
 - Do not resect → may cause fistula

Barium X-ray



Pancreas Divisum

- Dorsal and ventral pancreatic ducts do not fuse
- Two separate ducts
- Often asymptomatic
- May cause **pancreatitis**

