PEDIATRICS

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PEDIATRICS ... CONT.

PRIMARY CARE PEDIATRICS

REGULAR VISITS

❑ usual schedule: newborn, 1 week post-discharge, 1, 2, 4, 6, 9, 12, 15, 18, 24 months
- yearly until age 6, then every other year
- yearly after age 11

❑ history
- pregnancy and neonatal history
- feeding and diet (see Table 1)
- immunizations (see Tables 3 and 4)
- developmental assessment (see Table 5)
- growth, energy, appetite, sleep and review of systems
- past medical history, medications, allergies, family history and social history

❑ physical exam
- growth parameters: serial height, weight, head circumference
- head, eyes, nose and throat (HEENT): dysmorphic features, fontanelles (anterior closes between 9-18 months, posterior between 2-4 months), vision, red reflex, strabismus, hearing, tympanic membranes, palate
- CVS: auscultation, peripheral pulses (including femorals), blood pressure (BP) yearly after age 3
- respiratory, abdomen, genitourinary, dermatology
- musculoskeletal: hips (Barlow and Ortolani tests), scoliosis, lumbosacral spine (hairy patch, pigmentation, sinus tract)
- neurological: primitive reflexes in newborns and in early infancy

❑ immunization (see Immunization section)

❑ counselling/anticipatory guidance (see Nutrition, Colic, sudden infant death syndrome (SIDS), and Injury Prevention sections)

NUTRITION

Breast Feeding

❑ colostrum for first few days - clear fluid with nutrients (high protein, low fat) and immunoglobulins

❑ full milk production by 3-7 days; mature milk by 15-45 days

❑ support for mothers who want to breast feed should start while in hospital (nurses, primary care physician, breatfeeding clinics, La Leche League, lactation consultant)

❑ assessment of adequate intake: weight gain, number of wet diapers (6 per day), number of bowel movements, pause during swallowing

❑ feeding schedule (newborn baby needs 120kcal/kg/day: 180 cc most milks/kg/day)
- premature infants: q 2-3 hours
- term infants: q 3.5-4 hours, q 5 hours at night once 4.5 kg

❑ breast-fed babies require following supplements
- vitamin K (given IM at birth)
- vitamin D (Tri-Vi-Sol or Di-Vi-Sol); especially during winter months
- fluoride (after 6 months if not sufficient in water supply)
- iron (premature infants): from 8 weeks to 12 months

❑ contraindications
- mother receiving chemotherapy or radioactive compounds
- mother with HIV/AIDS, active untreated TB, herpes (in breast region)
- mother using alcohol and/or drugs (decrease milk production and/or directly toxic to baby)
- mother taking certain medications (some are safe) e.g. antimetabolites, bromocriptine, chloramphenicol, high dose diazepam, ergots, gold, metronidazole, tetracycline
- maternal cytomegalovirus (CMV), hepatitis and antibiotic-treated mastitis are NOT contraindications

❑ oral contraceptive pill (OCP): estrogen may decrease lactation but is not dangerous to infant

Advantages of Breast Feeding – "Breast is Best"

❑ composition of breast milk
- energy: 67 kcal/100 mL (20 kcal/oz.)
- carbohydrate: lactose
- protein: whey - 80% (more easily digested than casein), casein - 20%, essential amino acids (lower content than cow's milk, lower renal solute load for developing kidneys)
- fat: cholesterol, triglycerides, essential free fatty acids (up to 50% energy from fat)
- iron: higher bioavailability (50% of iron is absorbed vs. 10% from cow's milk), meets iron requirements only for first 6 months

❑ immunologic
- protection is greatest during early months, but is cumulative with increased duration of breastfeeding
- lower allergenicity than cow's milk protein
- IgA, macrophages, active lymphocytes, lysozyme, lactoferrin (lactoferrin inhibits E.*coli* growth in intestine)
- lower pH promotes growth of lactobacillus in the gastrointestinal (GI) tract (protective against pathogenic intestinal bacteria)

❑ parent-child bonding

❑ economical, convenient

Complications of Breast Feeding

❑ mother
- sore/cracked nipples: treat with warm compresses, massage, frequent feeds, soothing barrier creams (Penaten)
- breast engorgement (usually in first week): continue breast feeding and/or pumping
- mastitis (usually due to S. *aureus*): treat with cold compresses between feeds, cloxacillin for mother, continue nursing, +/– incision and drainage

❑ infant
- breast feeding jaundice: due to lack of milk production and subsequent dehydration (see Jaundice section)
- breast milk jaundice: rare (0.5% of newborns); due to substances in breast milk that inhibit conjugation of bilirubin (persists up to 4-6 months)
- poor weight gain: consider dehydration or failure to thrive
- thrush: check baby's mouth for white cheesy material; treat baby with antifungal (treat mother topically to prevent transmission)

Alternatives to Breast Feeding

❑ formula: 100-120 kcal/kg/day (minimum) or 150-180 cc/kg/day
- cow's milk-based formulas, e.g. SMA, Similac, Enfalac
- soy protein-based formula (use for vegan infants and galactosemia), e.g. Isomil, Prosobee
- lactose-free cow's milk protein-based formula, e.g. Similac LF, Enfalac LF
- protein hydrosylates
- whey based (for infants at risk for atopy), e.g. Goodstart
- casein based (for infants with confirmed allergy to cow's milk or soy), e.g. Alimentum, Neutramigen
- homo milk starting at 9-12 months until 24 months, then 2%/skim milk

❑ vegan diet is not recommended in first 2 years due to risk of iron, vitamin D and vitamin B_{12} deficiency

Table 1. Dietary Schedule

Age	Food	Comments
0 to 4 months	Breast milk, formula	Can be used exclusively until 6 months of age
4 to 6 months	Iron enriched cereals	Rice cereals first because less allergenic, avoid honey (botulism risk)
4 to 7 months	Pureed vegetables	Yellow/orange vegetables first and green last (more bulk) Avoid vegetables with high nitrite content (beets, spinach, turnips) Introduce vegetables before fruit
6 to 9 months	Pureed fruits and juices Pureed meats, fish, poultry, egg yolk	No egg white until 12 months (risk of allergy)
9 to 12 months	Finger foods, peeled fruit, cheese and cooked vegetables	NO peanuts or raw, hard vegetables until age 3 to 4 years No added sugar, salt, fat or seasonings

❑ do not delay introduction of solid foods beyond 9 months
❑ introduce 2-3 new foods per week (easier to identify adverse reactions) and allow a few days between each introduction

MILK CARIES

❑ decay of superior front teeth in first 4 years of life
❑ can also be caused by breast-feeding (especially prolonged night feeds)
❑ prevention
- no bottle at bedtime (unless plain water)
- use water as thirst quenchers during the day
- do not sweeten pacifier
- can clean teeth with soft damp cloth or toothbrush and water
- avoid fluoridated toothpaste until able to spit (>3 years) because of fluorosis risk
- first dental visit at three years of age

COLIC

- ❑ rule of 3's: unexplained paroxysms of irritability and crying for > 3 hours/day and > 3 days/week for > 3 weeks in an otherwise healthy, well-fed baby
- ❑ occurs in 10% of infants
- ❑ etiology: generally regarded as a lag in the development of normal peristaltic movement in GI tract: other theories suggest a lack of self-soothing mechanisms
- ❑ other reasons why babies cry: wet, hunger or gas pains, too hot or cold, overstimulated, need to suck or be held
- ❑ timing: onset 10 days to 3 months of age; peak 6-8 weeks
- ❑ child cries, pulls up legs and passes gas soon after feeding
- ❑ management
    - parental relief, rest and reassurance
    - hold baby, soother, car ride, music, vacuum, check diaper
    - medications (Ovol drops, gripe water) of no proven benefit
    - if breast feeding, elimination of cow's milk protein from mother's diet (effective in very small percentage of cases)
    - try casein hydrosylates formula (Neutramigen)

INJURY PREVENTION COUNSELLING

- ❑ injuries are the leading cause of death in children >1 year of age
- ❑ main causes: motor vehicle crashes, burns, drowning, falls, choking, suicide

Table 2. Injury Prevention Counselling

0-6 months	6-12 months	1-2 years	2-5 years
• do not leave infant alone on bed, change table or in tub • keep crib rails up • check water temp. before bathing • do not hold hot liquid and infant at the same time • turn down hot water heater • check milk temp. before feeding	• install stair barriers • discourage use of walkers • avoid play areas with sharp-edged tables and corners • cover electrical outlets • unplug appliances when not in use • keep small objects, plastic bags and medications out of reach	• never leave unattended • keep pot handles turned to back of stove • keep drugs and cleaning products out of reach • have ipecac syrup in house • no nuts, raw carrots, etc. due to choking hazard • no running while eating	• encourage bicycle helmet • never leave unsupervised at home, driveway or pool • teach bike safely, stranger safety and street safety • swimming lessons

- always have Poison Control number by telephone
- have smoke and carbon monoxide detectors in the house and check yearly
- have appropriate car seats
    - required before allowed to leave hospital
    - < 9 kg: rear-facing
    - 10-18 kg: front-facing
    - 18-36.4 kg: booster seat

SUDDEN INFANT DEATH SYNDROME (SIDS)

- ❑ sudden and unexpected death of an infant < 12 months of age in which the cause of death cannot be found by history, examination or a thorough postmortem
- ❑ 0.5/1,000 (leading cause of death between 1-12 months of age)
- ❑ frequency varies widely in different populations

Epidemiology

- ❑ more common in children placed in prone position (cause vs. association)
- ❑ number of deaths peak at age 2 months
- ❑ increase in deaths during peak respiratory scyncitial virus (RSV) season
- ❑ most deaths occur between midnight and 8:00 am
- ❑ more common in prematurity, if smoking in household, minorities, socially disadvantaged
- ❑ 3:2 male predominance
- ❑ risk of SIDS is increased 3-5 times in siblings of infants who have died of SIDS

Prevention

- ❑ place infant on back, NOT in prone position
- ❑ alarms/other monitors not recommended ~ increase anxiety and do not prevent life-threatening events
- ❑ avoid overheating and overdressing
- ❑ appropriate infant bedding

IMMUNIZATION

A. ROUTINE IMMUNIZATION

Table 3. Routine Immunization Schedule

Vaccine	Schedule	Route	Reaction	Contraindications
DPTP	2, 4, 6, 18 mos 4-6 yrs	IM	@ 24-48 hrs • minor: fever, local redness, swelling, irritability • major: prolonged crying (1%), hypotonic unresponsive state (1:1750), seizure (1:1950) • prophylaxis: acetaminophen 10-15 mg/kg given 4 hrs. prior to injection and q4h afterwards	previous anaphylactic reaction to vaccine; evolving unstable neurologic disease; hyporesponsive/hypotonic following previous vaccine
Hib	2, 4, 6, 18 mos	IM	safe, almost no reaction	not to be given after age 5
MMR	12 mos 4-6 yrs	SC	@ 7-14 days • fever, measle-like rash • lymphadenopathy, arthralgia, arthritis, parotitis (rare)	pregnancy, immunocompromised infants (except healthy HIV positive children)
Td+P	start at 14-16 yrs q 10 yrs	IM	anaphylaxis (very rare)	pregnancy (1st trimester)
Hep B	3 doses initial, 1 month, 6 months (given in Grade 7 in Ontario)	IM	safe, almost no reaction	

DPTP - diptheria, acellular pertussis, tetanus, inactivated polio vaccine
Hib - H*emophilus influenzae* type b conjugate vaccine
MMR - measles, mumps, rubella
Td+P - tetanus, diptheria toxoid, and polio

Administration of Vaccines

- ❑ injection site
  - infants (< 12 months old): anterolateral thigh
  - children: deltoid
- ❑ DTaP+IPV+Hib (Pentacel): 5 vaccines given as one IM injection

Contraindications to Any Vaccine

- ❑ moderate to severe illness +/– fever
- ❑ allergy to vaccine component (e.g. egg)

Possible Adverse Reactions

- ❑ any vaccine
  - local: induration or tenderness
  - systemic: fever, rash
  - allergic: urticaria, rhinitis, anaphylaxis
- ❑ specific vaccine reactions (see Table 3)

TB Skin Test (Mantoux)

- ❑ screen high risk populations only (family history, HIV, immigrants from countries with increased incidence, substance abuse in family, homeless, aboriginal)
- ❑ intradermal injection
- ❑ TB test should be post-poned for 4-6 weeks after administration of live vaccine due to risk of false negative result
- ❑ test interpretation
  - check area of INDURATION (not just area of erythema)
  - positive result
    - > 15 mm: children > 4 years with no risk factors
    - > 10 mm: children < 4 years, environmental exposure
    - > 5 mm: children with close TB contact, immunosuppressed
- ❑ BCG history irrelevant - does not usually give positive response
- ❑ positive reaction means active disease or previous contact with TB

B. DELAYED IMMUNIZATION

Table 4. Delayed Immunization Schedule

Unimmunized Children < 7 Years		Unimmunized Children ≥ 7 Years	
Visit	**Vaccine**	**Visit**	**Vaccine**
initial visit	DPTP + Hib, MMR (if ≥ 12 months)		
2 months after initial visit	DPTP	initial visit	Td+P, MMR
4 months after initial visit	DPTP	2 months after initial visit	Td+P
10-16 months after initial visit	DPTP	6-12 mos after second visit	Td+P
4-6 years old	DPTP, MMR	every 10 years thereafter	Td
14-16 years old	Td+P		

*pertussis not given if > 5 years old
*remember Hep B vaccine - given in Grade 7 in Ontario

C. OTHER VACCINES

Varivax
- ❑ live attenuated varicella virus vaccine protects against chicken pox and significantly decreases risk of developing Herpes Zoster (shingles)
- ❑ efficacy: protection rate is > 90%
- ❑ likely lifelong immunity, but longer studies are unavailable
- ❑ benefits
  - avoid chicken pox (5-7 days of discomfort, potential complications) (see Infectious Diseases section)
  - avoid parental cost of being off work or hiring babysitter
- ❑ may be protective if administered within 72 hours of exposure to active varicella virus
- ❑ contraindicated in pregnant women and in women planning to get pregnant within the next 3 months
- ❑ costs $65-100 per dose, covered by some drug plans
- ❑ 12 months - 13 years: 1 dose (0.5 mL SC injection); > 13 years: 2 doses required (4-8 weeks apart)
- ❑ mild local reactions in 5-10% (higher in immunocompromised)

Hepatitis A
- ❑ recommended for pre-exposure prophylaxis for individuals at increased risk of infection (e.g. travel to endemic countries, residents of communities with high endemic rates)
- ❑ given as a series of 2 injections; combination vaccine with Hep B available (Twinrix)
- ❑ side effects: erythema and tenderness at injection site
- ❑ exposure prophylaxis requires use of immunoglobulin which can be given if < 1 year

Hepatitis B
- ❑ set of 3 vaccinations given in infancy (0, 1, 6 months) or mid-childhood to early teens
- ❑ if mother is HBsAg +ve, then give HBIG and Hep B vaccine at birth, 1 month, 6 months

Influenza
- ❑ given annually in the fall since strains vary from year to year
- ❑ for children with severe or chronic disease, e.g. cardiac, pulmonary, or renal disease, sickle cell disease, diabetes, endocrine disorders, HIV, immunosuppressed, long-term aspirin therapy, residents of chronic care facilities
- ❑ contraindicated if allergic to eggs or < 6 months of age

Pneumococcal vaccines
- ❑ Pneumovax (polysaccharide vaccine)
  - protects against 23 serotypes of S. *pneumoniae*
  - indicated for children with HIV, functional/anatomic asplenia (e.g. sickle cell disease, splenic dysfunction, thalassemia)
  - vaccine only effective in children >2 years of age
- ❑ conjugated pneumococcal vaccine (Prevnar)
  - available in US, not yet approved in Canada
  - protects against 7 serotypes
  - can be administered to infants; routine immunization of all infants has been recommended
  - significantly decreases incidence of invasive pneumococcal disease (sepsis, meningitis); also reduces incidence of non-invasive disease (otitis media, sinusitis)
  - 4 doses required (~$60 US per dose)

Meningococcal vaccine
- ❑ recommended for children > 2 years with functional/anatomic asplenia, for outbreak control, and for travellers to areas with increased incidence
- ❑ vaccine consists of single dose of purified capsular polysaccharides
- ❑ side effects: local erythema and swelling
- ❑ pregnancy is not a contraindication

BCG vaccine
- ❑ infants of parents with infectious TB at time of delivery
- ❑ groups/communities with high rates of disease/infection
- ❑ offered to aboriginal children on reserves
- ❑ only given if patient has a negative TB skin test
- ❑ side effects: erythema, papule formation 3-6 weeks post intradermal injection, enlargement of regional lymph nodes

DEVELOPMENTAL MILESTONES

Table 5. Developmental Milestones

Age	Gross Motor	Fine Motor	Speech and Language	Adaptive and Social Skills
6 weeks	prone-lifts chin intermittently			social smile
2 months	prone-arms extended forward	pulls at clothes	coos	
4 months	prone-raises head + chest, rolls over F —> B, no head lag	reach and grasp, objects to mouth	responds to voice	
6 months	prone-weight on hands, tripod sit	ulnar grasp	begins to babble, responds to name	stranger anxiety
9 months	pulls to stand	finger-thumb grasp	mama, dada - appropriate, imitates 1 word	plays games separation/stranger anxiety
12 months	walks with support, "cruises"	pincer grasp, throws	2 words with meaning besides mama, dada	plays peek-a-boo, drinks with cup
15 months	walks without support	draws a line	jargon	points to needs
18 months	up steps with help	tower of 3 cubes, scribbling	10 words, follows simple commands	uses spoon, points to body parts
24 months	up 2 feet/step, runs, kicks ball	tower of 6 cubes, undresses	2-3 words phrases uses "I", "me", "you" 25% intelligible	parallel play, helps to dress
3 years	tricycle, up 1 foot/step, down 2 feet/step, stands on one foot, jumps	copies a circle and a cross, puts on shoes	prepositions, plurals, counts to 10, 75% intelligible, knows sex, age	dress/undress fully except buttons
4 years	hops on 1 foot, down 1 foot/step	copies a square, uses scissors	tells story, knows 4 colours, normal dysfluency, speech intelligible	cooperative play, toilet trained, buttons clothes
5 years	skips, rides bicycle	copies a triangle, prints name, ties shoelaces	fluent speech, future tense, alphabet	

Primitive Reflexes
- ❑ reflexes seen in normal newborns; abnormal if persist after 3-5 months
- ❑ Moro reflex
  - infant is placed semi-upright, head supported by examiner's hand, sudden withdrawal of supported head with immediate resupport elicits reflex
  - reflex consists of abduction and extension of the arms, opening of the hands, followed by flexion and adduction of arms
  - absence of Moro suggests CNS injury; asymmetry suggests focal motor lesions (e.g. brachial plexus injury)
  - disappears by 3-4 months
- ❑ Galant reflex
  - infant is held in ventral suspension and one side of the back is stroked along paravertebral line
  - reflex consists of lateral curvature of the trunk toward the stimulated side
  - disappears by 2-3 months
- ❑ grasp reflex: disappears by 1-4 months
- ❑ tonic neck reflex ("fencing"): disappears by 2-3 months
- ❑ placing and stepping reflex ("primitive walking"): disappears by 2-5 months
- ❑ rooting/sucking: disappears by 3-4 months

NORMAL PHYSICAL GROWTH

- ❑ newborn size influenced by maternal factors (placenta, in utero environment)
- ❑ premature infants: use corrected age until 2 years
- ❑ not linear: most rapid growth during first two years; growth spurt at puberty
- ❑ different tissue growth at different times
  - first two years: CNS
  - mid-childhood: lymphoid tissue
  - puberty: genital tissues
- ❑ body proportions: upper/lower segment ratio – midpoint is symphysis pubis
  - newborn 1.7; adult male 0.97; female 1.0

Table 6. Average Growth Parameters

	Birth	Normal Growth	Comments
Weight	3.5 kg	2 x birth wt. by 4-5 mo. 3 x birth wt. by 1 year 4 x birth wt. by 2 years	• wt. loss (up to 10% of birth wt.) in 1st few days of life is normal • neonate should regain wt. by 10 days of age
Length/Height	50 cm	25 cm in 1st year 12 cm in 2nd year 8 cm in 3rd year then 4-7 cm/year until puberty 1/2 adult height at 2 years	• measure supine length until 2 years of age, then measure standing height
Head Circumference (HC)	35 cm	2 cm/month for 1st 3 mo. 1 cm/month at 3-6 mo. 0.5 cm/month at 6-12 mo.	• measure around occipital, parietal and frontal promiences to obtain the greatest circumference

Clinical Pearls

- ❑ **Term newborn should gain 20-30 g/day. "1 oz. per day except on Sunday". (1 oz. = 30 g) 6 oz./week = 180 g/week.**
- ❑ **To estimate weight of child > 1 year (kg): Age x 2 + 8.**

Dentition

- ❑ primary dentition (20 teeth)
  - first tooth at 5-9 months (lower incisor), then 1 per month until 20 teeth
  - 6-8 central teeth by 1 year
- ❑ secondary dentition (32 teeth)
  - first adult tooth is 1st molar at 6 years
  - 2nd molars at 12 years, 3rd molars at 18 years

Table 7. Average Vitals at Various Ages

Age	Pulse	Resp. Rate	SBP (mm Hg)
Birth	120-160	35-50	70
Preschool	70-140	20-30	80-90
Adolescent	60-120	15-20	90-120

FAILURE TO THRIVE (FTT)

- ❑ definition: weight < 3rd percentile, or falls below two major percentile curves, or < 80% of expected weight for height and age
- ❑ 50% organic, 50% non-organic
- ❑ inadequate caloric intake most important factor in poor weight gain
- ❑ energy requirements
  - 0-10 kg: 100 cal/kg/day
  - 10-20 kg: 1,000 cal + 50 cal/kg/day for each kg > 10
  - 20 kg+: 1,500 cal + 20 cal/kg/day for each kg > 20
- ❑ may have other nutritional deficiencies, e.g. protein, iron, vitamin D

Approach to a Child with FTT
- ❑ history
  - duration of problem
  - detailed dietary and feeding history, appetite, behaviour during feeds
  - pregnancy, birth, and postpartum history; developmental and medical history, including medications; social and family history (parental height and weight)
  - assess 4 areas of functioning: child's temperament, child-parent interaction, feeding behaviour and parental psychosocial stressors
- ❑ physical examination
  - height (Ht), weight (Wt), head circumference (HC), arm span, upper:lower (U/L) segment ratio
  - assessment of nutritional status, dysmorphism, pubertal status, evidence of chronic disease
  - observation of a feeding session and parent-child interaction
  - signs of abuse or neglect
- ❑ laboratory investigations: as indicated by clinical presentation
  - CBC, blood smear, electrolytes, urea, ESR, T4, TSH, urinalysis
  - bone age x-ray
  - karyotype in all short girls and in short boys where appropriate
  - any other tests indicated from history and physical exam: e.g. renal or liver function tests, venous blood gases, ferritin, immunoglobulins, sweat chloride, fecal fat
- ❑ organic cause: usually apparent on full history and physical exam
- ❑ non-organic cause: often no obvious diagnosis from history and physical exam

Organic FTT
- ❑ inadequate intake
  - insufficient breast milk production
  - inappropriate feeding practices
  - CNS, neuromuscular, mechanical problems with swallowing, sucking
  - anorexia (associated with chronic disease)
- ❑ inadequate absorption
  - malabsorption: celiac disease, cystic fibrosis (CF), pancreatic insufficiency
- ❑ inappropriate utilization of nutrients
  - renal loss: e.g. tubular disorders
  - loss from the GI tract: chronic diarrhea, vomiting
  - inborn errors of metabolism
  - endocrine: type 1 diabetes, diabetes insipidus (DI), hypopituitarism
- ❑ increased energy requirements
  - pulmonary disease: CF
  - cardiac disease
  - endocrine: hyperthyroidism, DI, hypopituitarism
  - malignancies
  - chronic infections
  - inflammatory: systemic lupus erythematosus (SLE)
- ❑ decreased growth potential
  - specific syndromes, chromosomal abnormalities
  - intrauterine insults: fetal alcohol syndrome (FAS)
- ❑ treatment: cause-specific

Non-Organic FTT
- ❑ noted by 6-12 months
- ❑ often due to malnutrition, inadequate nutrition, poor feeding technique, errors in making formula
- ❑ these children are often picky, poor eaters with poor emotional support at home
- ❑ may have delayed psychomotor, language and personal/social development
- ❑ emotional deprivation, poor parent-child interaction, dysfunctional home
- ❑ child abuse and/or neglect
- ❑ parental psychosocial stress, childhood abuse and/or neglect
- ❑ treatment: most are managed as outpatients with multidisciplinary approach
  - primary care physician, dietitian, psychologist, social work, child protection services

Table 8. Failure to Thrive Patterns (head circumference = HC; height = Ht.; weight = Wt.)

Growth Parameters			Suggestive Abnormality	
decreased Wt.	normal Ht.	normal HC	• caloric insuffiency • decreased intake	• hypermetabolic state • increased losses
decreased Wt.	decreased Ht.	normal HC	• structural dystrophies • endocrine disorder	• constitutional growth delay • genetic short stature
decreased Wt.	decreased Ht.	decreased HC	• intrauterine insult	• genetic abnormality

CIRCUMCISION
- ❑ elective procedure only to be performed in healthy, stable infants
- ❑ usually performed for social reasons
- ❑ may have some medical benefits
  - prevention of phimosis
  - slightly decreased incidence of urinary tract infection (UTI), balanitis, cancer of penis, STD's (including HIV)
- ❑ complications (< 1%): local infection, bleeding, urethral injury
- ❑ contraindicated when genital abnormalities present (e.g. hypospadias)

CHILD ABUSE AND NEGLECT

Definition
- ❑ an act of commission or omission (physical, sexual, or emotional) by another person that harms a child in a significant way

Legal Duty to Report
- ❑ upon reasonable grounds to suspect abuse and/or neglect, physicians are required by law to contact the Children's Aid Society (CAS) personally to disclose all information
- ❑ duty to report overrides patient confidentiality, physician is protected against liability
- ❑ ongoing duty to report: if there are additional reasonable grounds to suspect abuse and/or neglect, a further report to the CAS must be made

Risk Factors
- ❑ environmental factors
  - social isolation
  - poverty
  - domestic violence
- ❑ caregiver factors
  - parents were abused as children
  - psychiatric illness
  - substance abuse
  - poor social and vocational skills, below average intelligence
- ❑ child factors
  - difficult child (temperament)
  - disability, special needs (e.g. mental retardation)
  - premature

Physical Abuse
- ❑ history inconsistent with physical findings or history not reproducible
- ❑ delay in seeking medical attention
- ❑ injuries of varied ages, recurrent or multiple injuries
- ❑ distinctive marks: e.g. belt buckle, cigarette burns, hand
- ❑ atypical patterns of injury: bruises on the face, abdomen, buttocks, genitalia, upper back, posterior rib fractures, immersion burns
- ❑ altered mental status: head injury, poisoning
- ❑ shaken baby syndrome
  - head trauma is the leading cause of death in child maltreatment
  - violent shaking of infant resulting in intracranial hematomas retinal hemorrhages and sometimes fractures
  - diagnosis confirmed by head CT or MRI, ophthalmologic exam, skeletal survey/bone scan

Sexual Abuse
- ❑ prevalence: 1 in 4 females, 1 in 10 males
- ❑ peak ages at 2-6 and 12-16 years
- ❑ most perpetrators are male and known to child
  - most common: father, stepfather, uncle
- ❑ diagnosis usually depends on child telling someone
- ❑ physical exam is often normal
- ❑ presentation
  - specific or generalized fears, depression, nightmares
  - social withdrawal, lack of trust, low self-esteem, school failure
  - sexually aggressive behaviour, advanced sexual knowledge, sexual preoccupation or play
  - recurrent UTIs, pregnancy, STDs, vaginitis, vaginal bleeding, genital injury
- ❑ investigations depend on presentation, age, sex, and maturity of child
  - up to 72 hours: rape kit
  - rule out STD, UTI, pregnancy (consider STD prophylaxis or morning after pill)
  - rule out other injuries

RED FLAGS - Presentation of Neglect
- ❑ failure to thrive, developmental delay
- ❑ inadequate or dirty clothing, poor hygiene
- ❑ child exhibits poor attachment to parents, no stranger anxiety

Management of Child Abuse and Neglect
- ❑ history
  - from child and caregiver(s) together and separately if possible
- ❑ physical exam
  - head to toe (do not force)
  - emotional state
  - development
  - document and/or photograph all injuries: type, location, size, shape, colour, pattern
- ❑ investigations
  - STD work-up
  - skeletal survey/bone scan
  - CT/MRI
- ❑ report all suspicions to Child Abuse Services (CAS)
- ❑ acute medical care: hospitalize if indicated or if concerns about further or ongoing abuse
- ❑ arrange consultation to social work and appropriate follow-up
- ❑ discharge child directly to CAS or to responsible guardian under CAS supervision

ADOLESCENT MEDICINE

HEALTH ISSUES

- ❑ growth and development
  - physical growth
  - sexual maturation and psychosocial issues
  - skin problems
- ❑ nutritional concerns
  - poor nutrition
  - eating disorders (see Psychiatry Chapter)
  - obesity
- ❑ sexuality issues
  - sexual activity/contraception/pregnancy
  - sexual abuse
  - STDs and HIV (incidence rising in adolescents)
  - sexual orientation
- ❑ substance abuse
  - tobacco
  - alcohol and drugs
- ❑ depression and mental health disorders
  - suicide, homicide and accidents (70% of teen mortality)
  - mood, behaviour, anxiety and other psychiatric disorders
  - self-esteem issues
  - chronic illness

Clinical Pearl

❑ **Injuries are the leading cause of death in adolescents, accounting for 80% of deaths in 15 to 19 year olds. Risk factors include: alcohol use, failure to use safety devices, access to firearms and athletic participation.**

HEEADSS INTERVIEW

- ❑ ASSURE CONFIDENTIALITY
- ❑ **H**ome
  - where, with whom?
  - relations with family
  - recent moves
  - ever run away?
- ❑ **E**ducation
  - attending school?
  - grades, failures, suspensions
  - future plans, goals
- ❑ **E**ating
  - habits
  - history of anorexia nervosa (AN), anemia, obesity
- ❑ **A**ctivities
  - extracurricular, sports, work
  - best friend
  - social clubs
  - car
  - gangs
- ❑ **D**rugs
  - types used (frequency, amount)
  - alcohol, smoking
  - with friends or alone?
- ❑ **S**exuality
  - dating, types of experiences
  - contraception, pregnancies, STDs
  - sexual abuse
- ❑ **S**uicide
  - self harm thoughts
  - prior attempts
  - depression

HEART MURMURS

- ❑ 50-80% of children have audible heart murmurs at some point in their lives
- ❑ most murmurs are functional (i.e. "innocent") without associated structural abnormalities
- ❑ murmurs can become audible or accentuated in high output states, e.g. fever, anemia

Table 9. Differentiating Innocent and Pathological Heart Murmurs

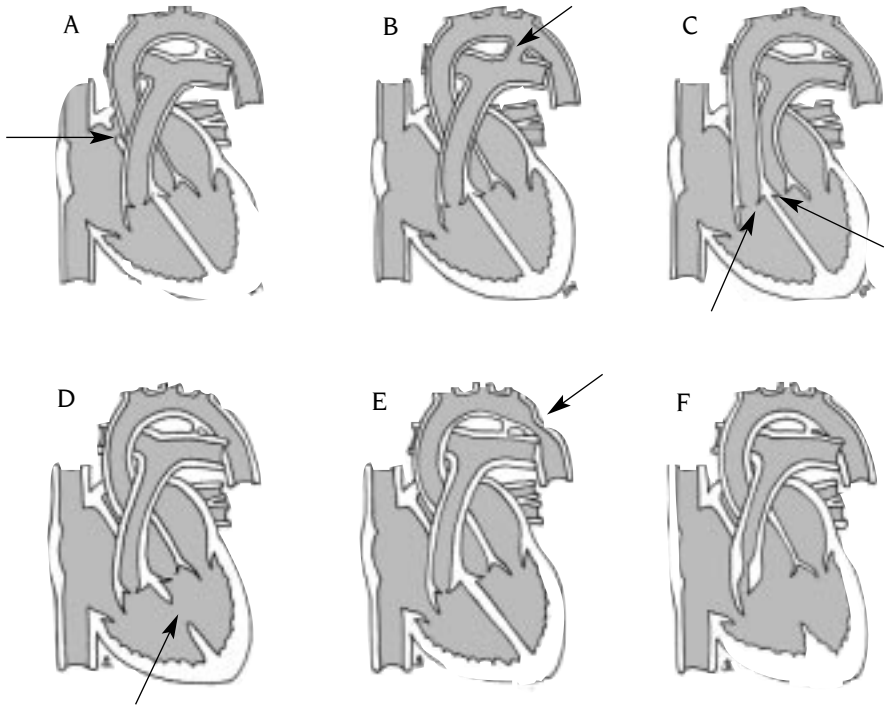
	Innocent	Pathological
history and physical	asymptomatic	symptoms and signs of cardiac disease
timing	systolic ejection murmur (except venous hum)	all diastolic, pansystolic or continuous
grade	≤ 3/6	> 3/6 (palpable thrill)
splitting	physiologic S2	fixed splitting or single S2
extra sounds/clicks	none	present
change of position	murmur varies	unchanged

Table 10. Five Innocent Heart Murmurs

Type	Description	Differential Diagnosis
Still's murmur	vibratory, lower left sternal border (LLSB) or apex	subaortic stenosis, small ventricular septal defect (VSD)
pulmonary ejection	soft, blowing, upper left sternal border (ULSB)	aterial septal defect (ASD) pulmonary stenosis (PS)
venous hum	infraclavicular hum, continuous, R > L	patent ductus ateriosus (PDA)
supraclavicular arterial bruit	low intensity, above clavicles	aortic stenosis (AS), bicuspid aortic valve
peripheral pulmonic stenosis	neonates, low-pitched radiates to axilla and back	PDA/pulmonary stenosis (PS)

CONGENITAL HEART DISEASE (CHD) (see Cardiac and Vascular Surgery Chapter)

- ❑ 8/1,000 live births, can present with heart murmur, heart failure, or cyanosis
- ❑ increased risk
  - maternal factors
    - diabetes mellitus (DM), phenylketonuria (PKU)
    - medication, alcohol or drug use
    - infection (e.g. rubella, cytomegalovirus (CMV))
  - infant factors
    - prematurity (e.g. patent ductus arteriosus (PDA))
    - chromosomal abnormalities (e.g. Down syndrome - AVSD)
    - positive family history (2-4% risk if sibling affected)
- ❑ ventricular septal defect (VSD) is the most common lesion
- ❑ subacute bacterial endocarditis (SBE) prophylaxis should be given to all patients with congenital heart disease except those with
  - an isolated secundum atrial septal defect (ASD)
  - corrected VSD or PDA without residua at greater than 6 months after repair
  - mitral valve prolapse (MVP) without mitral regurgitation (MR)
- ❑ SBE prophylaxis: amoxicillin 50mg/kg 1 hour before procedure, clindamycin 20mg/kg if allergic



A. Atrial Septal Defect

B. Patent Ductus Arteriorsus

C. Transposition of Great Ateries

D. Ventricular Septal Defect

E. Coarctation of the Aorta

F. Tetralogy of Fallot

Figure 1. Common Congenital Heart Diseases

Illustration by Kevin Millar and Jacquelyn Shaw

A. ACYANOTIC CONGENITAL HEART DISEASE (see Cardiac and Vascular Surgery Chapter)

1. LEFT TO RIGHT SHUNT LESIONS

- ❑ extra blood is displaced through a communication from the left to the right side of the heart, resulting in increased pulmonary blood flow
- ❑ shunt volume dependent upon three factors: size of defect, pressure gradient between chambers or vessels, peripheral outflow resistance
- ❑ untreated shunts can result in pulmonary vascular disease, right ventricular hypertension (RVH), and R to L shunts

Atrial Septal Defect (ASD)

- ❑ three types
  - ostium primum - common in Down syndrome
  - ostium secundum - most common type (50-70%)
  - sinus venosus - defect located at entry of superior vena cava (SVC) into right atrium
- ❑ often asymptomatic in childhood
- ❑ murmur: often grade 2/6-3/6 pulmonic outflow murmur with widely split and fixed S2
- ❑ ECG: right axis deviation (RAD), mild RVH, right bundle branch block (RBBB)
- ❑ CXR: increased pulmonary vasculature
- ❑ natural history: 80-100% spontaneous closure rate if ASD diameter < 8 mm
- ❑ if remains patent, congestive heart failure (CHF) and pulmonary hypertension can develop in adult life
- ❑ management: elective surgical or catheter closure (low risk procedures) between 2-5 years of age

Ventricular Septal Defect (VSD)

- ❑ most common congenital heart defect (30-50%)
- ❑ small VSD (majority)
  - asymptomatic, normal growth and development
  - murmur: early systolic to holosystolic, best heard at left lower sternal border (LLSB)
  - ECG and CXR are normal
  - most close spontaneously, do not need surgical closure even if remain patent
- ❑ moderate to large VSD
  - delayed growth and development, decreased exercise tolerance, recurrent URTIs or "asthma" episodes, CHF
  - murmur: holosystolic at LLSB with thrill, mid-diastolic rumble at apex, size of VSD is inversely related to intensity of murmur
  - ECG: left ventricular hypertrophy (LVH), left atrial hypertrophy (LAH), RVH
  - CXR: increased pulmonary vasculature, cardiomegaly, CHF
  - natural history: secondary pulmonary hypertension, CHF by 2 months of age
  - management: treatment of CHF; surgical closure

Patent Ductus Arteriosus (PDA)
- ❑ patent vessel between descending aorta and pulmonary artery
- ❑ functional closure within first 1-15 hours of life, anatomical closure within first days of life
- ❑ 5-10% of all congenital heart defects
- ❑ common in premature infants (1/3 of infants < 1750 grams)
- ❑ may be asymptomatic or have apneic or bradycardic spells, poor feeding, accessory muscle use
- ❑ associated tachycardia, bounding pulses, hyperactive precordium, wide pulse pressure
- ❑ murmur: continuous "machinery" murmur, best heard at left infraclavicular area
- ❑ ECG: may show LVH, RVH
- ❑ CXR: normal to mildly enlarged heart, increased pulmonary vasculature
- ❑ diagnosis by echocardiography (ECHO)
- ❑ natural history: spontaneous closure common in premature infants, less common in term infants
- ❑ management: indomethacin, surgical ligation, or catheter closure
- ❑ high risk of SBE, antibiotic prophylaxis required until 6 months after closure

Endocardial Cushion Defect (Atrioventricular (AV) Canal)
- ❑ spectrum from endocardial cushion VSD and ostium primum ASD to complete AV canal with common AV valve
- ❑ commonly associated with Down syndrome
- ❑ natural history depends on size of defect and valvular involvement
- ❑ complete AV canal requires early complete surgical repair, preferably before 3 months of age

2. OBSTRUCTIVE LESIONS
- ❑ present with pallor, decreased urine output, cool extremities and poor pulses

Coarctation of the Aorta
- ❑ narrowing of aorta almost always at the level of the ductus arteriosus
- ❑ commonly associated with bicuspid aortic valve (50%)
- ❑ few have high BP in infancy (160-200 mmHg systolic) but this decreases as collaterals develop
- ❑ if severe, presents with shock in the neonatal period when the ductus closes
- ❑ often asymptomatic with upper extremity systolic pressures of 140-145 mm Hg
- ❑ weak pulses, decreased blood pressure in lower extremities, radial-femoral delay
- ❑ if associated with other lesions (e.g. PDA, VSD), can cause CHF
- ❑ ECG: RVH early in infancy, LVH later in childhood
- ❑ murmur: absent or systolic with late peak at apex, left axilla, left back
- ❑ management: balloon arterioplasty or surgical correction
- ❑ complications: essential hypertension

Aortic Stenosis
- ❑ valvular (75%), subvalvular (20%), supravalvular and idiopathic hypertrophic subaortic stenosis (IHSS) (5%)
- ❑ often asymptomatic but may be associated with CHF, exertional chest pain, syncope or sudden death
- ❑ murmur: systolic ejection murmur (SEM) at upper right sternal border (URSB) with aortic ejection click at the apex
- ❑ management: surgical or balloon valvuloplasty, repeated interventions and valve replacement may be necessary
- ❑ SBE prophylaxis and exercise restriction required

Pulmonary Stenosis
- ❑ valvular (90%), subvalvular or supravalvular
- ❑ usually part of other congenital heart lesions (e.g. Tetralogy of Fallot) or in association with other syndromes (e.g. congenital rubella, Noonan syndrome)
- ❑ critical pulmonic stenosis: inadequate pulmonary blood flow, dependent on ductus for oxygenation, progressive hypoxia and cyanosis
- ❑ presentation varies from asymptomatic to CHF
- ❑ murmur: wide split S2 maximal on expiration, SEM at ULSB, pulmonary ejection click
- ❑ ECG: RVH
- ❑ CXR: dilated post-stenotic pulmonary artery
- ❑ management: balloon valvuloplasty

B. CYANOTIC CONGENITAL HEART DISEASE
- ❑ systemic venous return re-enters systemic circulation directly
- ❑ most prominent feature is cyanosis (O_2 sat < 75%)
- ❑ differentiate between cardiac and other causes of cyanosis with hyperoxic test (if improvement of PaO_2, less likely cardiac cause)
- ❑ survival depends on mixing via shunts (e.g. ASD, VSD, PDA)

1. LESIONS ASSOCIATED WITH DECREASED PULMONARY BLOOD FLOW

Tetralogy of Fallot

- ❑ 10% of all congenital heart defects, most common cyanotic heart defect beyond infancy
- ❑ embryologically a single defect with hypoplasia of the conus causing
  - ventricular septal defect (VSD)
  - right ventrical (RV) outflow tract obstruction (RVOTO)
  - overriding aorta
  - right venticular hypertrophy (RVH)
- ❑ direction and degree of shunt are functions of the relative outflow resistance
- ❑ infants may initially have a left to right shunt and therefore are not cyanotic but the RVOTO is progressive, resulting in increasing right to left shunting with hypoxemia and cyanosis
- ❑ hypoxic "tet" spells
  - primary pathophysiology is hypoxia, leading to increased pulmonary vascular resistance (PVR) and decreased systemic resistance, occurring in exertional states (e.g. crying, exercise)
  - paroxysm of rapid and deep breathing, irritability and crying
  - hyperpnea, increasing cyanosis often leading to deep sleep and decreased intensity of murmur
  - peak incidence at 2-4 months of age
  - if severe may lead to seizures, loss of consciousness (LOC), death (rare)
  - management: O_2, knee-chest position, fluid bolus, morphine sulfate, propanolol
- ❑ murmur: single loud S2 due to severe pulmonic stenosis
- ❑ ECG: right axis deviation, RVH
- ❑ CXR: boot shaped heart, decreased pulmonary vasculature, right aortic arch
- ❑ management: surgical repair including closure of VSD and widening of RVOTO

2. LESIONS ASSOCIATED WITH INCREASED PULMONARY BLOOD FLOW

Transposition of the Great Arteries (TGA)

- ❑ most common cardiac lesion after VSD
- ❑ parallel pulmonary and systemic circulations
  - systemic: body —> RA —> RV —> aorta —> body
  - pulmonary: lungs —> LA —> LV —> pulmonary artery —> lungs
- ❑ newborn presents with progressive cyanosis unresponsive to oxygen therapy as the ductus arteriosus closes and mixing between the two circulations diminishes; severe hypoxemia, acidosis, and death can occur rapidly
- ❑ if VSD present, cyanosis is not prominent, infant presents with CHF after a few weeks of life
- ❑ murmur: none if no VSD
- ❑ ECG: RAD, RVH
- ❑ CXR: egg-shaped heart with narrow mediastinum ("egg on a string")
- ❑ management
  - prostaglandin E1 (PGE1) infusion to keep ductus open until septotomy or surgery
  - balloon atrial septostomy with catheter
  - surgical correction: arterial switch procedure
- ❑ infants without VSD must be repaired within 2 weeks to avoid weak LV muscle

Hypoplastic Left Heart Syndrome

- ❑ a spectrum of hypoplasia of left ventricle, atretic mitral and/or aortic valves, small ascending aorta, coarctation of the aorta with resultant systemic hypoperfusion
- ❑ most common cause of death from congenital heart disease in first month of life
- ❑ presents with circulatory shock and metabolic acidosis on closure of the ductus
- ❑ management
  - intubate and correct metabolic acidosis
  - IV infusion of PGE1 to keep ductus open
  - surgical correction (overall survival 50% to late childhood): Norwood procedure, Fontan
  - transplantation
  - palliative

Clinical Pearl

- ❑ **Characteristic Chest X-Ray Findings in Congenital Heart Disease**
  Boot-Shaped Heart - Tetralogy of Fallot, Tricuspid Atresia
  Egg-Shaped Heart - Transposition of Great Arteries
  "Snowman" Heart - Total Anomalous Pulmonary Venous Return.

CONGESTIVE HEART FAILURE (CHF) (see Cardiology Chapter)

Etiology
- ❑ congenital heart defects (CHD)
- ❑ arteriovenous malformations (AVM's)
- ❑ cardiomyopathy
- ❑ arrhythmias
- ❑ acute hypertension
- ❑ anemia
- ❑ cor pulmonale
- ❑ myocarditis

Symptoms
- ❑ infant: feeding difficulties, easy fatiguability, exertional dyspnea, diaphoresis when sleeping or eating, respiratory distress, vomiting, lethargy, cyanosis
- ❑ child: decreased exercise tolerance, fatigue, decreased appetite, failure to thrive, respiratory distress, syncope, frequent URTIs or "asthma" episodes
- ❑ orthopnea, paroxysmal nocturnal dyspnea, edema are all uncommon in children

Physical Findings
- ❑ four key features: tachycardia, tachypnea, cardiomegaly, hepatomegaly (2 tachy's, 2 megaly's)
- ❑ failure to thrive (FTT)
- ❑ respiratory distress, gallop rhythm, wheezing, crackles, cyanosis, clubbing (with CHD)
- ❑ alterations in peripheral pulses, four limb blood pressures
- ❑ dysmorphic features associated with congenital syndromes

Management
- ❑ correction of underlying cause
- ❑ general: sitting up, O_2, sodium and water restriction, increased caloric intake
- ❑ pharmacologic: diuretics, inotropic agents, afterload reduction

INFECTIVE ENDOCARDITIS (see Cardiology Chapter)
- ❑ serial positive cultures are needed for definitive diagnosis, but rely on clinical suspicion and other investigations if initially negative
- ❑ 10-15% of cases are culture negative, this is a risk factor for poor prognosis
- ❑ Osler's nodes, Janeway's lesions, splinter hemorrhages are late findings in children
- ❑ antibiotic prophylaxis for prevention is necessary for all patients with
  - congenital heart disease (except for isolated secundum ASD)
  - rheumatic valve lesions
  - prosthetic heart valves
  - surgical shunts
  - previous endocarditis
  - pacemaker leads

DYSRHYTHMIAS (see Cardiology Chapter)
- ❑ can be transient or permanent, congenital (structurally normal or abnormal) or acquired (toxin, infection)

Sinus Arrhythmia
- ❑ phasic variations with respiration
- ❑ in almost all normal children

Premature Atrial Contractions (PACs)
- ❑ may be normal variant or can be caused by electrolyte disturbances, hyperthyroidism, cardiac surgery, digitalis toxicity

Premature Ventricular Contractions (PVCs)
- ❑ common in adolescents
- ❑ benign if single, uniform, disappear with exercise, no associated structural lesions
- ❑ if not benign, may degenerate into more severe dysrhythmias

Supraventricular Tachycardia (SVT)
- ❑ most frequent sustained dysrhythmia in children
- ❑ not life-threatening but can lead to symptoms
- ❑ caused by re-entry via accessory connection (atrioventricular (AV) node most common site)
- ❑ characterized by a rate of greater than 210 bpm
- ❑ treatment: vagal maneuver, adenosine, digoxin (except in Wolfe-Parkinson-White (WPW)) or B-blockers

Complete Heart Block
- ❑ congenital heart block can be caused by maternal Rho antibody formed in mothers with CVD
- ❑ clinical symptoms related to level of block
- ❑ the lower the block, the greater the symptoms of inadequate cardiac output (CO)
- ❑ symptomatic patients need a pacemaker

DERMATOLOGY

COMMON NEONATAL SKIN CONDITIONS (see Dermatology Chapter)

- ❑ vascular instability (cutis marmorata, acrocyanosis)
  - usually normal, particularly in premature infants
- ❑ vernix caseosa
  - soft creamy white layer, common in pre-term babies, disappears by term (peeling of extremities in post-term babies)
- ❑ Mongolian spots
  - bluish black macules over lower back and buttocks (may look like bruises)
  - common in black, Indian and Asian infants
- ❑ capillary hemangioma
  - raised red lesion which increases in size after birth and generally involutes between 1-4 years of age
- ❑ erythema toxicum
  - erythematous vesiculo-papular rash; self-limited
- ❑ pustular melanosis
  - defined by brown macular base with dry vesicles
  - more common in black infants
- ❑ neonatal acne

DIAPER DERMATITIS

- ❑ differential diagnosis
  1. irritant contact dermatitis
  2. seborrheic dermatitis
  3. candidiasis
  4. psoriasis

Primary Irritant Dermatitis

- ❑ intertriginous areas not involved (differentiates from candida)
- ❑ chemical irritation (urine, feces) - very common
- ❑ seen in infants on with diarrhea, or cloth diapers

Treatment

- ❑ disposable diapers
- ❑ 1% hydrocortisone cream
- ❑ protective ointments (e.g. petroleum jelly, zinc oxide)

SEBORRHEIC DERMATITIS - (see Colour Atlas D4)

- ❑ usually appears in the first few days of life
- ❑ thick yellow greasy scales
- ❑ sites include scalp (cradle cap), eyebrows, nose, diaper area (including intertriginous areas)
- ❑ non-pruritic
  - usually happy baby
  - +/– mild steroid: 1% hydrocortisone cream

Treatment

- ❑ scale removal with oils and by physical means (soft hair brush, manual removal), tar shampoos, hydrocortisone

CANDIDA

- ❑ red confluent lesions with irregular, scaly border and “satellite" lesions
- ❑ intertriginous areas involved (distinguish from diaper dermatitis)
- ❑ may have concomitant oral thrush

Treatment

- ❑ topical antifungal

ITCHY ERUPTIONS IN CHILDHOOD

- ❑ “**UC SCAB**”
  - **U**rticaria
  - **C**ontact dermatitis
  - **S**cabies
  - **C**hicken pox
  - **A**topic dermatitis
  - **B**ites (mosquito, flea)

ATOPIC DERMATITIS (ECZEMA)

- ❑ family history positive for atopy (asthma, allergy, ASA sensitivity)
- ❑ those affected thought to have a decreased threshold for pruritus and for reaction to irritants
- ❑ serum IgE levels are higher in 80-85% of those affected
- ❑ 95% manifest before 2 years old

Table 11. Clinical Stages of Atopic Dermatitis (Eczema)	
Age Group	**Location**
infantile (3 months - 3 years)	face and extensors of lower legs
childhood (3 years - puberty)	flexural areas
adult (puberty onwards)	diffuse on face and extremities

- ❑ diagnostic criteria include
  - characteristics of lesions (acute and chronic)
  - follows typical distribution
  - chronic relapsing course
  - family history of atopy
- ❑ acutely: erythema, vesicles, exudate and crusts, pruritis
- ❑ chronic: scaling, xerosis, lichenification and pigment changes
- ❑ prognosis: approximately 75% have remission by adolescence
  - if severe, consider underlying immune-deficiency

Treatment
- ❑ general: educate re: chronicity of illness; avoid scratching
- ❑ therapy
  - skin hygiene to prevent infection
  - avoid harsh soaps, chemicals, perfumes, wool, etc.
  - skin hydration by petroleum jelly application while wet
  - topical steroids: hydrocortisone 1% to face and folds, medium strength on rest of body
  - antihistamines are effective against pruritus
- ❑ systemic medication
  - antihistamines
  - antibiotics for secondary bacterial infections
  - do not use systemic steroids

Complications
- ❑ secondary infection (e.g. Staph, H*erpes simplex*, fungal)
- ❑ malnutrition from unnecessary food restrictions by parents
- ❑ severe and chronic atopic dermatitis may lead to growth retardation due to catabolic state: reversed when eczema is controlled

IMPETIGO
- ❑ contagious infection by S. *aureus* (most common) and Group A Strep(GAS) **(see Colour Atlas ID5)**
- ❑ honey-coloured, crusting erosions - S*treptococcus*
- ❑ may have bullous lesions (bullous impetigo) - S*taphylococcus*
- ❑ occurs primarily on exposed areas (face), but can affect skin flexors and extremities
- ❑ satellite lesions by autoinoculation
- ❑ non-pruritic

Complications
- ❑ local cellulitis
- ❑ post-streptococcal glomerulonephritis (PSGN)
- ❑ does NOT cause rheumatic fever

Treatment
- ❑ topical antibiotics (Fucidin/Bactroban)
- ❑ oral antibiotics: penicillin, erythromycin, cephalexin
- ❑ local crust removal
- ❑ careful hygiene to prevent spread

SCABIES
- ❑ very itchy polymorphic papules; hands and feet commonly involved
- ❑ track marks (S-shaped burrows) **(see Colour Atlas ID2)**
- ❑ infants or immunosuppressed patients can get very severe scabies (sparing of head and neck in adults)
- ❑ may have excoriations, xerosis, honey-coloured crusts, and pustules from secondary infection
  - family members often also affected

Treatment
- ❑ wash all bedding and personal clothing in hot water
- ❑ premethrin (Nix) or gamma benzene hexachloride (Lindane)
- ❑ precipitated sulfur
- ❑ treat family and contacts
- ❑ antihistamines: e.g. hydroxyzine (Atarax) or diphenhydramine (Benadryl)

ERYTHEMA MULTIFORME (EM) - (see Dermatology Chapter) **(see Colour Atlas D16)**

Minor - 80%
- ❑ 1-2 cm erythematous papules; center clears to a purpuric or cyanotic lesion (i.e. "target lesions")
- ❑ symmetrical; common on dorsum of hands/feet, elbows, knees and face
- ❑ may have mild mucous membrane involvement
- ❑ no systemic signs
- ❑ etiology
  - idiopathic (most common)
  - infectious: herpes simplex virus (HSV) implicated
  - drugs
- ❑ treatment
  - attempt to identify agent
  - symptomatic treatment
  - no antihistamines, NSAIDs or salicylates necessary
- ❑ prognosis
  - self-limited

Major (Stevens-Johnson Syndrome (SJS)) - 20%
- ❑ lesions of erythema multiforme minor + bullous lesions with mucous membrane involvement (oral, nasal, conjunctival and genital)
- ❑ etiology
  - drugs (sulfa, phenytoin, penicillin, phenobarbital)
  - infections (e.g. M*ycoplasma*)
  - may have non-specific viral prodrome
- ❑ treatment
  - supportive: IV fluids, analgesia, ophthalmology consult
  - antibiotics for infection only, systemic steroids controversial

VIRAL EXANTHEMS (see Pediatric Infectious Diseases section)

DEVELOPMENT AND BEHAVIOUR

DEVELOPMENTAL DELAY (see Pediatric Psychiatry section)

Differential Diagnosis
- ❑ chromosomal: Down syndrome, Fragile X, Turner syndrome
- ❑ metabolic: Tay-Sachs, PKU, storage diseases
- ❑ cerebral degenerative: adrenal leukodystrophy
- ❑ prenatal infection: TORCH, HIV
- ❑ postnatal infection: meningitis, encephalitis, HIV
- ❑ toxic agents/drugs: alcohol, street drugs
- ❑ trauma/hypoxia: birth trauma, intracerebral hemorrhage (ICH), hypoxic ischemic encephalopathy (HIE)
- ❑ other syndromes: autism
- ❑ sensory defects: vision, hearing

LANGUAGE DELAY
- ❑ present in 10% of the population

Differential Diagnosis
- ❑ hearing impairment
  - spectrum of impairment - slight to profound loss
  - language development may seem normal for up to 6 months (including cooing and babbling) but may regress due to lack of feedback
  - risk factors for sensorineural hearing loss (presence of one or more warrants infant screening):
    - genetic syndromes/family history (30-50%)
    - congenital (TORCH) infections
    - craniofacial abnormalties
    - <1,500 g birthweight
    - hyperbilirubinemia/kernicterus
    - asphyxia/low APGAR scars
    - bacterial meningitis
  - to evaluate hearing loss in children
    - < 6 month old auditory brainstem response(ABR): tympanometry (impedence testing), evoked potentials
    - > 6-8 month old: behaviour audiometry
    - > 3-4 years old: pure tone audiometry

- ❑ cognitive disability
  - global developmental delay, mental retardation
  - both receptive and expressive language components affected
  - child often has interest in communication
- ❑ pervasive developmental disorder (PDD), including autism (see Psychiatry Chapter)
  - poor social interaction and language impairment
- ❑ selective mutism
  - usually starts at age 5-6 years when child goes to school
  - only speaks in certain situations, usually at home
  - healthy children with no hearing impairment
  - often above-average intelligence
- ❑ Landau-Kleffner syndrome (acquired epileptic aphasia)
  - presents in late preschool to early school age years
  - child begins to develop language normally, then sudden regression of language
  - child has severe aphasia with EEG changes
  - often has overt seizure activity
  - initial presentation may be similar to autism
- ❑ mechanical problems
  - cleft palate
  - cranial nerve palsy
- ❑ social deprivation

FETAL ALCOHOL SYNDROME (FAS)

- ❑ prevalence of FAS: 1 in 500-600
- ❑ not known how much alcohol is harmful during pregnancy
- ❑ no "safe" level of alcohol consumption during pregnancy

Criteria for Diagnosis of Fetal Alcohol Syndrome

- ❑ A: Growth deficiency
  - low birth weight and/or length at birth that continues through childhood
- ❑ B: Abnormal craniofacial features
  - small head, small eyes, long smooth philtrum, thin upper lip, maxillary hypoplasia
- ❑ C: Central nervous system dysfunction
  - microcephaly and/or neurobehavioral dysfunction (e.g. hyperactivity, fine motor problems, attention deficits, learning disabilities, cognitive disabilities)
- ❑ D: Strong evidence of maternal drinking during pregnancy

Fetal Alcohol Effects (FAE)

- ❑ prevalence of FAE: 1 in 300-350
- ❑ child born to a mother who was known to be drinking heavily during pregnancy
- ❑ child has some but not all of physical characteristics of FAS
- ❑ often missed diagnosis since features are subtle

TOILET TRAINING

- ❑ 90% of kids attain bowel control before bladder control
- ❑ generally females before males
- ❑ 25% by 2 years old (in North America)
- ❑ 98% by 3 years old
- ❑ signs of toilet readiness
  - ambulating independently, stable on potty, desire to be independent or to please caregivers (eg. motivation), sufficient expressive and receptive language skills (2-step command level), can stay dry for several hours (large enough bladder)

ELIMINATION DISORDERS

A. ENURESIS

- ❑ involuntary urinary incontinence by day and/or night in a child > 5 years old not due to neurological disorder or structural abnormality of the urinary tract
- ❑ prevalence: 10% of 6 year olds, 3% of 12 year olds, 1% of 18 year olds
- ❑ should be evaluated if >4 years old: dysuria, gross colour change, odour, stream

Primary Nocturnal Enuresis (90%)

- ❑ wet only at night during sleep
- ❑ developmental disorder or maturational lag in bladder control while asleep
- ❑ more common in boys, family history common
- ❑ treatment
  - time and reassurance (~20% resolve spontaneously each year)
  - bladder retention exercises
- ❑ conditioning: "wet" alarm wakes child upon voiding (70% success rate)
- ❑ medications: DDAVP

Secondary Enuresis
- ❑ develops after child has sustained period of bladder control (3 months or more)
- ❑ nonspecific regression in the face of stress or anxiety (e.g. birth of sibling, significant loss, family discord)
- ❑ may also be secondary to urinary tract infection (UTI), diabetes mellitus (DM), diabetes insipidus (DI), neurogenic bladder, neurogenic bladder, cerebral palsy (CP), sickle cell disease, seizures, pinworms
- ❑ may occur if engrossed in other activities

Diurnal Enuresis
- ❑ daytime wetting (60-80% also wet at night)
- ❑ timid, shy, temperament problems
- ❑ rule out structural anomaly (e.g. ectopic ureteral site, neurogenic bladder)
- ❑ treatment depends on cause
- ❑ remind child to go to toilet, focus on verbal expression of feelings, mental health treatment

B. ENCOPRESIS
- ❑ fecal incontinence in a child at least 4 years old
- ❑ prevalence: 1-1.5% of school-aged children (rare in adolescence)
- ❑ M:F = 6:1
- ❑ must exclude medical causes (e.g. Hirschsprung disease, hypothyroidism, hypercalcemia, spinal cord lesions, anorectal malformations)

Retentive Encopresis (Psychogenic Megacolon)
- ❑ causes
  - physical: anal fissure (painful stooling)
  - emotional: disturbed parent-child relationship, coercive toilet training
- ❑ history
  - child withholds bowel movement, develops constipation, leading to fecal impaction and seepage of soft or liquid stool
  - crosses legs or stands on toes to resist urge to defecate
  - distressed by symptoms, soiling of clothes
  - toilet training: coercive or lackadaisical
- ❑ physical exam
  - rectal exam: large fecal mass in rectal vault
  - anal fissures (result from passage of hard stools)
- ❑ diet modification (see Pediatric Gastroenterology section)
- ❑ treatment
  - stool softeners (e.g. Senokot, Lansoyl at bedtime)
  - toilet schedule
  - positive reinforcement
  - enemas and suppositories
  - complete clean-out of bowel
- ❑ complications: continuing cycle, toxic megacolon (requires >3-12 months to treat), bowel perforation

Non-Retentive Encopresis
- ❑ continuous: present from birth (never gained primary control of bowel function)
  - bowel movement randomly deposited without regard to social norms
  - family structure usually does not encourage organization and skill training
  - child has not had adequate consistent bowel training
  - treatment: consistent toilet training
- ❑ discontinuous: previous history of normal bowel control
  - bowel movements as an expression of anger or wish to be seen as a younger child
  - breakdown occurs in face of stressful event, regression
  - displays relative indifference to symptoms
  - treatment: psychotherapy if persists for many weeks

Toilet Phobia
- ❑ relatively young child
- ❑ views toilet as a frightening structure
- ❑ child thinks they may be swept away by toilet
- ❑ treatment
  - gradual series of steps with rewards
  - desensitization

SLEEP DISTURBANCES

Nightmares
- ❑ prevalence: common in boys, 4-7 years old
- ❑ associated with REM sleep anytime at night
- ❑ upon awakening, child is alert and clearly recalls frightening dream
- ❑ may be associated with stress/anxiety
- ❑ treatment: reassurance

Night Terrors
- ❑ prevalence: 15% of children have occasional episodes
- ❑ abrupt sitting up, eyes open, screaming
- ❑ panic and signs of autonomic arousal
- ❑ occurs in early hours of sleep, non REM, stage 4 of sleep
- ❑ no memory of event, parents unable to calm child
- ❑ stress/anxiety can aggravate them
- ❑ course: remits spontaneously at puberty
- ❑ treatment: reassurance

Table 12. Comparison of Nightmares and Night Terrors

	Nightmare	Night Terrors
stage	REM	non REM, stage 4
motor	–	+
memory for event	+	–
onset	early morning	first 2 hours of sleep
associated	stress/anxiety	hyperarousal state
treatment	reassurance	reassurance

BREATHOLDING SPELLS
- ❑ occur in 0.1% - 5% of healthy children 6 months - 4 years of age
- ❑ spells usually start during first year of life
- ❑ 2 types
  - anger/frustration —> blue/cyanotic (more common)
  - pain/surprise —> white/pallid
- ❑ child is provoked (usually by anger, injury or fear), starts to cry and then becomes silent
- ❑ spell resolves spontaneously or the child may lose consciousness; rarely progresses to seizures
- ❑ treatment: behavioural
  - help child control response to frustration and avoid drawing attention to spell
  - avoid being too permissive in fear of precipitating a spell

ENDOCRINOLOGY

DIABETES MELLITUS (see Endocrinology Chapter)

Type 1 Diabetes
- ❑ insulin dependent, most common type in childhood
- ❑ prevalence: 1 in 400-500 children under 18 years of age
- ❑ etiology: genetic predisposition and environmental trigger
  - autoimmune destruction of β-cells of the pancreas (antibodies directed towards glutamic acid decarboxylase have been identified)
  - a non-immune variation has been described
- ❑ classic presentation: polyuria, polydipsia, abdominal pain, weight loss, and fatigue
- ❑ 25% present in diabetic ketoacidosis (DKA)

Management of Uncomplicated Diabetes
- ❑ insulin, blood glucose monitoring
- ❑ young children more susceptible to CNS damage with hypoglycemia with fewer benefits from tight control, hence target glucose range higher at 6-12 mmol/L (110-220 mg/dL)
- ❑ increasingly tighter control in older children, 4-8 mmol/L (70-140 mg/dL)
- ❑ meal plan, exercise, education, psychosocial support

Complications of Diabetes

- ❑ hypoglycemia
  - cause: missed/delayed meals, excess insulin, increased exercise
  - complications: seizures, coma
  - must have glucagon kit for quick injections
- ❑ hyperglycemia
  - cause: infection, stress, diet-to-insulin mismatch
  - complications: risk of DKA, long-term end-organ damage
- ❑ DKA
  - cause: new-onset diabetes, missed insulin doses, infection
  - medical emergency: most common cause of death in children with diabetes (attributed to cerebral edema)
- ❑ long-term complications (retinopathy, nephropathy, neuropathy)
  - usually not seen in childhood (often begin 5 years after presentation or 3-5 years after puberty)

Type 2 Diabetes

- ❑ incidence increasing dramatically in children: up to 7.2 in 100,000
- ❑ especially prevalent among North American Aboriginals, Africans, Asians, Hispanics

Mature Onset Diabetes of the Young (MODY)

- ❑ autosomal dominant inheritance

HYPOTHYROIDISM (see Endocrinology Chapter)

Congenital Hypothyroidism

- ❑ incidence: 1 in 4000 births
  - usually caused by dysgenetic (agenesis or ectopic) malformation of the thyroid gland
- ❑ diagnosis through routine neonatal screening
- ❑ usually asymptomatic in neonatal period but may have
  - prolonged jaundice
  - constipation
  - sluggish, coarse cry, lethargy, poor feeding
  - macroglossia, coarse facial features, large fontanelle, umbilical hernia
- ❑ prognosis
  - excellent if treatment started within 1-2 months of birth
  - if treatment started after 3-6 months of age may result in developmental delay
- ❑ management: thyroxine replacement

Acquired Hypothyroidism

- ❑ most common: Hashimoto's thyroiditis (autoimmune destruction of the thyroid)
- ❑ signs and symptoms similar to hypothyroidism in adults, but also
  - delayed bone age, decline in growth velocity, short stature
  - precocious puberty
  - does not cause permanent developmental delay

HYPERTHYROIDISM (see Endocrinology Chapter)

Congenital Hyperthyroidism

- ❑ results from transplacental passage of maternal thyroid stimulating antibodies (mother with Graves' disease)
- ❑ clinical manifestations in the neonate may be masked by transplacental maternal antithyroid medication
- ❑ presentation: tachycardia with congestive heart failure (CHV), irritability, craniosynostosis, poor feeding, failure to thrive (FTT)
- ❑ spontaneous resolution by 2-3 months of life as antibodies cleared
- ❑ management: propylthiouracil until antibodies cleared

Graves Disease (see Colour Atlas E2)

- ❑ peak incidence in adolescence
- ❑ F:M = 5:1
- ❑ may exhibit classic signs and symptoms of hyperthyroidism, but also personality changes, school difficulty, mood instability
- ❑ management similar to adults: anti-thyroid drugs (propylthiouracil, methimazole), radioiodine reserved for older teens, surgical thyroidectomy
- ❑ children with a solitary thyroid nodule require prompt evaluation as 30-40% have carcinoma. The rest have adenoma, abscess, cyst or multinodular goiter

AMBIGUOUS GENITALIA

Etiology
- ❑ male pseudohermaphrodite (XY)
  - inborn error of testosterone biosynthesis or Leydig cell hypoplasia
  - 5-α-reductase deficiency, androgen receptor deficiency or insensitivity
  - leutenizing hormone (LH)/hCG unresponsiveness
  - nonandrogen-induced structural malformations
- ❑ female pseudohermaphrodite (XX)
  - virilizing congenital adrenal hyperplasia (CAH)(most common)
  - maternal source: virilizing ovarian or adrenal tumours, untreated maternal congenital adrenal hyperplasia (CAH), placental aromatase deficiency
  - nonandrogen-induced structural malformations
- ❑ mixed pattern
- ❑ true hermaphrodite
- ❑ mixed gonadal dysgenesis

Diagnosis
- ❑ history: pregnancy (hormones and medications), family history
- ❑ physical exam: palpation of gonads, rectal exam
- ❑ investigations
  - karyotype
  - electrolytes and renin (evidence of salt-wasting)
  - 17-OH-progesterone (must wait until day 3 of life), androgens, follicle stimulating hormone (FSH) and leutenizing hormone (LH)
  - pelvic U/S to look for uterus, testicles, ovaries

CONGENITAL ADRENAL HYPERPLASIA (CAH) (see Endocrinology Chapter)

Pathophysiology
- ❑ autosomal recessive pattern of transmission, leading to enzyme defects, which can range from partial to total
- ❑ 21-hydroxylase deficiency is the most common form (95%)
- ❑ results in decreased cortisol and aldosterone with shunting toward adrenal androgen pathway
- ❑ deficiency of cortisol leads to elevated ACTH, which increases levels of unaffected steroids and causes bilateral adrenal hyperplasia

Clinical Features
- ❑ depends on the degree and the specific deficiency
- ❑ infants may present with FTT, salt-wasting (adrenal crisis due to lack of aldosterone), clitoral hypertrophy, fused labia
- ❑ hypertension is very unlikely (usually seen in the 11-hydroxylase variant)
- ❑ adult onset (11-hydroxylase variant) more insidious, may present as hirsutism
- ❑ female: ambiguous genitalia to complete virilization, amenorrhea
- ❑ precocious puberty, with early adrenarche
- ❑ accelerated linear bone growth in early years, but premature epiphyseal closure due to high testosterone, resulting in short stature
- ❑ possible Addisonian picture (adrenal insufficiency) if adrenal output of cortisol severely compromised

Lab Findings
- ❑ low Na^+, high K^+, low cortisol, high ACTH if both glucocorticoid and mineralocorticoid deficiency
- ❑ increased serum 17-OH-progesterone (substrate for 21-hydroxylase)
- ❑ increased testosterone
- ❑ increased DHEA-S
- ❑ increased urinary 17-ketosteroids
- ❑ advanced bone age

Treatment
- ❑ diagnose and treat before epiphyseal closure to prevent short stature
- ❑ glucocorticoid replacement to lower ACTH, and therefore reduce adrenal androgen production
- ❑ mineralocorticoid replacement (if salt-wasting type)
- ❑ surgical repair of virilized female external genitalia

Late-Onset 21-Hydroxylase Deficiency
- ❑ allelic variant of classic 21-hydroxylase deficiency
- ❑ mild enzymatic defect
- ❑ manifests during or after puberty: signs of virilization (hirsutism and acne) and amenorrhea or oligomenorrhea
- ❑ consider in women with unexplained hirsutism and menstrual abnormalities
- ❑ diagnosis
  - increased plasma 17-OH-progesterone after ACTH stimulation test
- ❑ treatment
  - dexamethasone, spironolactone (anti-androgen)
  - mineralocorticoid replacement is not needed

NORMAL SEXUAL DEVELOPMENT

❑ puberty occurs with the maturation of the hypothalamic–pituitary axis
❑ increases in the pulsatile release of gonadotropin hormone (GnRH) —> increased release of LH and FSH —> maturation of gonads and release of sex steriods —> secondary sexual characteristics
❑ also requires adrenal production of androgens (adrenarche: axillary hair, body odour, mild acne)

Females

❑ occurs between age 8-13 (may occur as early as age 7); usual sequence
- thelarche: breast budding
- adrenarche: axillary hair, body odour, mild acne
- growth spurt: occurs at Tanner Stage 3
- menarche: occurs during Tanner stage 4; mean age 12.8 years; occurs 18-24 months after breast development and indicates the end of growth spurt

Males

❑ occurs between age 9-14
❑ usual sequence
- testicular enlargement: > 2cc
- penile enlargement: occurs at Tanner Stage 4
- adrenarche: axillary and facial hair, body odour, mild acne
- growth spurt: occurs at Tanner Stage 4

Table 13. Tanner Staging (Sexual Maturity Rating)

	FEMALE		MALE	
stage	**breast**	**pubic hair**	**genitalia**	**pubic hair**
1	–	–	–	–
2	bud	sparse labial hair	scrotal/testes enlargement	sparse hair at base of penis
3	single contour	hair over pubis	increase in length of penis	hair over pubis
4	nipple forms secondary mound	coarse adult hair	further increase in length and breadth of penis	coarse adult hair
5	adult size and shape	extends to medial thigh	adult size and shape	extends to medial thigh

NORMAL VARIATION IN PUBERTY

Premature Thelarche

❑ isolated breast tissue development in girls 6 months - 3 years
❑ breast asymmetry may occur as one breast may grow faster than the other; becomes less noticeable as maturation continues
❑ requires careful history and physical to ensure no other estrogen effects or other signs of puberty
❑ may be due to increased sensitivity to estrogen
❑ requires observation and periodic examinations every 6-12 months to ensure no further signs of puberty

Gynecomastia

❑ common self-limited condition seen in 50-60% of early male adolescents
❑ must distinguish true breast tissue from fat: 1-3 cm round, mobile, sometimes tender, firm mass under areola
❑ discharge from nipple or fixed mass should be investigated

Physiologic Leukorrhea

❑ occurs prior to menarche; scant mucoid, clear to milky discharge not associated with pruritis or foul odour
❑ due to stimulation of endometrial glands by estrogen

Irregular Menstruation

❑ menses may be irregular in duration of period and length of cycle
❑ on average it takes 18 months to go through the first 12 periods
❑ birth control pills should be avoided as treatment

Premature Adrenarche
❑ usually develops in boys and girls before the age of 6, benign self-limiting condition
❑ adrenal production of DHEAS reaches pubertal levels at an earlier age
❑ pubic and axillary hair, body odour, mild acne
❑ determine whether other signs of puberty are present (thelarche - girls, testicular enlargement - boys)
❑ exclude androgen secreting tumours (DHEAS levels, androstenedione, testosterone, bone age)

PRECOCIOUS PUBERTY
❑ secondary sexual development before 8 years in girls, 9 years in boys
- incidence: 1 in 10,000
- more common in females
- more worrisome in males (i.e. higher incidence of pathology)

Isosexual Precocious Puberty
❑ sexual maturation appropriate to genotypic sex of individual

True (Central) Precocious Puberty
❑ hypergonadotropic hypergonadism, hormone levels as in normal puberty
❑ premature activation hypothalamic-pituitary-gonadal axis
❑ much more common in females than males - 9:1
❑ differential diagnosis
- idiopathic or constitutional (most common, especially females)
- CNS disturbances: tumours, hamartomas, postmeningitis, increased ICP, radiotherapy
- neurofibromatosis (NF), primary severe hypothyriodism

Pseudo (Peripheral) Precocious Puberty
❑ hypogonadotropic hypergonadism
❑ differential diagnosis
- adrenal disorders: CAH, adrenal neoplasm
- testicular/ovarian tumour
- gonadotropin secreting tumour: hepatoblastoma, intracranial teratoma, germinoma
- exogenous steroid administration

Evaluation
❑ history: symptoms of puberty, family history of puberty onset, medical illness
❑ physical exam: growth velocity, Tanner staging, neurological exam
❑ investigations
- estradiol, testosterone, LH, FSH, TSH, GnRH test
- bone age often advanced
- consider CT or MRI of head; U/S of adrenals, pelvis

Management
❑ GnRH analogs, GnRH agonist (Lupron) - negative feedback to downregulate GnRH receptors
❑ medroxyprogesterone
❑ treat underlying cause

Heterosexual Precocious Puberty
❑ development of secondary sexual characteristics opposite to genotypic sex
❑ e.g. virilizing tumour (ovarian, adrenal), CAH, exogenous androgen exposure

DELAYED PUBERTY (see Gynecology Chapter)
❑ absence of pubertal development by age 13 in girls and age 14 in boys
❑ more common in males, more suggestive of pathology in females

Central Causes
❑ delay in activation of hypothalamic-pituitary-gonadal axis
❑ hypogonadotropic hypogonadism
❑ differential diagnosis
- constitutional (bone age delayed) - most common (> 90%)
- chronic disease, anorexia nervosa, malnutrition
- pituitary/hypothalamic failure (idiopathic or acquired)
- genetic (e.g. Kallman symdrome)
- hypothyrodism

Peripheral Causes
❑ hypergonadotropic hypogonadism (eg. primary gonadal failure)
❑ differential diagnosis
- genetic (e.g. Turner syndrome, Klinefelter syndrome)
- gonadal damage - infection, radiation, trauma
- gonadal dysgenesis
- hormonal defect - androgen insensitivity, 5-α-reductase deficiency

Evaluation
- ❑ history: weight loss, short stature, family history of puberty onset, medical illness
- ❑ physical exam: growth velocity, Tanner staging, neurological exam, complete physical exam
- ❑ hormone levels: estradiol, testosterone, LH, FSH, TSH, GnRH test bone age
- ❑ consider CT or MRI of head, ultrasound of adrenals, pelvis
- ❑ karyotype in girls < 3rd percentile in height (rule out Turner syndrome)

Management
- ❑ identify and treat underlying cause
- ❑ hormonal replacement: cyclic estradiol and progesterone for females, testosterone for males

SHORT STATURE
- ❑ special growth charts available for Turner's, achondroplasia, Downs syndrome (DS), different ethnic groups
- ❑ note: large child born to small parents may decelerate in growth, therefore any deceleration after 3 years of age is pathological (even if absolute height in normal range)

Assessment of Short Stature
- ❑ height << 3rd percentile, height crosses 2 major percentile lines, low growth velocity (< 25th percentile)
- ❑ history: perinatal history, growth pattern, medical history, parental height and age of pubertal growth spurt
- ❑ physical exam: growth velocity (over 6 month period), sexual development
- ❑ calculate mid-parental height (predicted adult height) +/– 8 cm for 2 SD range
  - check the mid-parental height for percentile of adults
  - boy = [father height (cm) + mother height (cm) + 13 cm] / 2
  - girl = [father height (cm) – 13 cm + mother height (cm)] / 2
- ❑ true growth hormone (GH) deficiency is rare; associated with other congenital anomalies (midline defects, vocal abnormalities, micropenis, neonatal hypoglycemia and hepatitis)

Table 14. Short Stature

NORMAL GROWTH VELOCITY (non-pathological short stature)	**DECREASED GROWTH VELOCITY** (pathological short stature)
❑ **Constitutional** - delayed adolescence - may have family history of delayed puberty - may require short-term therapy with androgens/estrogens - delayed bone age ❑ **Familial** - normal bone age - treatment not indicated	❑ **Primordial** (height, weight, and HC are affected) - chromosomal (e.g. Turner, Down syndrome, dysmorphic features) - skeletal dysplasias - intrauterine growth restriction (IUGR) (teratogen, placental insufficiency, infection) ❑ **Endocrine** (height more affected than weight) - "short and fat" - GH deficiency - hypothyroidism - Cushing syndrome - hypopituitarism ❑ **Chronic disease** (wt more affected than ht) - "short and skinny" - celiac disease, inflammatory bowel disease(IBD), cystic fibrosis (CF) - chronic infections - chronic renal failure (often height more affected) ❑ **Psychosocial neglect** (psychosocial dwarfism) - usually decreased height and weight (decreased head circumference (HC) if severe)

Clinical Pearl
❑ 4 questions to ask when evaluating short stature
1. **was there IUGR?**
2. **is the growth proportionate?**
3. **is the growth velocity normal?**
4. **is bone age delayed?**

Investigations
- ❑ bone age (x-ray of left hand and wrist)
- ❑ karyotype in girls to rule out Turner syndrome or if dysmorphic features present
- ❑ other tests as indicated by history and physical exam

Management
- ❑ depends on severity of problem as perceived by parents, child
- ❑ no treatment for the short normal child
- ❑ GH therapy if requirements met

Growth Hormone (GH)
- ❑ important for chondrocyte proliferation and IGF-1 release
- ❑ little effect on fetal growth (maternal IGF-1, uterine factors more important)
- ❑ IGF-1 acts at long bones, liver, negative feedback

Congenital GH Deficiency
- ❑ embryologic malformation: CNS central defects, midface anomalies, micropenis in males
- ❑ perinatal asphyxia
- ❑ rare mutations

Acquired GH Deficiency
- ❑ tumours (e.g. craniopharyngioma), trauma, past infection, irradiation, post-surgical

Testing for GH Deficiency
- ❑ only performed when: < third percentile, delayed growth velocity
- ❑ midline craniofacial anomalies
- ❑ episodes of hypoglycemia
- ❑ delayed bone age, puberty
- ❑ physiologic increase in GH with insulin, arginine, dopamine, clonidine, propanolol
- ❑ positive test if failure to raise GH> 8-10 ng/ml post-stimulation

Criteria for GH Therapy
- ❑ GH shown to be deficient by 2 different stimulation tests
- ❑ patient is short, not growing, < third percentile
- ❑ x-rays show there is growth potential
- ❑ signs and symptoms of GH-deficiency – eg. infantile features and fat distribution, delayed puberty

TALL STATURE
- ❑ also constitutional and familial variants
- ❑ assessment
  - history and physical examination: differentiate familial from other causes
  - calculate mid-parental height (predicted adult height)
  - look for associated abnormalities (e.g. hyperextensible joints, long fingers in Marfan syndrome)
- ❑ etiology
  - constitutional: most common, advanced bone age/physical development in childhood but normal once adulthood reached
  - endocrine: e.g. hypophyseal (pituitary) gigantism, precocious puberty, thyrotoxicosis, Beckwith-Wiedeman syndrome
  - genetic: e.g. Marfan, Klinefelter syndromes
- ❑ treatment: depends on etiology
  - estrogen used in females to cause epiphyseal fusion

Clinical Pearl
- ❑ **Upper to lower (U/L) segment ratio is...**
  - **Increased in achondroplasia, short limb syndromes, hypothyroid, storage diseases.**
  - **Decreased in Marfan's, Klinefelter, Kallman, testosterone deficiency.**

OBESITY
- ❑ weight > 20% greater than expected for age and height
- ❑ Body Mass Index (BMI) tends to vary and increases with age. Tends not to be used by pediatricians prior to adolescence
- ❑ history: diet, activity, family heights and weights, growth curves
- ❑ physical examination: may suggest secondary cause, e.g. Cushing syndrome
  - caliper determination of fat is more sensitive than weight
- ❑ organic causes are rare (< 5%)
  - genetic: e.g. Prader-Willi, Carpenter, Turner syndrome
  - endocrine: e.g. Cushing syndrome, hypothyroidism
- ❑ complications
  - low correlation between obese children and obese adults
  - some association with: hypertension, increased LDL, slipped capital femoral epiphysis, type 2 diabetes
  - boys: gynecomastia; girls: polycystic ovarian disease, early menarche
  - psychological: discrimination, teasing, decreased self-esteem
- ❑ management
  - encouragement and reassurance
  - diet: qualitative changes; do not encourage weight loss but allow for linear growth to catch up with weight
  - evidence against very low calorie diets for preadolescents
  - behavior modification: increase activity, change meal patterns
  - insufficient evidence for or against exercise, family programs for obese children
  - education: multidisciplinary approach, dietitian, counselling

VOMITING

❑ history
- age of onset, duration, severity
- quality: bilious, bloody, regurgitation
- associated symptoms (e.g. fever, abdominal pain, bowel movements, headaches)
- effect on growth and development, concurrent disease

❑ physical exam: tenderness, abdominal distention, masses
❑ assess hydration (see Tables 26 and 27)
❑ investigations (based on history and physical exam)
- bloody emesis: investigate for causes of upper gastrointestinal (GI) bleed
- bilious emesis: rule out obstruction (upper GI series, U/S)
- regurgitation: evaluate for reflux (barium swallow with fluoroscopy, 24 hour esophageal pH probe)
- CBC, lytes, BUN, creatinine, ESR, venous blood gases
- urine, blood, stool C&S
- amylase, lipase
- abdominal x-ray, U/S, contrast radiology, endoscopy

❑ management
- treat underlying cause
- rehydration (see Nephrology section)

A. VOMITING IN THE NEWBORN PERIOD

Tracheoesophageal Fistula (TEF)

❑ incidence: 1:3,000-1:4,500
❑ clinical features vary with type of fistula
- may have history of maternal polyhydramnios
- vomiting, coughing and gagging
- cyanosis with feeds, respiratory distress
- frothy bubbles of mucus in mouth and nose that return after suctioning
- associated anomalies in 50%: VACTERL association (see Genetics and Metabolism section)

❑ x-ray: plain and contrast studies show anatomic abnormality, NG tube curled in pouch
❑ management
- investigate for other congenital anomalies
- early repair to prevent lung damage and maintain nutrition

❑ complications
- pneumonia, sepsis, chronic reactive airways
- stenosis and strictures at repair site
- gastroesophageal (GE) reflux and poor swallowing following repair

Duodenal Atresia

❑ clinical features
- bile-stained vomiting if atresia distal to bile duct
- peristaltic waves
- without abdominal distention
- dehydration
- associated with Down syndrome (DS)
- may have history of maternal polyhydramnios

❑ abdominal x-ray: air-fluid levels on upright film
- "double bubble" sign (dilated stomach and duodenum)

❑ differential diagnosis: annular pancreas, aberrant mesenteric vessels, pyloric stenosis
❑ treatment
- decompression with NG tube
- correction of metabolic abnormalities
- surgical correction

Pyloric Stenosis

❑ incidence: most common in first-born males, family history often positive
- M:F = 5:1

❑ clinical features
- non-bilious projectile vomiting that occurs after feeding
- usually starts at 2-6 weeks of age
- infant hungry and alert, will re-feed
- FTT, wasting
- dehydration, may lead to prolonged jaundice
- gastric peristalsis goes from left upper quadrant (LUQ) to epigastrium
- "olive sign": olive-shaped mass at margin of right rectus abdominis muscle
- hypochloremic metabolic alkalosis

❑ diagnosis: clinical, abdominal U/S
❑ treatment: surgical (pyloromyotomy)

Malrotation of the Intestine
- ❑ 3 presentations
  - recurrent vomiting (bilious intermittently)
  - FTT with vomiting
  - sudden onset abdominal pain and then shock (if vomiting with bilious material, malrotation with volvulus until proven otherwise)
- ❑ 80% experience symptoms in first two months of life
- ❑ clinical features
  - distended abdomen
  - vomiting due to volvulus and bands across duodenum
- ❑ diagnosed by upper GI studies: duodenum not fixed, spiral jejenum, mobile cecum (may not be in right lower quadrant (RLQ))
- ❑ treatment: surgical

Other
- ❑ meconium ileus (see Cystic Fibrosis section)

B. VOMITING AFTER THE NEWBORN PERIOD

Infectious
- ❑ GI causes: gastroenteritis, peritonitis, appendicitis, hepatitis, ulcers, pancreatitis
- ❑ non-GI causes: urinary tract infection (UTI), otitis media, CNS infection

Anatomic
- ❑ GI tract obstruction
  - intussusception
  - foreign body (e.g. bezoar)
  - gastroesophageal reflux (GER)

Gastroesophageal Reflux
- ❑ extremely common in infancy: thriving baby requires no investigation
- ❑ investigations required if: FTT, recurrent cough, pneumonia or bronchospasm, GI blood loss
  - 24-hour pH probe, UGI series to rule out anatomical cause, upper endoscopy and esophageal biopsy for suspected esophagitis
- ❑ management
  - conservative: thickened feeds, elevate bed to 45 degrees
  - medical: short-term enteral feeding to enhance weight gain
  - drugs:
    - ranitidine, omeprazole: to decrease gastric acidity, decrease esophageal irritation or esophagitis
    - domperidone: to improve gastric emptying and GI motility
  - surgical: indicated for failure of medical therapy (Nissen fundoplication)

Central Nervous System
- ❑ increased intracranial pressure (ICP) (e.g. hydrocephalus, neoplasm)
- ❑ drugs/intoxicants
- ❑ migraine
- ❑ meningitis, encephalitis

Other
- ❑ metabolic/endocrine: DKA, inborn errors of metabolism, liver failure
- ❑ poisons/drugs: lead, digoxin, erythromycin, theophylline
- ❑ psychogenic: rumination syndrome, anorexia/bulimia, cyclic vomiting
- ❑ food allergy
- ❑ overfeeding

ACUTE DIARRHEA

Etiology
- ❑ viral infection
  - most common in Canada, e.g. Rotavirus
  - associated with URTIs
  - slight fever, malaise, vomiting, vague abdominal pain
  - resolves in 3-7 days
- ❑ bacterial infection
  - *Salmonella*, *Campylobacter*, *Shigella*, pathogenic E. *coli*, *Yersinia*
  - more severe abdominal pain, high fever, bloody diarrhea
- ❑ parasitic infection
  - *Giardia lamblia*, *Entameoba histolytica*
- ❑ toxin-induced: staphylococcal food poisoning, C. *difficile* toxin
- ❑ allergic: food intolerance
- ❑ antibiotic-induced
- ❑ non-specific: associated with any non-GI infection, generalized sepsis or shock

Investigations
- ❑ history and physical examination critical to determine degree of dehydration (see Nephrology section)
- ❑ rectal exam for fecal consistency and for microscopy (leukocytes)
- ❑ stool for culture and sensitivity (C & S), ova and parasites (O & P), electron microscopy for viruses
- ❑ if severe: routine blood work, blood and urine cultures

Management
- ❑ prevention and treatment of dehydration is most important (see Nephrology section)
- ❑ replacement of fluid deficit + maintenance + ongoing losses (see Tables 28 and 29)
- ❑ antibiotic therapy when indicated
- ❑ oral rehydration therapy with frequent small volumes of pediatric oral rehydration solutions (e.g. Pedialyte)
- ❑ IV may be required for severe dehydration
- ❑ early refeeding advisable
- ❑ antidiarrheal medications not indicated

Complications
- ❑ dehydration
- ❑ electrolyte disturbances
  - hyper or hyponatremia, hypokalemia, metabolic acidosis
- ❑ secondary disaccharidase deficiency (post-infectious diarrhea)
  - transient, due to villous damage

CHRONIC DIARRHEA
- ❑ diarrhea lasting > 14 days

Investigations for Chronic Diarrhea of Unknown Etiology
- ❑ serial heights, weights, growth percentiles
- ❑ if child is growing well and thriving, minimal workup is required
- ❑ if chronic diarrhea with FTT (the diagnosis can usually be made with history and physical exam), but the following investigations depending on suspected diagnosis:
  - stool: consistency, pH, reducing substances, microscopy, occult blood, O&P, C&S, *C. difficile* toxin, 3-day fecal fat
  - urinalysis
  - CBC, differential, ESR, smear, electrolytes, total protein, immunoglobulins
  - absorptive and nutritional status: albumin, carotene, Ca^{2+}, PO_4, Mg, Zn, Fe, ferritin, folate, fat-soluble vitamins, PT, PTT
  - sweat chloride
  - α-antitrypsin level, thyroid function tests, urine VMA and HVA, HIV test, lead levels
  - CXR, upper GI series + follow-through
  - specialized tests: small bowel biopsy, endoscopy and biopsy

A. CHRONIC DIARRHEA WITHOUT FAILURE TO THRIVE

Infectious
- ❑ bacterial: e.g. *Campylobacter, Salmonella*
- ❑ antibiotic-induced: *C. difficile colitis*
- ❑ parasitic: *Giardia lamblia*
- ❑ post-infectious: secondary lactase deficiency

Toddler's Diarrhea
- ❑ most common cause of chronic diarrhea during infancy
- ❑ diagnosis of exclusion in thriving child (no weight loss, no fluid or electrolyte abnormalities, no FTT)
- ❑ onset between 6-36 months of age, ceases spontaneously between 2-4 years
- ❑ diet history: too much juice overwhelms small bowel resulting in disaccharide malabsorption
- ❑ stool may contain undigested food particles, 4-6 bowel movements (BM's) per day
- ❑ excoriated diaper rash
- ❑ management
  - reassurance, self-limiting
    - four F's (adequate **f**iber, normal **f**luid intake, 35-40% **f**at, discourage excess **f**ruit juice)

Lactase Deficiency (Lactose Intolerance)
- ❑ clinical features
  - chronic, watery diarrhea
  - abdominal pain, bloating, borborygmi
- ❑ two scenarios
  - primary lactose intolerance: crampy abdominal pain with loose stool (in older children, usually in Orientals, Blacks)
  - secondary lactose intolerance: older infant, persistent diarrhea (post viral/bacterial infection, celiac disease, or IBD)

❑ diagnosis
- clinical trial off milk or lactose free milk
- watery stool, acid pH, positive reducing sugars
- positive breath hydrogen test if > 6 years

❑ management
- lactose-free diet, soy formula
- Lacteeze, Lactaid tabs/drops

B. CHRONIC DIARRHEA WITH FAILURE TO THRIVE

1. INTESTINAL CAUSES

Celiac Disease
❑ also known as "gluten-sensitive enteropathy"
❑ defect at the mucosal level
- toxic or immunologic reaction to gluten in "BROW" (**B**arley, **R**ye, **O**ats, **W**heat)

❑ clinical features
- presents at any age, usually 6-18 months
- FTT with poor appetite, irritability, apathy
- anorexia, nausea, vomiting, edema
- wasted muscles, distended abdomen and flat buttocks
- anemia, bleeding
- rickets
- clubbing of fingers

❑ diagnosis
- fat malabsorption studies
- small bowel biopsy: flat atrophic mucosa with resolution after trial of gluten-free diet (villous atrophy)
- antigliadin, antiendomysial antibodies, low D-xylose absorption

❑ treatment
- gluten-free diet for life
- avoid BROW

❑ complications if untreated
- small bowel lymphoma
- malnutrition

Milk Protein Allergy
❑ immune-mediated mucosal injury
❑ can be associated with anemia, hypoalbuminemia, edema
❑ up to 50% of children intolerant to cow's milk may be intolerant to soy protein
❑ often in atopic individuals
❑ 2 scenarios
- enterocolitis – vomiting, diarrhea, anemia, hematochezia
- enteropathy – chronic diarrhea, hypoalbuminemia

❑ treatment: casein hydrosylate formula

Inflammatory Bowel Disease (IBD) (see Gastroenterology Chapter)
❑ incidence: increasing in North America, mostly older children, teenagers

Other
❑ specific enzyme deficiencies
❑ liver disease, biliary atresia
❑ a-β-lipoproteinemia
❑ short gut toxic or immunologic reaction
❑ blind loop syndrome
❑ *Giardia lamblia*

2. PANCREATIC INSUFFICIENCY

Cystic Fibrosis (CF) (see Cystic Fibrosis section)

Schwachman-Diamond Syndrome
❑ incidence: 1:20,000, autosomal recessive
❑ pancreatic insufficiency, cyclic neutropenia, and anemia
❑ skeletal abnormalities (metaphyseal dysostosis leading to short stature)
❑ recurrent pyogenic infections (acute otitis media (AOM), pneumonia, osteomyelitis)
❑ distinguished from CF by normal sweat chloride test, characteristic metaphyseal lesions, fatty pancreas on CT

3. OTHER
- ❑ diets rich in sorbitol, fructose (poorly absorbed carbohydrates (CHO))
- ❑ metabolic/endocrine
  - thyrotoxicosis, Addison disease
  - galactosemia
- ❑ immune defects
  - IgA deficiency, hypogammaglobulinemia, severe combined immunodeficiency (SCID), AIDS
- ❑ neoplastic
  - pheochromocytoma
  - lymphoma of small bowel
- ❑ food allergy

CONSTIPATION
- ❑ as many as 20% of children < 5 years of age

Assessment
- ❑ history
  - age of onset, dietary history
  - associated symptoms: abdominal pain, encopresis, overflow diarrhea
- ❑ physical exam
  - examine lower back for evidence of occult cord lesion (neural tube defect (NTD))
  - abdominal exam, rectal exam
- ❑ most often diet-related (functional constipation) with no specific disease

Functional Constipation
- ❑ 99% of cases of constipation
- ❑ lack of bulk or fibre in diet or change in diet
- ❑ poor fluid intake
- ❑ infants: often when introducing cow's milk after breast milk
- ❑ toddlers/older children: can occur during toilet training, or due to pain on defecation, stool witholding
- ❑ complications
  - pain retention cycle: anal fissures and pain —> withholding passing stool —> chronic dilatation and overflow incontinence (encopresis)
- ❑ treatment
  - adequate fluid intake (if < 6 months, 150 ml/kg/day)
  - adequate dietary fibre, mineral oil, laxatives
  - appropriate toilet training technique

Hirschsprung's Disease
- ❑ also known as "congenital aganglionic megacolon"
- ❑ rectosigmoid in 75% of cases
- ❑ incidence: M:F = 3:1; 1/5,000 live births
- ❑ associated with Down Syndrome (DS)
- ❑ clinical features
  - severity depends on length of colon involved
  - no meconium within first 24 hours
  - palpable stool on abdominal exam with empty rectum on digital rectal exam (DRE)
  - intermittent diarrhea, BM only with rectal stimulation
  - constipation, abdominal distention, vomiting
  - failure to thrive (FTT)
- ❑ complications
  - enterocolitis: may be fatal, peak incidence 2-3 months of age
  - toxic megacolon and perforation
- ❑ diagnosis
  - barium enema: proximal dilatation due to functional obstruction, empty rectum
  - manometric studies: may have false positives
  - rectal biopsy: definitive diagnosis (absent ganglion cells)
- ❑ treatment
  - nonsurgical if short segment
  - surgical: colostomy and re-anastomosis

Other Organic Disorders
- ❑ intestinal obstruction
- ❑ endocrine
  - hypothyroidism
  - diabetes mellitus (DM)
  - hypercalcemia
- ❑ neurogenic bowel (e.g. spina bifida)
- ❑ anal fissure/stricture/stenosis
- ❑ collagen vascular disease
- ❑ drugs: lead, chemotherapy, opioids

ACUTE ABDOMINAL PAIN

Assessment
- ❑ accurate description of pain and its characteristics
- ❑ vomiting before pain suggests gastroenteritis
- ❑ vomiting after pain suggests a surgical condition
- ❑ physical examination: rebound tenderness, bowel sounds, rectal exam
- ❑ labs
  - CBC and differential
  - urinalysis to rule out urinary tract infection (UTI)

Differential Diagnosis
- gastroenteritis
- incarcerated hernia
- UTI
- appendicitis
- intussusception
- malrotation
- volvulus
- Henoch-Schönlein Purpura (HSP)
- sickle cell crisis
- pneumonia
- DKA
- mesenteric adenitis
- Meckle's diverticulum

1. Appendicitis
- ❑ most common bowel disorder after 5 years of age
- ❑ clinical features
  - low grade fever, anorexia
  - nausea, vomiting (after onset of pain)
  - abdominal pain (periumbilical —> RLQ), peritoneal signs
  - generalized peritonitis is a common presentation in infants/young children
- ❑ treatment: surgical
- ❑ complications: perforation, abscess

2. Intussusception
- ❑ 90% idiopathic, children with CF at significantly increased risk
- ❑ 50% between 3 - 12 months, 75% before 2 years of age
- ❑ telescoping of segment of bowel into distal segment —> ischemia and necrosis
  - usual site: ileocecal junction
- ❑ lead point may be swollen Peyer's patches, Meckel's diverticulum, polyp, malignancy, HSP
- ❑ clinical features
  - "classic triad"
    1. abdominal pain
    2. palpable sausage-shaped mass: upper to mid abdomen
    3. "red currant jelly" stools (only in 10-15% of patients)
  - sudden onset of recurrent, paroxysmal, severe periumbilical pain
  - pain-free remissions
  - later vomiting and rectal bleeding ("red currant jelly" stools)
  - shock and dehydration
- ❑ diagnosis and treatment
  - U/S
  - air enema
    - diagnostic: see reverse "E" sign
    - therapeutic: reduce intussusception
  - reduction under hydrostatic pressure
  - surgery rarely needed

CHRONIC ABDOMINAL PAIN
- ❑ 10-15% of children
- ❑ definition: = 3 episodes of pain severe enough to affect activities, occurring in a child >3 years of age over a period of 3 months

Assessment
- ❑ distinguish organic from non organic
- ❑ history
  - weight loss, appetite, energy, fever
  - associated vomiting, diarrhea, constipation
  - characteristics of pain
  - psychosocial issues
- ❑ physical exam: abnormalities suggest organic nature
- ❑ red flags for organic etiology
  - age < 5 years old
  - pain away from midline
  - localized pain awakens child at night
  - prominent vomiting, diarrhea
  - joint pain
  - rectal bleed
  - fever
  - anemia
  - travel history
  - weight loss or failure to gain weight
  - rash

Organic (< 10%)
- ❑ chronic infection
- ❑ gastrointestinal
  - constipation (cause vs. effect)
  - IBD, esophagitis, peptic ulcer disease, lactose intolerance
  - anatomic anomalies, masses
  - pancreatic, hepatobiliary
- ❑ genitourinary disease
- ❑ gynecological
- ❑ cardiovascular
- ❑ neoplastic

Functional/Recurrent Abdominal Pain (RAP) (90%)
- ❑ school age, peak 8-10 years
- ❑ prevalence: 10% of school children
- ❑ F > M
- ❑ characteristics
  - vague, crampy periumbilical or epigastric pain, vivid imagery to describe pain, clustering of episodes
  - seldom awakens child from sleep
  - aggravated by exercise, alleviated by rest
- ❑ school avoidance
- ❑ psychological factors related to onset and/or maintenance of pain
- ❑ absence of organic illness
- ❑ psychiatric comorbidity: anxiety, somatoform, mood, learning disorders, sexual abuse, eating disorders, elimination disorders
- ❑ diagnosis
  - exclude organic disorders (e.g. kidney disease, IBD)
  - consider school phobia
- ❑ investigations as indicated
  - CBC, ESR, urinalysis, stools for O&P, C&S, occult blood
- ❑ treatment
  - continue to attend school
  - manage any emotional or family problems
  - trial of high fibre diet, trial of lactose-free diet
  - reassurance
- ❑ prognosis
  - pain resolves in 30-50% of kids within 2-6 weeks of diagnosis
  - 30-50% of kids with RAP have functional pain as adults (e.g. Irritable Bowel Syndrome)

ABDOMINAL MASS

Table 15. Differential Diagnosis of Abdominal Mass

	Benign	Malignant
Renal	hydronephrosis polycystic kidney disease (PCKD) hamartoma	nephroblastoma (Wilm's) renal cell carcinoma (RCC)
Adrenal		neuroblastoma
Ovarian	ovarian cysts	ovarian tumours
Other	splenomegaly pyloric stenosis abdominal hernia teratoma	lymphoma retroperitoneal rhabdomyoscarcoma

- ❑ 50% of abdominal masses in the newborn are renal in origin

UPPER GASTROINTESTINAL (GI) BLEEDING (see Gastroenterology Chapter)

Etiology
- ❑ mucosal lesions
  - gastritis/gastroenteritis
  - esophagitis
  - duodenal/gastric ulcer
  - Mallory-Weiss tear
  - epistaxis, foreign body
- ❑ vascular
  - coagulopathy
  - vitamin K deficiency (hemorrhagic disease of the newborn)
  - esophageal varices
- ❑ other
  - swallowed blood, food colouring

Assessment
- ❑ physical exam: hemodynamic status, evidence of oropharyngeal bleeding, evidence of liver disease
- ❑ investigations: cross and type, CBC, hematocrit, smear, platelets, PT, PTT, urea, creatinine, urinalysis, LFTs if indicated
- ❑ nasogastric aspirate: test for blood, pH, and Apt test (for fetal hemoglobin) in newborn

Management
- ❑ acute stabilization: ABCs, reclining at 45 degree angle, vitamin K if suspect liver disease, may require volume and blood replacement, NG saline lavage, H_2 blocker (ranitidine), proton pump inhibitor (omeprazole)
- ❑ once stablized: diagnostic endoscopy, radiologic exam
- ❑ treat underlying cause

LOWER GASTROINTESTINAL (GI) BLEEDING (see Gastroenterology Chapter)

Etiology
- ❑ acute
- ❑ infection
- ❑ bacterial, parasitic, antibiotic-induced (C. *difficile*)
- ❑ anatomic
  - malrotation/volvulus
  - intussusception
  - Meckel's diverticulum
  - anal fissures
- ❑ vascular/hematologic
  - Henoch-Schönlein Purpura (HSP)
  - hemolytic uremia syndrome (HUS)
  - coagulopathy
- ❑ chronic
  - anal fissures (most common)
  - colitis
  - IBD
  - allergic (milk protein)
- ❑ structural
  - polyps (most are hamartomas)
  - neoplasms (rare)
- ❑ coagulopathy

Assessment
- ❑ hemodynamic status, evidence of growth failure, fevers
- ❑ anal and rectal exam
  - tags, fissures, anal fistulas, polyps
  - foreign body
  - blood
  - stool appearance
- ❑ NG aspirate
  - lower GI bleed may present as melena or hematochezia
- ❑ stool cultures (C. *difficile*)
- ❑ urinalysis and microscopy
- ❑ CBC, smear, differential, platelets, ESR, electrolytes, urea, creatinine, PT, PTT, Apt test, albumin, iron studies, ameoba titers
- ❑ radiologic investigations
  - abdominal x-ray (AXR) to rule out obstruction

Management
- ❑ acute stabilization: ABCs, volume and blood replacement, bowel rest (NPO, NG tube)
- ❑ once stable, endoscopy and surgery when indicated

GENETICS AND METABOLISM

APPROACH TO THE DYSMORPHIC CHILD

- ❑ 3/100 infants are born with a congenital defect, many are associated with a degree of developmental disability
- ❑ genetic disorders and birth defects account for ~ 40% of childhood deaths
- ❑ diagnosis of syndromes is based on pattern of dysmorphic features and organ involvement

History

- ❑ prenatal/obstetrical history (see Obstetrics Chapter)
- ❑ complete 3 generation family pedigree: consanguinity, stillbirths, neonatal deaths, specific illnesses, mental retardation (MR), multiple miscarriages, ethnicity

Physical Examination

- ❑ growth parameters: head circumference (HC), height(Ht), and weight (Wt)
- ❑ skull: contour and symmetry
- ❑ hair: texture and pattern
- ❑ neck: look for redundant nuchal skin/webbed neck
- ❑ facial gestalt: compare with siblings and parents
- ❑ ears: structure, size, placement and rotation
- ❑ eyes and adnexa: distance apart, orientation, eyebrows and eyelashes, any folds or creases, coloboma, fundus
- ❑ nose: nasal bridge, nostrils
- ❑ philtrum: length and shape
- ❑ mouth: lips, palate, tongue and teeth
- ❑ chin: size and position
- ❑ thorax: shape, size, and nipple spacing
- ❑ hands and feet: creases, structure (e.g overlapping fingers/toes), and nails
- ❑ limbs: proportions, reduction defects, and amputations
- ❑ spine: scoliosis
- ❑ genitalia: ambiguous
- ❑ skin: hair tufts, sacral dimples/sinus

Investigations

- ❑ ask for serial photographs if child is older, family pictures
- ❑ x-rays if bony abnormalities or if suspect a congenital infection
- ❑ cytogenetic/chromosome studies +/– skin fibroblasts
- ❑ biochemistry: specific enzyme assays
- ❑ molecular biology for specific testing
- ❑ genetic probes now available e.g. Fragile X, microdeletion 22
- ❑ counselling and recurrence risk assessment

DOWN SYNDROME (DS)

- ❑ most common abnormality of autosomal chromosomes
- ❑ trisomy 21
  - 80-90% nondisjunction
  - 5% translocations
  - 3% mosaics (may be less noticeable/less severe)

Incidence

- ❑ 1 in 600-800 live births
- ❑ rises with advanced maternal age to 1 in 20 by age 45 years
- ❑ affected fetuses have increased risk of spontaneous abortion

Clinical Features

- ❑ very wide range of severity
- ❑ low IQ, developmental delay, short stature, obesity
- ❑ shorter life expectancy
- ❑ HEENT: flat occiput, 3rd fontanelle, microcephaly, small midface, small mandible and maxillae, upslanting palpebral fissures, epicanthal folds, speckled iris (Brushfield spots), refractive errors and strabismus, furrowed prominent tongue, high arched palate, ear anomalies, frequent AOM, hearing problems
- ❑ CVS: congenital cardiac defects (50%), particularly septal defects (AVSD)
- ❑ GI: duodenal/esophageal/anal atresia, TE fistula, Hirschsprung disease, chronic constipation
- ❑ MSK: lax joints including dysplastic hips, vertebral anomalies, atlantoaxial instability, wide gap between 1st and 2nd toes
- ❑ GU: cryptorchidism
- ❑ CNS: hypotonia, onset of Alzheimer disease in 40's
- ❑ DERMATOLOGY: Simian (palmar) crease, abnormal dermatoglyphics
- ❑ HEMATOLOGY: 1% lifetime risk of leukemia
- ❑ ENDOCRINE: hypothyroidism

Management

- ❑ mainly symptomatic
- ❑ recommended testing
  - ECHO, thyroid tests, atlanto-occipital x-ray at 2 and 12 years (controversial), hearing test, ophthlamology assessment
- ❑ early intervention programs to help children reach full potential

OTHER TRISOMIES

Trisomy 13
- ❑ incidence 1:5,000 live births
- ❑ increased risk of spontaneous abortions
- ❑ features: seizures, deafness, microcephaly, cleft lip/palate, polydactyly, retinal anomalies, single umbilical artery, cardiac defects, scalp defects
- ❑ midline anomalies: scalp, pituitary, palate, heart, umbilicus, anus
- ❑ prognosis: 44% die in 1st month
    - < 10% survive past 1 year (profound mental retardation (MR) in survivors)

Trisomy 18
- ❑ incidence: 1:8,000 live births, female: male = 3:1
- ❑ increased risk of spontaneous abortion
- ❑ features: prominent occiput, micrognathia, ocular abnormalities, cleft lip and palate, low set ears, rocker bottom feet, short stature, clenched fist with overlapping digits, hypoplastic nails, clinodactyly, polydactyly, cardiac defects, hernia, severe CNS malformation, urogenital abnormalities (cryptorchidism, polycystic kidneys)
- ❑ key point: small babies (small for gestational age (SGA), microcephaly, short)
- ❑ prognosis of severe FTT: 33% die in 1st month, 50% by 2 months, 90% by 12 months, profound mental retardation (MR) in survivors

TURNER SYNDROME
- ❑ genotype: 45X (most common), mosaic (45X0)
- ❑ incidence 1:2,500 live female births
- ❑ risk not increased with advanced maternal age
- ❑ clinical features
    - intelligence usually normal, may have mild learning disabilities
    - short stature, short webbed neck, low posterior hair line, wide carrying angle at elbows
    - broad chest, widely spaced nipples
    - lymphedema, cystic hygroma in the newborn with polyhydramnios, lung hypoplasia
    - gonadal dysgenesis, infertility, primary amenorrhea, lack of development of secondary sexual characteristics
    - coarctation of the aorta, bicuspid aortic valve
    - renal abnormalities, increased risk of hypertension (HTN)
- ❑ prognosis: normal life expectancy if no complications; increased risk of X-linked diseases (same as males)
- ❑ management
    - screening for cardiac disease
    - growth hormone therapy for short stature
    - estrogen replacement at time of puberty

NOONAN SYNDROME
- ❑ genotype: 46XX and 46XY, autosomal dominant with variable expression
- ❑ incidence 1:1000 live births
- ❑ higher maternal transmission of maternal gene
- ❑ clinical features
    - triangular facies, hypertelorism,low set ears
    - epicanthal folds, ptosis, webbed neck
    - pectus excavatum
    - short stature
    - right-sided congenital heart disease: pulmonary stenosis, ASD
    - hypertrophic cardiomyopathy
    - mental retardation
    - delayed puberty
    - management: affected males may require testosterone replacement therapy at puberty

KLINEFELTER SYNDROME
- ❑ genotype: 47 XXY (most common)
- ❑ incidence: 1:1,000 live male births
- ❑ associated with late maternal age
- ❑ developmental delay, mild mental retardation, long limbs, hypogonadism, hypospermia
- ❑ gynecomastia, lack of facial hair
- ❑ treatment: testosterone in adolescence

FRAGILE X

- ❑ most common genetic cause of developmental delay in boys
- ❑ incidence 1:1,250; X-linked recessive
- ❑ clinical features
  - overgrowth: prominent jaw, forehead, ears; elongated, narrow face; marcroorchidism
  - hyperextensibility, high arched palate, mitral valve prolapse
  - often hyperactive and/or autistic
  - IQ typically 30-65 but 20% of affected males have normal intelligence
  - female carriers may show some intellectual impairment
- ❑ diagnosis
  - cytogenetic studies: region on Xq which fails to condense during mitosis
  - molecular testing: overamplification of a trinucleotide repeat, length of segment is proportional to severity of clinical phenotype (genetic anticipation)

PRADER-WILLI SYNDROME

- ❑ results from lack of paternally imprinted genes located on chromosome 15q11; most commonly due to
  - deletion of paternal chromosome 15q11
  - maternal uniparental disomy
- ❑ clinical characteristics
  - "**H₃O**": **h**ypotonia and weakness, **h**ypogonadism, obsessive **h**yperphagia, **o**besity
  - short stature, almond-shaped eyes, small hands and feet with tapering of fingers
  - developmental delay (variable), hypopigmentation, type 2 diabetes

DIGEORGE SYNDROME

- ❑ 2nd most common genetic diagnosis (next to Down syndrome)
- ❑ results from microdeletions of 22q11 (unequal crossing of chromosomes in meiosis)
- ❑ presents in newborn period; high phenotypic variability
- ❑ clinical features: "**CATCH 22**"
  - **C**yanotic CHD (may account for up to 5% of all cases of CHD)
  - **A**nomalies in face: craniofacial anomalies
  - **T**hymic hypoplasia —> immunodeficiency —> recurrent infections
  - **C**ognitive impairment
  - **H**ypoparathyroidism —> hypocalcemia
  - **22**q11 microdeletion
- ❑ less severe phenotypes of 22q11 deletions present later in childhood
  - velocardiofacial syndrome
  - Shpritzen syndrome

MUSCULAR DYSTROPHY (MD)

- ❑ a group of inherited diseases characterized by progressive skeletal and cardiac muscle degeneration

Duchenne Muscular Dystrophy (DMD)

- ❑ X linked recessive, 1:3,000 males, 1/3 spontaneous mutations
- ❑ missing structural protein dystrophin —> muscle fibre fragility —> fibre breakdown —> necrosis and regeneration
- ❑ clinical features
  - proximal muscle weakness by age 3; Gower's sign (child uses hands to "climb up" the legs to assume an upright position)
  - pseudo-hypertrophy of muscles
  - decreased reflexes
  - may develop mild mental retardation, obesity
- ❑ diagnosis
  - family history (pedigree analysis)
  - increased CPK, LDH
  - muscle biopsy, electromyelography (EMG)
- ❑ complications
  - patient usually wheelchair-bound by 12 years of age
  - early flexion contractures, scoliosis
  - death due to pneumonia/respiratory failure or CHF
- ❑ treatment
  - supportive (physiotherapy, wheelchairs, braces), prevent obesity
  - surgical (for scoliosis)
  - use of steroids (e.g. prednisone or deflazacort)
  - gene therapy trials underway

Becker's Muscular Dystrophy

- ❑ dystrophin gene abnormal
- ❑ symptoms similar to Duchenne but onset is later and progression is slower

VACTERL ASSOCIATION

❑ number of congenital anomalies occurring together

- **V** **V**ertebral anomalies
- **A** imperforate **A**nus
- **C** **C**ardiac abnormalities
- **TE** **T**racheo**E**sophageal fistula
- **R** **R**adial and **R**enal dysplasia
- **L** **L**imb deformity

CHARGE ASSOCIATION

- **C** **C**oloboma
- **H** congenital **H**eart disease
- **A** **C**hoanal **A**tresia
- **R** mental **R**etardation
- **G** **G**U anomalies
- **E** **E**ar anomalies

METABOLIC DISEASE

❑ an inherited disorder of intermediary metabolism
❑ must be ruled out in any newborn who becomes acutely ill after a period of normal behavior and development
❑ infants and older children may present with failure to thrive (FTT) or developmental delay
❑ treatment possible if the biochemical basis of the disorder is understood

Clinical Manifestations

❑ vomiting and acidosis after feeding initiation (amino acid (AA) or carbohydrate (CHO) metabolic disorder)
❑ hepatosplenomegaly (metabolites accumulate in the liver)
❑ neurologic syndrome: acute and chronic encephalopathy, mental retardation (MR), megalencephaly (mucopolysaccharide disorders)
❑ severe acidosis (aminoaciduria)
❑ hyperammonemia (urea cycle and organic acid disorders)
❑ growth retardation
❑ seizures
❑ hypoglycemia
❑ family history of early infant death

Physical Exam

❑ odour: burnt sugar, sweaty feet, musty, ammonia-like
❑ skin: hypo/hyperpigmentation, rash, icthyosis, xanthomas
❑ hair: alopecia, hirsutism, abnormal architecture, fair colouring
❑ eyes: cornea (clouding, crystals), lens (cataracts, dislocation), retina (macular cherry red spot, pigment retinopathy, optic atrophy)

Initial Investigations

❑ electrolytes, ABGs (calculate anion gap)
❑ CBC with differential and smear
❑ blood glucose (hypoglycemia seen with organic acidemia, fatty acid oxidation defects, and glycogen storage diseases)
❑ lactate, ammonium (hyperammonemia with urea cycle defects), plasma Ca^{2+} and Mg^{2+}
❑ routine urinalysis: ketonuria must be investigated
❑ others: urate, urine 2,4-DNPH, urine nitroprusside, amino acid screen, CSF glycine, free fatty acids (3-β-hydroxybutyrate ratio > 4 in fatty acid oxidation defect)
❑ storage diseases: urine mucopolysaccharide and oligosaccharide screen

PHENYLKETONURIA (PKU)

❑ 1 in 12,000
❑ deficiency of phenylalanine hydroxylase prevents conversion of phenylalanine to tyrosine and subsequent build up toxic metabolites phenylacetic acid and phenyllactic acid
❑ symptoms seen later in infancy and during childhood
❑ mothers who have PKU may have infants with congenital anomalities

Presentation

❑ mental retardation, neurological symptoms (hypertonic, tremors, behaviour disorders), skin hypopigmentation

Treatment

❑ PKU screened at birth
❑ dietary restriction starting at one month of age

HEMATOLOGY

ANEMIA (see Hematology Chapter)

History
- ❑ acute anemia: pallor, excessive sleepiness, irritability and poor feeding. In older children: SOB, decreased exercise tolerance, headachea, fatigue, syncope
- ❑ chronic anemia: usually well tolerated
- ❑ maternal condition during pregnancy: maternal bleeding, pica, premature delivery (alll suggestive of decreased Fe^{2+} stores in infants)
- ❑ maternal exposure to drugs or toxins: during pregnancy or breast-feeding
- ❑ diet history: milk excess —> iron deficiency anemia
- ❑ melena/hematochezia —> blood loss —> iron deficiency anemia
- ❑ family history of cholecystectomy or splenectomy —> hereditary hemolytic disorder
- ❑ ethnic origin —> thalassemia, sickle cell anemia
- ❑ exposure to oxidant drugs (sulpha drugs) —> G6PD deficiency
- ❑ underlying chronic illness (renal, hepatic, inflammatory, gastrointestinal)
- ❑ social history —> older housing/inner city —> lead poisoning

Physical Exam
- ❑ heart rate, blood pressure, orthostatic changes
- ❑ flow murmur, pallor, level of activity
- ❑ jaundice —> hemolysis
- ❑ petechiae, purpura —> bleeding tendency
- ❑ hepatomegaly, splenomegaly —> infiltrative disorder
- ❑ failure to thrive —> chronic disease, organ failure
- ❑ stool —> occult blood

Table 16. Differential Diagnosis of Anemia

Microcytic
- iron deficiency
  - blood loss or dietary lack
- thalassemia trait
- chronic disease
- sideroblastic anemia
- lead poisoning

Normocytic

low reticulocyte count
- bone marrow infiltration
- transient erythroblastopenia of childhood
- chronic disease
- aplastic anemia

high reticulocyte count
- blood loss (acute)
- hemolysis
  - extrinsic
    - antibody-mediated
    - fragmentation: DIC, HUS, prosthetic heart valve
  - intrinsic
    - membrane disorders: spherocytosis
    - enzyme deficiencies: G6PD
    - hemoglobin disorders: sickle cell

Macrocytic
- folic acid deficiency
- vitamin B_{12} deficiency
- hypothyroidism
- liver disease

A. PHYSIOLOGIC ANEMIA
- ❑ elevated hemoglobin (> 170 g/L) and reticulocyte count at birth as a result of relatively hypoxic environment in utero
- ❑ during first 6-8 weeks of life virtually no erythropoiesis due to new, O_2-rich environment
- ❑ after birth, levels start to fall due to shorter RBC lifespan, (70 days vs. 120 days for adult) decreased RBC production, and increasing blood volume secondary to growth
  - lowest levels at 6-12 weeks age (earlier and more exaggerated in premature infants), about 100 g/L, levels rise spontaneously with activation of erythropoiesis
- ❑ no treatment required if asymptomatic

B. IRON DEFICIENCY ANEMIA
- ❑ microcytic, hypochromic anemia, decreased ferritin, decreased TIBC, marrow deplete of stainable Fe^{2+}
- ❑ most common cause of childhood anemia **(see Colour Atlas H3)**
- ❑ full-term infants exhaust Fe^{2+} reserves by 5 months age, preterm infants have lower reserves – exhaust by 2-3 months of age
- ❑ common diagnosis between 6 months – 3 years and 11 –17 years: periods of rapid growth and increased Fe^{2+} requirements
- ❑ can cause irreversible effects on development if untreated

Etiology
- ❑ dietary
  - vegan
  - secondary to poor intake of iron-rich foods and gastrointestinal blood loss
    - typically in bottle-fed infants (6-24 months) receiving large volumes of cow's milk
- ❑ blood loss
  - iatrogenic: repeated blood sampling (especially in neonates)
  - cow's milk allergy: occult bleeding & protein-losing enteropathy secondary to inflammation enteropathy secondary to GI inflammation

Prevention
- ❑ breast-fed infants: after 6 months, give iron-fortified cereals and iron-rich foods
- ❑ non-breast fed infants: give iron-fortified formula from birth
- ❑ premature infants: start iron supplements at 6-8 weeks of age and continue until 1 year old

Management
- ❑ determine cause
- ❑ encourage diverse, balanced diet
- ❑ oral iron therapy – ferrous sulfate 3mg/kg/day BID-TID for 3 months
    - increased reticulocyte count in 48-72 hours
    - increased hemoglobin in 4-30 days
    - repletion of iron stores in 1-3 months
- ❑ poor response to oral Fe^{2+} therapy: non-ompliance, ongoing blood loss, insufficient duration of therapy, high gastric pH, incorrect diagnosis

C. ANEMIA OF CHRONIC DISEASE
- ❑ most often normocytic, normochromic (microcyti, hypochromic may occur with chronic infection/malignancy
- ❑ multi-factorial in origin
- ❑ chronic inflammatory states including juvenil rheumatoid arthritis (JRA), chronic infections, chronic renal failure, and malignancies
- ❑ iron stores are variable and ferritin levels are unreliable (acute phase reactant) therefore bone marrow assessment may be necessary for diagnosis
- ❑ treatment with erythropoeitin helpful in some cases (renal disease)

D. HEMOGLOBINOPATHIES (see Hematology Chapter)

E. SICKLE CELL DISEASE
- ❑ describes syndrome of hemoglobin SS, SC, sickle cell thalassemia and SD disease
- ❑ identification of specific genotypes important due to differences in frequency, type and severity of clinical complications (most severe is SS, least severe SD)

Pathophysiology
- ❑ red blood cells sickle with low pO_2, dehydration, fever, acidosis
- ❑ acute intravascular sickling results in infarction of tissue
- ❑ hemolysis causes chronic, well-compensated anemia (Hb 60-90 g/L) **(see Colour Atlas H6)**
- ❑ increased incidence in Blacks and Mediterraneans

Presentation
- ❑ trait: asymptomatic ± microscopic hematuria
- ❑ disease: after 10-12 weeks with fall in fetal Hb, anemia, jaundice, splenomegaly

Types of Crises
- ❑ vaso-occlusive crisis
    - most common hallmark of disease
    - due to obstrution of blood vessels by rigid, sickled cells —> tissue hypoxia —> cell death; presents as PAIN and fever
    - in any organ; most commonly in long bones of arms and legs, chest, abdomen, CNS (stroke), dactylitis (in young children)
- ❑ aplastic crisis
    - depression of erythropoiesis, generally associated with infection (Parvovirus B19)
- ❑ splenic sequestration
    - sudden massive pooling of red cells in spleen, acute fall in hemoglobin, shock (increased reticulocyte count, decreased Hb)

Functional Asplenia
- ❑ splenic dysfunction usually by 5 years secondary to autoinfarction
- ❑ susceptible to infection by encapsulated organisms (especially S. *pneumoniae*)
- ❑ requires prophylactic antibiotics, pneumococcal vaccine, and immediate evaluation of fever

Other Manifestations
- ❑ growth delay, bony abnormalities, avascular necrosis (AVN) of femoral head, priapism (often results in permanent impotence in adults), stones
- ❑ acute chest crisis: fever, chest pain, increased WBC count, pulmonary infiltrates

Management
- ❑ acute
  - supportive and symptomatic
  - fluids (1 1/2 maintenance), analgesia, exchange/straight transfusions, antibiotics
  - O_2 if respiratory distress or chest crisis, incentive spirometry
- ❑ chronic
  - early aggressive treatment of infections, prophylactic antibiotics (daily oral penicillin)
  - pneumococcal, meningococcal, Hepatitis B, Hib and influenza vaccines
  - folate supplementation if macrocytic
  - hydroxyurea if have frequent crises
  - chronic transfusion program if history of stroke
  - genetic counselling and education

F. SPHEROCYTOSIS
- ❑ red cell membrane disorder, causes a sphering of red blood cells which are removed by the spleen **(see Colour Atlas H8)**
- ❑ genetics
  - autosomal dominant (positive family history)
  - high spontaneous mutation rate (no family history)
- ❑ wide range of clinical severity: well-compensated, mild hemolytic anemia to severe hemolytic anemia with growth failure, splenomegaly, and chronic transfusion requirements in infancy
- ❑ management
  - splenectomy as needed
  - genetic counselling

G. GLUCOSE-6-PHOSPHATE DEHYDROGENASE (G6PD) DEFICIENCY
- ❑ X-linked recessive, different variants of the disease
  - higher prevalence in Mediterraneans, Blacks, Orientals
  - enzyme deficient red blood cells are unable to defend against oxidant stress (infection, drugs) and form Heinz bodies (denatured hemoglobin) which are phagocytosed by splenic macrophages, creating "bites" on cells
  - presents with acute hemolytic anemia with jaundice and dark urine
- ❑ management: supportive, hydration, transfusion, phototherapy
- ❑ prevention: avoid known oxidants (e.g. fava beans, ASA, antimalarials, sulfonamides)

BLEEDING DISORDERS (see Hematology Chapter)

Coagulation Defects
- ❑ characterized by deep bleeding into joints and muscles
- ❑ large spreading ecchymotic lesions and hematomas

Platelet Abnormalities
- ❑ characterized by petechiae, purpura, bruises, mucocutaneous bleeding, bleeding from superficial cuts (i.e. epitaxis, gum bleeding, menorrhagia)

Table 17. Classification of Bleeding Disorders

	Mechanism	Examples
Blood Vessels	vasculitis	HSP
Platelets	low production	drugs, marrow infiltration, leukemia
	high destruction	idiopathic thrombocytopenic prupura (ITP), infection, drugs
	high consumption	DIC, giant hemangioma, hypersplenism
	dysfunctional	vW disease, drugs (ASA), uremia
Coagulation Pathway	Vitamin K deficiency	hemorrhagic disease of the newborn
	Factor VIII deficiency	Hemophilia A
	Factor IX deficiency	Hemophilia B
	abnormal vWF	vonWillebrand disease

A. IDIOPATHIC THROMBOCYTOPENIC PURPURA (ITP)

- ❑ peak age: 2-6 years, M=F
- ❑ caused by antibodies that bind to platelet membranes —> splenic destruction of antibody-coated platelets
- ❑ presentation and course
  - typically presents after viral illness or immunization 1-3 weeks prior to presentation
  - sudden onset of petechiae, purpura, epistaxis, hematuria or GI hemorrhage in an otherwise well child
  - no lymphadenopathy, no hepatosplenomegaly
  - rarely a presenting symptom of autoimmune disease (e.g. SLE)
  - if atypical presentation (more than one cell line abnormal, hepatosplenomegaly), do bone marrow to rule out leukemia
  - self-limited in children; spontaneous recovery in 80% of cases but usually treat because spontaneous recovery takes a few months
- ❑ differential diagnosis: leukemia, drug-induced thrombocytopenia, HIV, infection (viral), SLE
- ❑ labs: thrombocytopenia with normal RBC, WBC
- ❑ management
  - IVIG or prednisone (rule out leukemia before using prednisone)
  - splenectomy (only for life-threatening bleeding)

B. NEONATAL THROMBOCYTOPENIA

- ❑ neonatal alloimmune thrombocytopenia (NAIT)
  - mother mounts immune response against antigens on fetal platelets
  - suspect in thrombocytopenic newborn who is otherwise well, normal maternal platelets, no history of maternal autoimmune disease or ITP
  - diagnosis: maternal serum (with immunoglobulins) reacts with father's or child's platelets
  - treatment: transfusion of infant with washed maternal platelets
- ❑ autoimmune thrombocytopenia
  - caused by antiplatelet antibodies from maternal ITP or SLE
  - similar presentation to NAIT but must distinguish; if infant is transfused with maternal platelets, the transfused platelets will also be destroyed
  - treatment: steroids to mother x 10-14 days prior to delivery, or IVIG to mother before delivery or to infant after delivery

C. HEMORRHAGIC DISEASE OF THE NEWBORN

- ❑ caused by vitamin K deficiency
- ❑ factors II, VII, IX, X are vitamin K-dependent, therefore both PT and PTT are abnormal
- ❑ presents at 2-7 days of life with GI hemorrhage, intracranial hemorrhage bleeding from a circumcision or umbilical stump
- ❑ prevention: IM vitamin K administration at birth to all newborns

D. HEMOPHILIA

Hemophilia A

- ❑ X-linked recessive, 5 times more common than Hemophilia B
- ❑ factor VIII defiency: delayed formation of thrombin which is crucial to forming a normal, functional fibrin clot and solidifying the platelet plug at areas of vascular injury
- ❑ severity determined by level of factor VIII, severity of bleeds, and presence of antibodies to factor VIII
  - severe (< 1% factor VIII): spontaneous bleeding or bleeding from minor trauma, manifests in infancy, hallmark: hemarthrosis
  - mild (> 5% factor VIII): bleeding with significant trauma (e.g. surgery), may go undiagnosed for many years
- ❑ treatment
  - factor VIII replacement, DDAVP for mild disease

Hemophilia B (Christmas Disease)

- ❑ factor IX deficiency
- ❑ X-linked recessive, treated with factor IX replacement or plasma
- ❑ presentation same as Hemophilia A

E. von WILLEBRAND'S DISEASE

- ❑ defect: variable abnormality in von Willebrand factor (vWF)
  - vWF is an adhesive protein that bridges subendothelial collagen and platelets, and protects factor VIII from rapid clearance
  - autosomal dominant (more common, mild) or autosomal recessive (rarer, more severe)
- ❑ presentation
  - mucocutaneous bleeding, epistaxis, gingival bleeding, ecchymosis, menorrhagia
  - abnormal PTT and bleeding time
- ❑ treatment
  - DDAVP for mild disease (increases release of vWF), cryoprecipitate

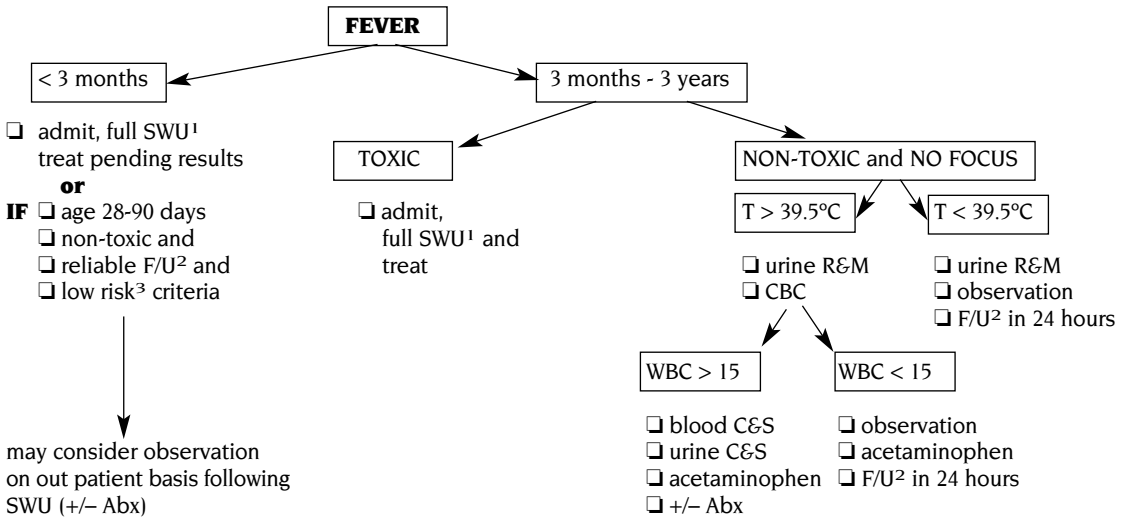
Table 18. Evaluation of Abnormal Bruising/Bleeding

	BT	PT	PTT	VIII:C	vWF	Platelets	Fibrinogen
hemophilia A	N	N	↑	↓	N	N	N
hemophilia B	N	N	↑	N	N	N	N
vonWillebrand's	↑	N	N or ↑	↓	↓	N	N
DIC	N or ↑	↑	↑	↓	N	↓	↓
vit K deficiency	N	↑	↑	N	N	N	N
thrombocytopenia	↑	N	N	N	N	↓	N

BT = bleeding time, VIII:C = factor VIII coagulant activity, vWF = von Willebrand's Factor, DIC = disseminated intravascular coagulation

❑ extensive bruising in the absence of lab abnormalites: consider child abuse

INFECTIOUS DISEASES



NOTES:

1. Full Septic Workup (SWU) - blood C&S, CBC and differential, urine R&M, C&S, LP, CXR if respiratory SSx, stool C&S if GI SSx
2. Follow-up is **crucial** - if adequate F/U is not assured, a more aggressive diagnostic and therapeutic approach may be indicated
3. Low-Risk Criteria - previously healthy, normal physical exam (non-toxic), negative lab screen (WBC 5-15, < 1.5 x 10^9 bands, urine < 10 WBC/hpf, stool < 5 WBC/hpf)
4. Important Principles - the younger the child, the greater the difficulty to clinically assess the degree of illness

Figure 2. Approach to the Febrile Child

Clinical Pearl

❑ **Teething may cause a temperature elevation >37.5ºC on the first day of the eruption in 50% of infants. However, significant temperature elevation should never be attributed solely to teething!**

SEPSIS IN THE NEONATE

Table 19. Neonatal Sepsis

Early Onset (birth-8 days)	Late Onset (8-28 days)
• begins in utero • Risk Factors: maternal UTI, GBS positive, 1° maternal infection maternal fever/ leukocytosis/ chorioamnionitis prolonged rupture of membranes, prematurity, large inocculum • GBS, E. *coli*, *Listeria*, *Klebsiella*	• acquired after birth • usually healthy, full-term • same pathogens plus: *Pneumococcus*, *Meningococcus*, HSV, *Staphylococcus*

Signs of Sepsis
- ❑ respiratory distress, cyanosis, apnea
- ❑ tachycardia/bradycardia
- ❑ lethargy, poor feeding
- ❑ hypotonia, seizures, bulging fontanelle
- ❑ jaundice
- ❑ temperature instability (hypo/hyperthermia)

Rochester Criteria: for determining risk of febrile infant of having a serious bacterial infection
- ❑ risk < 1% if
  - past health
    - born at (37 weeks gestation)
    - home with or before mother
    - no subsequent hospitalizations
    - no perinatal, postnatal or current antibiotics
    - no treatment for unexplained hyperbilirubinemia
    - no chronic disease
  - physical exam
    - rectal temperature > 38.0°C
    - appears generally well (no evidence of infection)
  - laboratory
    - total WBC 5.0-15.0 X 10^9/L
    - bands < 1.5 X 10^9/L
    - urine > 10 WBC/HPF
    - stool (if diarrhea) > 5 WBC/HPF
- ❑ if criteria are met, may observe on out-patient basis without specific antibacterial treatment
- ❑ if F/U is a problem, observation should be done in hospital

Table 20. Antibiotic Treatment of Serious Bacterial Infections

Neonate pathogens: GBS, E.*coli*, *Listeria*, S. *aureus*	ampicillin + gentamicin or ampicillin + cefotaxime +/– cloxacillin if risk of S. *aureus*
1-3 months same pathogens as above and below	ampicillin + cefotaxime +/– cloxacillin if risk of S. *aureus*
> 3 months pneumococcus, H. *influenzae* type b (> 5 years),* meningococcus	cefuroxime ceftriaxone or cefotaxime, if risk of meningitis vancomycin, if penicillin/cephalosporin-resistant pneumococci

*Hib has dramatically decreased since introduction of Hib vaccine

MENINGITIS
- ❑ peak age: 6-12 months; 90% occurs in < 5 years old

Risk Factors
- ❑ immunocompromised (e.g. HIV, asplenia, prematurity)
- ❑ neuroanatomical defects (e.g. dermal sinus, neurosurgery)
- ❑ parameningeal infection (e.g. sinusitis, mastoiditis)
- ❑ environmental (e.g. day-care centres, household contact, travel to endemic regions)

Etiology
- ❑ 0-3 months: Group B Strep., E.*coli*, L. *monocytogenes*, viral (HSV, enteroviruses, CMV)
- ❑ 3 months - 3 years: S. *pneumoniae*, N. *meningitidis*, TB, viral (enteroviruses, herpes viruses 6, HSV)
- ❑ 3-21 years: S. *pneumoniae*, N. *meningitidis*, viral (enteroviruses, adenoviruses, herpes viruses)

Pathophysiology
- ❑ bacterial meningitis: URTI —> blood stream invasion from respiratory tract —> hematogenous seeding of meninges —> meningeal and CNS inflammation
- ❑ viral, cryptococcal, mycobacterial and fungal meningitis: may have similar pathogenesis as bacterial meningitis

Clinical Features
- ❑ toxic
- ❑ +/– URI prodrome
- ❑ fever, lethargy, irritability, photophobia, nausea/vomiting
- ❑ younger infants: may not demonstrate localizing signs, may have non-specific symptoms (poor feeding, irritability, lethargy), bulging fontanelle, increasing head circumference
- ❑ signs of meningismus
  - Brudzinski's sign: reflex flexion of hips and knees upon flexion of the neck
  - Kernig's sign: reflex contraction and pain in hamstrings upon extension of leg that is flexed at the hip
  - opisthotonos: spasm in which head and heels are bent backward and body bowed forward
  - nuchal rigidity
- ❑ signs of increased ICP: headache, diplopia, ptosis, CN IV palsy, anisocoria, bradycardia with hypertension, apnea, papilledema is uncommon
- ❑ seizure in 20-30% of patients with bacterial meningitis
- ❑ petechial rash (meningococcus) **(see Colour Atlas ID1)**

Diagnosis
- ❑ lumbar puncture (LP) for cerebrospinal fluid (CSF)
  - raised opening pressure (norms: recumbent and relaxed, less flexed position < 160 mm H_2O, flexed lateral decubitus position = 100-280 mm H_2O)
  - cloudy in bacterial infection
- ❑ CSF examination: WBC (> 2 x 10^9/L WBC = bad prognostic marker), protein, glucose, Gram stain, C&S, latex agglutination tests (if partially treated bacterial meningitis), Ziehl-Neilson stain (if TB suspected)
- ❑ viral meningitis
  - see Table 21
- ❑ bacterial meningitis
  - see Table 21
- ❑ partially treated meningitis: LP may show persistent abnormalities, plus a positive CSF culture
- ❑ bloodwork
  - CBC, blood cultures (positive in 90% cases), blood glucose, electrolytes (to monitor for SIADH)

Table 21. CSF Findings of Meningitis

	WBC	Protein	Glucose
Bacterial	> 1000 x 10^6 increased PMNs	Elevated > 0.4 g/L (> 4 g/dL)	Decreased < 2.1 mmol/L (< 38 mg/dL)
Viral	< 300 x 10^6	Normal to high	Normal to high

Complications
- ❑ mortality: neonate 15-20%, children < 10%
- ❑ pneumococcus > meningococcus > Hib
- ❑ acute
  - SIADH —> hyponatremia —> brain edema
  - seizures
  - subdural hematoma
  - brain abscess, disseminated infection (osteomyelitis, septic arthritis, abscess)
  - shock/DIC
- ❑ chronic
  - hearing loss
  - mental retardation, learning disability
  - neurological deficit, seizure disorder
  - hydrocephalus

Treatment
- ❑ isolation
- ❑ bacterial: antibiotics (see Table 18) should be immediate, do not wait for LP results
- ❑ viral: supportive, acyclovir for herpes
- ❑ monitor: glucose, acid-base and volume status
- ❑ appropriate management of associated complications: fluid restriction for SIADH
- ❑ steroids in Hib meningitis may reduce neurologic sequelae if given very early
- ❑ anticonvulsants may be needed to treat seizures
- ❑ prophylaxis
    - active immunization
    - H. *influenzae* type b vaccine - routine
    - meningococcal vaccine - asplenism, complement deficiency, for outbreaks
    - pneumococcal vaccine - immunocompromised, asplenism
    - BCG vaccine - if born in TB-endemic area
    - chemoprophylaxis for contacts and index case
    - H. *influenzae* - rifampin
    - N. *meningitidis* - rifampin, ceftriaxone or ciprofloxacin
- ❑ report to public health: acute meningitis (bacterial, viral, other)

HIV INFECTION (see Infectious Diseases Chapter)

Epidemiology
- ❑ risk of infection 20-30% born to untreated HIV infected women
- ❑ transmission
- ❑ infants and children: transplacental (most common), maternal blood, rarely through breast milk
    - adolescents: sexual intercourse, needles, blood products

Incubation
- ❑ months to years (short incubation in 25%)

Clinical Features of AIDS in Infants and Children
- ❑ signs and symptoms occur often within the first year, most within two years of age
- ❑ encephalopathy
- ❑ recurrent/persistent thrush
- ❑ chronic interstitial pneumonitis (relatively common); PCP
- ❑ hepatomegaly
- ❑ FTT, opportunistic infections, lymphadenopathy

HIV Testing
- ❑ HIV antibody - ELISA and Western blot to confirm
    - maternal HIV antibodies can persist up to 18 months
    - if child breastfeeding, repeat test 3 months after stopping breastfeeding
- ❑ other tests: viral nucleic acid by PCR, viral culture, viral antigen - p24

Management
- ❑ prompt treatment of infections
- ❑ adequate nutrition
- ❑ prophylaxis
    - TMP/SMX for PCP
    - azithromycin for MAC
- ❑ +/– IVIG
- ❑ immunizations
    - all routine immunizations (including MMR if well)
    - avoid OPV and BCG
    - pneumococcal, influenza and varicella vaccines
- ❑ nystatin, cotrimoxazole, ketoconazole, acyclovir if indicated
- ❑ suppression of HIV
    - Zidovudine, others (e.g. didanosine)

PHARYNGITIS AND TONSILLITIS (see Colour Atlas OT7)

Etiology
- ❑ viral (adenoviruses, enteroviruses, EBV, Coxsackie viruses) – 80%
- ❑ sore throat, nasal symptoms, low-grade fever, minimal to moderate toxicity, may have exudative tonsillitis, nonpurulent conjunctivitis, rash
- ❑ bacterial (Group A *Streptococcus* - GAS) – 20%

Clinical Features
- ❑ exudative tonsillitis: GAS, adenovirus, EBV, diphtheria
- ❑ soft palate petechiae seen in GAS, EBV

A. STREPTOCOCCAL (GAS) PHARYNGITIS

Clinical Features
- ❑ > 2 years old
- ❑ fever, sore throat, erythematous tonsils with exudate, soft palate petechiae, tender cervical adenopathy, no nasal symptoms or cough, associated headache, abdominal pain

Management
- ❑ > 2 years old, culture before treatment or do rapid Strep antigen test
- ❑ rapid Strep test only 70-90% sensitive, do cultures if negative
- ❑ symptomatic
    - antibiotics for proven bacterial infection
    - penicillin or erythromycin x 10 days
    - can prevent rheumatic fever if treated within 9-10 days
    - antibiotics do not alter the risk of glomerulonephritis
    - tonsillectomy for proven, recurrent Streptococcal tonsillitis

SCARLET FEVER (see Colour Atlas P5)
- ❑ erythrogenic strain of Group A hemolytic Strep
- ❑ most commonly between 5 and 15 years old
- ❑ acute onset of fever, sore throat, strawberry tongue
- ❑ 24-48 hours after pharyngitis, rash develops which begins in the groin, axillae, neck, antecubital fossa
- ❑ within 24 hours, rash becomes generalized with perioral sparing
- ❑ rash fades after 3-4 days, may be followed by peeling
- ❑ treatment: penicillin or erythromycin x 10 days

POST-INFECTIOUS COMPLICATIONS

Rheumatic Fever
- ❑ Jones Criteria (revised)
    - requires 2 major OR 1 major and 2 minor PLUS evidence of preceding Strep infection (increased ASOT, throat swab, recent scarlet fever)
    - major criteria: "SPACE"
        - **S**ubcutaneous nodules
        - **P**ancarditis
        - **A**rthritis (migratory)
        - **C**horea (Sydenham's)
        - **E**rythema marginatum
    - minor critera
        - previous rheumatic fever or rheumatic heart disease
        - polyarthralgia
        - fever
        - elevated ESR or C-reactive protein or leukocytosis
        - prolonged PR interval (ECG)
- ❑ treatment
    - penicillin for acute course
    - secondary prophylaxis for at least 5 years or until 21 years old
    - anti-inflammatory drugs (ASA)
- ❑ complications
    - mitral insufficiency/stenosis
    - aortic insufficiency/stenosis

Post-Infectious Glomerulonephritis (see Nephrology Chapter)

B. INFECTIOUS MONONUCLEOSIS
- ❑ the “great imitator"
- ❑ Epstein-Barr virus (EBV): a human herpes virus
    - systemic viral infection that affects many organ systems
    - incubation: 1-2 months
    - spread: through saliva (“kissing disease”), sexual activity, transfusions

Clinical Features
- ❑ prodrome: 2-3 days of malaise, anorexia
- ❑ infants and young children: often asymptomatic or mild disease
- ❑ older children and young adults: may develop typical infectious mononucleosis syndrome
    - fever, tonsillar exudate, lymphadenopathy
    - +/– hepatosplenomegaly
    - +/– rash (pathognomonic rash with amoxicillin/ampicillin)
    - any –“itis” (including arthritis, hepatitis, nephritis)
- ❑ resolves over 2-3 weeks although fatigue may persist for several months
- ❑ lab findings: atypical lymphocytes, lymphocytosis, Downey cells, +/– anemia, +/– thrombocytopenia

Diagnosis
- ❑ heterophil antibody test (Monospot test) - not sensitive in children < 4 years old
- ❑ EBV titres
- ❑ WBC + differential: atypical lymphocytes and lymphocytosis

Treatment
- ❑ throat culture to rule out streptococcal pharyngitis
- ❑ supportive care (bed rest, fluids, saline gargles for sore throat, acetaminophen)
- ❑ if airway obstruction, admit to hospital, steroids
- ❑ patients with splenic enlargement should avoid contact sports for 6 - 8 weeks

PERTUSSIS
- ❑ *Bordetella pertussis*
- ❑ whooping cough, "100-day cough"
- ❑ incubation: 6-20 days
- ❑ infectivity: 1 week before paroxysms to 3 weeks after
- ❑ decreased incidence due to immunizations
- ❑ spread: highly contagious; airborne, transmitted via air droplets, released during intense coughing

Clinical Features
- ❑ prodromal catarrhal stage
  - 1-2 weeks, most contagious
  - coryza, mild cough, low grade fever
- ❑ paroxysmal stage
  - 2-4 weeks
  - paroxysms of cough, sometimes followed by inspiratory whoop (whoop may be absent in children < 6 months or adults)
- ❑ infants may present with apnea
  - +/– vomiting with coughing spells
- ❑ onset of attacks precipitated by yawning, sneezing, eating, physical exertion
  - can have severe symptoms for 6 weeks, cough for 6 months
  - pressure effect - subconjunctival hemorrhage, rectal prolapse, hernias, epistaxis
- ❑ convalescent stage
  - 1-2 weeks, noninfectious
  - occasional paroxysms of cough, but decreased frequency and severity

Diagnosis
- ❑ clinical: URTI symptoms followed by paroxysms of cough in an afebrile child
- ❑ lymphocytosis
- ❑ culture of nasopharyngeal swab or aspirate
- ❑ fluorescent antibody staining of pharyngeal specimen (most sensitive); PCR

Complications
- ❑ otitis media
- ❑ respiratory
  - sinusitis
  - secondary pneumonia, atelectasis
  - pneumomediastinum, pneumothorax, interstitial or subcutaneous emphysema secondary to ruptured alveoli
- ❑ neurological
  - seizures
  - encephalopathy (1:100,000)
  - intracranial hemorrhage

Treatment
- ❑ supportive care
- ❑ hospitalize if paroxysms of cough are associated with cyanosis and/or apnea
- ❑ erythromycin x 14 days
  - isolate until 5 days of treatment
  - treatment will decrease infectivity but not change course
  - shortens period of communicability
- ❑ chemoprophylaxis: erythromycin for all household contacts

VARICELLA (CHICKENPOX)

Varicella-Zoster virus (VZV)
- ❑ incubation: 10-21 days
- ❑ primary infection with virus usually results in life-long immunity - > 95% of young adults with varicella are immune
- ❑ virus latent in sensory ganglia and reappears as herpes zoster in 10-15% (incidence is increased in immunocompromised patients)
- ❑ spread: > 95% infection rate in susceptible patients, respiratory secretions, fomites from vesicles or pustules
- ❑ infectivity: 1-2 days pre-rash until vesicles have crusted over

Clinical Features (see Colour Atlas P1)
❑ 1-3 day prodrome: fever and respiratory symptoms
❑ characteristic rash
- very pruritic
- crops of red macules which quickly become vesicles surrounded by erythema; "dewdrop on erythematous base"
- vesicles burst and lesions crust over
- on trunk, face, scalp, conjunctivae, vagina
- new crops usually stop forming after 5-7 days

Complications
❑ secondary bacterial infection (most common)
- infection with Staph, GAS
- presents as impetigo, abscesses, cellulitis, necrotizing fasciitis, sepsis

❑ cerebellar ataxia, pneumonia, hepatitis, encephalitis
❑ Reye syndrome: patients who are also on salicylates
- encephalopathy and noninflammatory fatty infiltration of liver and kidney

❑ immunocompromised patients: varicella may be life-threatening
❑ neonates born to mothers who develop varicella from 5 days before to 2 days after delivery are considered high risk
- must administer varicella-zoster immune globulin (VZIG) and follow

Treatment
❑ supportive (hydration, acetaminophen, antipruritics)
❑ proper hygiene
❑ acyclovir for severe disease, immunocompromised patients, neonates

Prophylaxis and Prevention
❑ immunization (see Immunization section)
❑ Varicella-Zoster immune globulin (VZIG)
❑ for post-exposure in high risk patient
❑ must be within 96 hours of exposure

ROSEOLA
❑ human herpes virus 6
❑ incubation: 5-15 days
❑ infectivitity and spread: unknown

Clinical Features (see Colour Atlas P2)
❑ high fever lasting up to 8 days
❑ pharynx, tonsils and tympanic membranes are erythematous
❑ fever ceases, rash appears
- pink non-pruritic macules and maculopapules
- macules coelesce and disappear in 1-2 days

Complications
❑ febrile seizures

Treatment
❑ supportive (acetaminophen)

MEASLES
❑ morbillivirus
❑ incubation: 10-14 days
❑ infectivity: 4 days pre-rash
❑ spread: droplet

Clinical Features
❑ prodrome: "**3 C's**": **c**ough, **c**oryza, **c**onjunctivitis, fever, eyelid edema
❑ Koplik spots (1-2 days before and after rash): small white papules on red base of buccal mucosa
❑ maculopapular rash spreads over face and hairline over 3 days

Complications
❑ secondary bacterial infection (lung, otitis media, sinusitis)
❑ bronchopneumonia, croup
❑ encephalitis (1:2,000)
❑ ataxia, vomiting, seizures, coma
❑ subacute sclerosing panencephalitis (1:100,000)
❑ slow measles virus infection of brain manifesting years later
❑ progressive cerebral deterioration with myoclonic jerks, fatal in 6-12 months

Treatment
❑ supportive and symptomatic (i.e. ocular care, appropriate treatment of secondary bacterial infection)
❑ immunoglobulin to prevent or modify disease if administered within 6 days

MUMPS

- ❑ paramyxovirus
- ❑ incubation: 12-25 days
- ❑ infectivity: 7 days pre-parotitis, 7 days post-parotitis
- ❑ spread: droplet

Clinical Features

- ❑ fever, headache, parotitis (bilateral), myalgia, malaise
- ❑ parotitis: swelling obscures angle of mandible and pushes earlobe up and out
- ❑ 30-40% of cases are subclinical

Complications

- ❑ meningoencephalomyelitis: over 10% of patient with parotitis
- ❑ orchitis, epididymitis
  - occurs in 15-35% of adolescents and adults, rarely before puberty
  - swollen, erythematous and tender testes (usually at end of 1st week)
  - infertility rare
- ❑ pancreatitis: may see elevated serum amylase without pancreatitis
- ❑ other: ocular complications, thyroiditis, deafness, myocarditis, arthritis, thrombocytopenia

Treatment

- ❑ supportive

RUBELLA

- ❑ rubivirus
- ❑ incubation:14-21 days
- ❑ infectivity: 7 days pre-rash, and 5 days post-rash
- ❑ spread: droplet

Clinical Features

- ❑ prodrome of nonspecific respiratory symptoms and adenopathy (suboccipital)
- ❑ rash
  - maculopapular, initially on face, then spreading to entire body
  - pruritic, disappearing by fourth day

Complications

- ❑ arthritis/arthralgia: polyarticular (fingers, wrists, knees), lasts days to weeks
- ❑ encephalitis
- ❑ congenital infection (mother infected in first 4 months of pregnancy): retarded growth, ocular anomalies (e.g. cataracts), "blueberry muffin" rash, jaundice, deafness, heart defects

Treatment

- ❑ symptomatic

Prognosis

- ❑ excellent prognosis in patients with acquired disease
- ❑ irreversible defects in congenitally infected patients

ERYTHEMA INFECTIOSUM

- ❑ parvovirus B19, "fifth disease"
- ❑ incubation: 4-14 days
- ❑ infectivity: prior to onset of rash

Clinical Features

- ❑ initial 7-10 days: flu-like illness
- ❑ day 10-17: rash appears (immune response)
  - raised maculopapular lesions on cheeks ("slapped cheek" appearance), forehead, chin, circumoral sparing
  - warm, nontender, may be pruritic, may also appear on extensor surfaces, trunk, neck, buttocks
- ❑ days to weeks: rash fades, may reappear with local irritation (heat, sunlight)

Complications

- ❑ arthritis (10%): pain and stiffness in peripheral joints
- ❑ aplastic crisis: reticulocytopenia occurs for 1 week during illness, unnoticed in normal individuals, but severe anemia in patients with chronic hemolytic anemia

Treatments

- ❑ supportive
- ❑ blood transfusions for some with aplastic crisis

NEONATOLOGY

INFANT MORTALITY

- ❑ 9-10:1,000 births
- ❑ causes: congenital abnormalities, prematurity, asphyxia, infections (respiratory, enteric), sudden infant death syndrome (SIDS)

NORMAL BABY AT TERM

- ❑ HR 120-160/per min
- ❑ RR 40-60/per min
- ❑ weight 2,500-4,500 g
- ❑ glucose > 2.2 mmol/L (40 mg/dL)
- ❑ sBP 50-80 mmHg; dBP 30-40 mmHg

GESTATIONAL AGE (GA) AND SIZE

Definitions

- ❑ Gestational Age (GA)
  - pre-term: < 37 weeks
  - term: 37-42 weeks
  - post-term: > 42 weeks
- ❑ small for gestational age (SGA): measurements < 2 SD below mean for GA
- ❑ accurate for gestational age (AGA): within 2 SD of mean for GA
- ❑ large for gestational age (LGA): > 2 SD above the mean for GA
- ❑ GA can be clinically assessed using the Ballard or Dubowitz Score

Table 22. Infant Maturity

Sites	≤ 36 Weeks	37-38 Weeks	≥ 39 Weeks
skin	pale, translucent	pinker, smoother	pink, thick
sole creases	transverse creases on anterior 1/3 only	transverse creases extend to heel	increasing depth of sole creases
breast size	≤ 2 mm	4 mm	5-10 mm
scalp hair	fine and fuzzy	fine and fuzzy	thick and silky
ear lobe	flat, pliable, no cartilage	some cartilage	stiffened by thick cartilage
testes and scrotum	testes in lower canal, small scrotum, few rugae	intermediate scrotum full	covered with rugae
labia and clitoria	prominent clitoris, small labia	clitoris nearly covered by prepuce	clitoris covered by prepuce large labia

Table 23. Abnormalities of Gestational Age and Size

Features	Causes	Problems
Pre-term infants < 37 weeks	• infections (TORCH) • maternal pathology • drugs/EtOH, smoking • chromosomal • multiple pregnancy • placental causes	• RDS, respiratory diseases, recurrent apnea, bronchopulmonary dysplasia (BPD) • feeding difficulties, necrotizing enterocolitis (NEC) • hypocalcemia, hypoglycemia, hypothermia • anemia, jaundice • intracranial hemorrhage, cerebral anoxia, retinopathy of prematurity (ROP)
Post-term infants • wisened looking, leathery skin • meconium staining		• severe asphyxia, meconium aspiration • hypoglycemia • birth trauma
SGA infants • Asymmetric (head-sparing): late onset, growth arrest • Symmetric: early onset, lower growth potential	• Extrinsic causes: poor nutrition, hypertension, multiple pregnancies, drugs, EtOH, smoking • Intrinsic causes: infections (TORCH), congenital abnormalities, syndromal, idiopathic	• asphyxia • hypoglycemia, hypocalcemia, hypothermia • hyperviscosity (polycythemia) • NEC • PDA
LGA infants	• maternal DM • racial or familial factors	• birth trauma, asphyxia, meconium aspiration, respiratory distress, transient tachypnea of newborn (TTN), persistent pulmonary hypertension (PPHN) • jaundice, hypoglycemia, hypocalcemia, polycythemia

NEONATAL RESUSCITATION

❑ assess Apgars at 1 and 5 minutes
❑ if < 7 at 5 min then q 5 min, until > 7

Table 24. Apgar Score: "How Ready Is This Child?"

Sign	0	1	2
Heart Rate	absent	< 100/min.	> 100/min.
Respiratory Effort	absent	slow, irregular	good, crying
Irritability	no response	grimace	cough/sneeze/cry
Tone	limp	some flexion of extremities	active motion
Colour	blue, pale	body pink, extremities blue	completely pink

Initial Resuscitation

❑ anticipation - know maternal history, history of pregnancy, labour, and delivery
❑ all infants ("before ABC's")
- prevent heat loss by drying, warming (on radiant heater, remove wet towels)
- position head and neck to open airway for suction
- stimulate infant by rubbing back or slapping foot

❑ Airway
- gentle suction of mouth then nose
- with thick meconium, suction the nasopharynx as the head is delivered, then intubate and suction trachea

❑ Breathing
- check for spontaneous respirations
- bag and mask if apneic/gasping/HR < 100/min, bag at a rate of 40-60/min with 100% O_2
- intubation is indicated if
  - prolonged ventilation is required
  - bag and mask are not effective
  - tracheal suctioning is needed (thick meconium)
  - HR remains < 100/min
  - diaphragmatic hernia is suspected (do NOT bag)

❑ Circulation
- bradycardia is usually due to hypoxia from respiratory arrest and often responds to ventilation with 100% O_2
- "80 or less compress" - if bradycardic (apex < 80/min and no improvement with bagging) or asystolic, compressions begin at rate of 120/min
- coordinate 3 compressions with 1 ventilation (120 compressions/min, 40 ventilations/min) - check after 30 seconds
  - if HR > 80 stop compressions but continue ventilation until HR >100

❑ Drugs
- epinephrine - for asystole or severe bradycardia
- HCO_3 (4.2% solution given slowly) - for documented acidosis or prolonged resuscitation
- $CaCO_3$ - may be indicated for continued circulatory failure
- Narcan - if mother given narcotics in labour

ROUTINE NEONATAL CARE (in delivery suite)

❑ erythromycin ointment - applied to conjunctival sac of both eyes for ophthalmia neonatorum (gonorrhea, chlamydia) prophylaxis
❑ vitamin K (IM) - to avoid hemorrhagic disease of newborn
❑ screening tests
- all neonates: PKU, TSH usually after 24 hours of life
- if mother Rh negative: blood group, direct antiglobulin test
- if indicated: sickle cell, G6PD deficiency

❑ if mother Hep B positive: HBIG and start Hep B vaccine series

RESPIRATORY DISTRESS IN THE NEWBORN

Presentation

❑ tachypnea: RR > 60
❑ grunting
❑ intercostal retractions/indrawing
❑ nasal flaring
❑ duskiness/central cyanosis
❑ decreased air entry, crackles on auscultation
❑ tachycardia: HR > 160

Investigations
❑ CXR, ABG, CBC, blood glucose
❑ blood cultures

Differential Diagnosis of Respiratory Distress
❑ pulmonary
- respiratory distress syndrome (RDS)
- transient tachypnea of the newborn (TTN)
- meconium aspiration
- pleural effusions, pneumothorax
- congenital lung malformations
- persistent pulmonary hypertension (PPHN)

❑ infectious
- sepsis
- pneumonia (GBS + others)

❑ cardiac
- congenital heart disease (cyanotic, acyantotic)
- persistent pulmonary hypertension (PPHN)

❑ hematologic
- blood loss
- polycythemia

❑ anatomic
- tracheoesophageal fistula
- congenital diaphragmatic hernia
- upper airway obstruction

❑ metabolic
- hypoglycemia
- inborn errors of metabolism

❑ neurologic
- CNS damage (trauma, hemorrhage)
- drug withdrawal syndromes

Upper Airway Obstruction (see Otolaryngology Chapter)
❑ choanal atresia
❑ Pierre-Robin sequence (retrognathia and/or micrognathia plus cleft palate, and glossoptosis)
❑ laryngeal obstruction (stenosis, atresia, malacia)
❑ tracheal obstruction (mass, stenosis, malacia, vascular ring)
❑ mucous plug
❑ cleft palate

CYANOSIS
❑ peripheral cyanosis
- usually normal but may indicate sepsis, temperature instability

❑ central cyanosis
- due to poor oxygenation - decreased SaO_2, decreased PaO_2
- secondary to
  - respiratory insufficiency
  - cardiac (CHD, PPHN)
  - CNS (asphyxia)
  - hematologic (polycythemia)

❑ management
- ABGs
- hyperoxic test (to rule out CHD): pO_2 on 100% O_2 x 10-15 min
  - $pO_2 < 150$: suggests congenital heart disease (see Pediatric Cardiology section)
  - $pO_2 > 150$: suggests respiratory (airway, chest, lungs), brain or blood problems

APNEA

Definition
❑ absence of respiratory gas flow for 20 seconds in the preterm infant and 15 seconds in the term infant (less if associated with bradycardia or cyanosis)
❑ central: no chest wall movement
❑ obstructive: chest wall movement continues
❑ mixed: combination of central and obstructive apnea

Differential Diagnosis
- ❑ apnea < 24 hrs – strongly associated with sepsis
- ❑ apnea > 24 hrs – if not pathological, apnea of prematurity
- ❑ CNS
  - apnea of prematurity: presents in the first week of life due to prematurity of CNS and resolves by 36 weeks GA
  - seizures
  - intracranial hemorrhage (ICH)
- ❑ infectious: sepsis, meningitis
- ❑ GI: gastroesophageal reflux (GERD)
- ❑ metabolic: hypoglycemia, hyponatremia, hypocalcemia
- ❑ cardiovascular
  - low and high blood pressure
  - anemia, hypovolemia, PDA
- ❑ drugs: Demerol, morphine

Management
- ❑ in term infants, apnea always requires full work-up
- ❑ tactile stimulation
- ❑ correct underlying cause
- ❑ monitoring
- ❑ O_2, continuous positive airway pressure (CPAP), ventilation
- ❑ medications: methylxanthines (caffeine, theophylline) which stimulate CNS and diaphragm; doxapram (direct CNS stimulant) used in some centres

RESPIRATORY DISTRESS SYNDROME (RDS)
- ❑ also known as "hyaline membrane disease"
- ❑ most common cause of respiratory distress in the pre-term infant

Pathophysiology
- ❑ surfactant deficiency —> poor lung compliance due to high alveolar surface tension and atelectasis —> respiratory distress —> hypoxia + acidosis
- ❑ surfactant decreases alveolar surface tension, improves lung compliance and maintains functional residual capacity

Risk Factors
- ❑ premature babies: rare at term, risk is inversely proportional to birth weight and GA
- ❑ infants of diabetic mothers (IDM): insulin inhibits the cortisol surge necessary for surfactant synthesis
- ❑ C-section
- ❑ asphyxia, acidosis
- ❑ males > females

Clinical Features
- ❑ onset within first few hours of life, worsens over next 24-72 hours, with symptoms of respiratory distress
- ❑ infants may develop respiratory failure and require ventilation
- ❑ CXR: decreased aeration and lung volumes, reticulogranular pattern throughout lung fields with air bronchograms, atelectasis; may resemble pneumonia
  - "ground glass" apperance of lungs is pathognomonic of RDS

Prevention
- ❑ steroid therapy (e.g. Celestone in Toronto) for mothers prior to delivery of premature infants
- ❑ monitor lecithin:sphingomyelin (L/S) ratio

Treatment
- ❑ supportive
  - O_2, assist ventilation with PEEP or CPAP, nutrition
  - administer fluids cautiously to avoid pulmonary edema
- ❑ surfactant administration

Prognosis
- ❑ in severe prematurity and/or prolonged ventilation, increased risk of bronchopulmonary dysplasia (BPD)

Complications
- ❑ patent ductus arteriosus (PDA)
- ❑ bronchopulmonary dysplasia (BPD)
- ❑ retinopathy of prematurity
- ❑ pulmonary air leaks (pneumothorax)
- ❑ intracerebral/intraventricular hemorrhage (ICH/IVH)

TRANSIENT TACHYPNEA OF THE NEWBORN (TTN)

❑ also known as
- "wet lung syndrome"
- respiratory distress syndrome type II

Pathophysiology

❑ delayed resorption of fetal lung fluid —> accumulation of fluid in peribronchial lymphatics and vascular spaces —> tachypnea

Risk Factors

❑ full term or slightly premature infant
❑ no labour/short labour (?lack of catecholamine release)
❑ C-section (lungs are not compressed during passage through pelvic floor)

Clinical Features

❑ tachypnea within the first few hours of life, mild retractions, grunting, without signs of severe respiratory distress
❑ usually resolves in 24-72 hours
❑ CXR: fluid in fissures, increased vascularity, slight cardiomegaly

Treatment

❑ supportive: O_2, nutrition, careful fluid administration

MECONIUM ASPIRATION SYNDROME (MAS)

❑ 10-15% of all infants are meconium stained at birth, ~5% of meconium stained infants get MAS
❑ usually associated with fetal distress in utero, or post-term infant
❑ higher incidence of MAS with thick meconium
❑ respiratory distress within hours of birth
❑ tachypnea, hypercarbia, small airway obstruction, chemical pneumonitis
❑ CXR: hyperinflation, streaky atelectasis, patchy infiltrates
❑ complications: hypoxemia, acidosis, PPHN, pneumothorax, repiratory failure, death
❑ treatment: supportive care and ventilation, may benefit from surfactant replacement (surfactant function is inhibited by meconium)
❑ prevention: careful in utero monitoring, suction naso/oropharynx at perineum, then intubate and suction below cords at birth

PNEUMONIA

❑ consider in infants with prolonged rupture of membranes (PROM), maternal fever, or if mother GBS positive (septic set-up)
❑ suspect if temperature unstable, WBC elevated, or neutropenic
❑ symptoms may be non-specific
❑ CXR: hazy lung (as in TTN) + distinct infiltrates (may be difficult to differentiate from RDS)

DIAPHRAGMATIC HERNIA

❑ if resuscitation required at birth DO NOT bag because air may enter stomach and compress lungs
❑ clinical features
- respiratory distress, cyanosis
- scaphoid abdomen
- affected side dull to percussion and breath sounds absent; may hear bowel sounds instead
- asymmetric chest movements, trachea deviated away from affected side
- resultant pulmonary hypoplasia
- may present outside of neonatal period

❑ CXR: portion of GI tract in thorax (usually left side), displaced mediastinum
❑ treatment: surgical
❑ often associated with other anomalies (cardiovascular, CNS lesions)

PERSISTENT PULMONARY HYPERTENSION (PPHN)

❑ severe hypoxemia due to persistence of fetal circulation
❑ R to L shunt through PDA, foramen ovale, intrapulmonary channels —> decreased pulmonary blood flow and hypoxemia —> further pulmonary vasoconstriction
❑ risk factors
- asphyxia, MAS, RDS, sepsis, structural abnormalities (e.g. diaphragmatic hernia)

❑ treatment
- O_2 given early and tapered slowly, minimize stress and hypoxia
- high frequency oscillation, inotropes (to make systemic pressure greater than pulmonary pressure), alkalinization, extracorporeal membrane oxygenation (ECMO)

BRONCHOPULMONARY DYSPLASIA (BPD)

- ❑ usually after prolonged intubation/ventilation with high pressures and high O_2 concentration
- ❑ chronic respiratory distress
  - hypoxemia, hypercapnia, O_2 requirement at 28 days/36 wks GA
- ❑ may have cardiac component (CHF)
- ❑ treatment: gradual weaning from ventilator, nutrition, avoid stress, dexamethasone may help decrease inflammation and encourage weaning, diuretics, branchodilators

JAUNDICE

- ❑ very common - 50% of term newborns develop visible jaundice
- ❑ jaundice visible at serum bilirubin levels of 85-120 umol/L (5-6 mg/dL)
- ❑ look at sclera, mucous membranes, palmar creases, tip of nose
- ❑ jaundice more severe/prolonged (due to increased retention of bilirubin in the circulation) if following factors present
  - prematurity
  - acidosis
  - hypoalbuminemia
  - dehydration

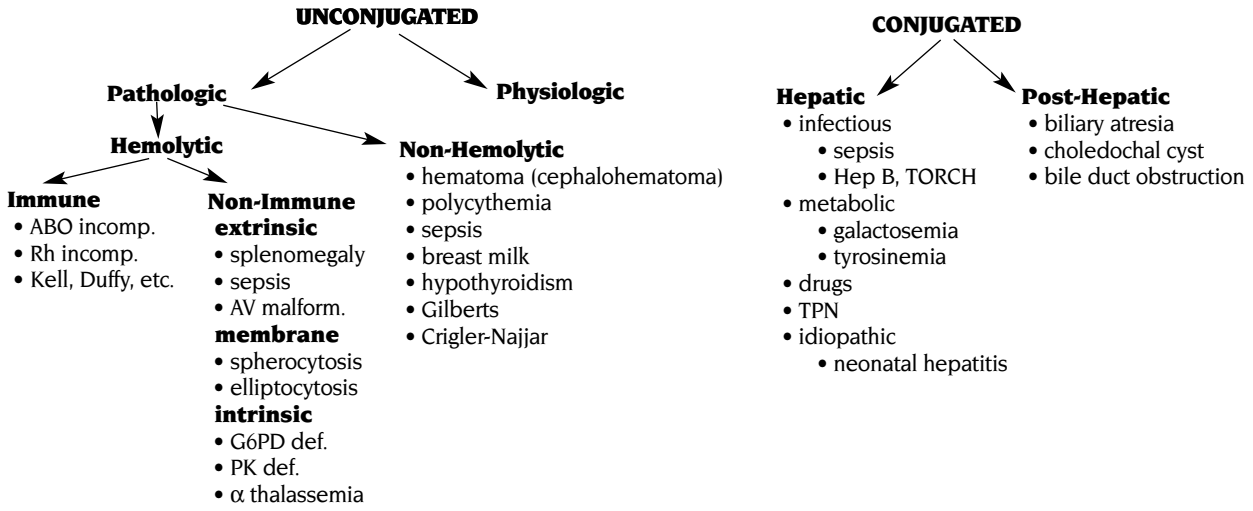


Figure 3. Approach to Neonatal Hyperbilirubinemia

Physiologic Jaundice

- ❑ onset NEVER within 1st day of life
- ❑ pathophysiology
  - increased hematocrit and decreased RBC lifespan
  - immature glucuronyl transferase enzyme system (slow conjugation of bilirubin)
  - increased enterohepatic circulation
- ❑ term infants: onset day 2-3 of life, resolution by day 7 of life
- ❑ premature infants: higher peak and longer duration
- ❑ risk factors
  - polycythemia
  - prematurity
  - infant of diabetic mother (IDM)
  - ethnic group (i.e. Native)
  - cephalohematoma
  - breast feeding

Breast Feeding Jaundice

- ❑ common
- ❑ due to lack of milk production and subsequent dehydration

Breast Milk Jaundice

- ❑ rare (1 in 200 breast-fed infants)
- ❑ due to substance in breast milk that inhibits glucuronyl transfersase
- ❑ onset day 4 to 7 of life, peak at 2nd to 3rd week of life

Table 25. Causes of Neonatal Jaundice by Age

< 24 hours	24-72 hours	72-96 hours	Prolonged (> 1 week)
ALWAYS PATHOLOGIC • hemolysis - Rh or ABO incompatibility • sepsis - GBS - congenital infection (TORCH)	• physiologic, polycythemia • dehydration (breast feeding jaundice) • hemolytic - G6PD deficiency - pyruvate kinase deficiency - spherocytosis - bruising hemorrhage, hematoma • sepsis/congential infection	• physiologic +/– breast feeding jaundice • sepsis	• breast milk jaundice • prolonged physiologic jaundice in preterm • hypothyroidism • neonatal hepatitis • conjugation dysfunction - eg. Gilbert's syndrome, Crigler-Najjar syndrome • inborn errors of metabolism - eg. galactosemia • obstruction - eg. biliary atresia

Pathologic Jaundice

❑ must be investigated if
- visible jaundice at < 24 hours of age
- serum unconjugated bilirubin rises rapidly (> 85 µmol/L per day or > 220 µmol/L before 4 days of age)
- conjugated bilirubin > 35 µmol/L

❑ investigations
- CBC, blood group (mother and infant), peripheral blood smear
- Coombs test (direct and indirect), unconjugated and conjugated bilirubin
- septic work-up if indicated: CBC + differential, blood and urine cultures + CXR (if respiratory symptoms) ± lumbar puncture (LP)
- investigations for conjugated hyperbilirubinemia: e.g. LFTs abdominal U/S, TORCH/galactosemia screen, TSH, HIDA scan

Treatment of Unconjugated Hyperbilirubinemia

❑ to prevent kernicterus (see below)
❑ breast feeding does not need to be discontinued
❑ treat underlying causes: e.g. sepsis
❑ phototherapy
- insoluble unconjugated bilirubin is converted to excretable form via photoisomerization
- serum bilirubin should be monitored during and immediately after therapy (risk of rebound)
- contraindicated in conjugated hyperbilirubinemia: results in "bronzed" baby
- side effects: hypernatremic dehydration, eye damage

❑ exchange transfusion
- prevents toxic effects of bilirubin by removal from body
- indications: depend on level and rate of rise of bilirubin
- most commonly performed for hemolytic disease

Kernicterus

❑ unconjugated bilirubin concentrations exceed albumin binding capacity and bilirubin enters and is deposited in the brain resulting in damage
❑ incidence increases as serum bilirubin levels increase above 20mg/dl
❑ can occur at lower levels in presence of sepsis, meningitis, hemolysis, hypoxia, hypothermia, hypoglycemia and prematurity
❑ early manifestations: lethargy, hypotonia, poor feeding, high-pitched cry and emesis
❑ later signs: bulging fontanel, opisthotonic posturing, pulmonary hemorrhage, fever, hypertonicity, seizures
❑ complications: sensorineural deafness, choreoathetoid cerebral palsy (CP), enamel dysplasia
❑ treatment: exchange transfusion

NECROTIZING ENTEROCOLITIS (NEC)

❑ intestinal inflammation associated with focal or diffuse ulceration and necrosis primarily affecting terminal ileum and colon
❑ affects 1-5% of all newborns admitted to ICU

Etiology

❑ multifactorial associations
- prematurity —> immature defenses
- perinatal asphyxia leading to bowel ischemia
- introduction of formula/breast milk provides substrate for bacterial overgrowth
- bacterial invasion of bowel wall with gas production (pneumatosis intestinalis)
- infection: C. *difficile* toxin, coagulase negative Staph in NICU
- tissue necrosis and perforation results

Clinical Features

❑ distended abdomen and signs of obstruction (vomiting)
❑ increased amount + bile stained gastric aspirate/vomitus
❑ frank or occult blood in stool
❑ feeding intolerance
❑ diminished bowel sounds
❑ signs of bowel perforation - sepsis, shock, peritonitis, DIC

Investigations

❑ abdominal x-ray: intramural air ("train tracks"), free air, fixed loops, thickened bowel wall
❑ high WBC, low platelets, electrolyte imbalances, acidosis, hypoxia, hypercarbia

Treatment

❑ NPO, vigorous IV fluid resuscitation, NG decompression
❑ TPN
❑ antibiotics for infection (triple therapy given empirically)
❑ serial abdominal x-rays detect early perforation
❑ surgical resection of necrotic bowel and surgery for complications (e.g. perforation, strictures)

HYPOGLYCEMIA

❑ glucose < 2.2 mmol/L (40 mg/dL) in full term infant

Causes

❑ decreased carbohydrate stores (premature, IUGR)
❑ infant of a diabetic mother (IDM): maternal hyperglycemia —> fetal hyperglycemia and hyperinsulinism —> hypoglycemia in the newborn infant
❑ sepsis
❑ endocrine: hyperinsulinism due to islet cell hyperplasia (e.g. Beckwith Wiedeman syndrome), panhypopituitarism, suppression of hypothalamo-pituitary axis (HPA)
❑ inborn errors of metabolism: fatty acid oxidation defects, galactosemia

Clinical Findings

❑ signs often non-specific and subtle: lethargy, poor feeding, irritability, tremors, apnea, cyanosis, seizures

Management

❑ obtain critical sample (blood taken during hypoglycemic episode)
- send for
  - glucose
  - insulin
  - cortisol
  - growth hormone (GH)
  - β-hydroxybutyrate
  - lactate
  - ammonia
  - free fatty acids (FFA's)
  - acid-base status

❑ provide glucose IV (e.g. D25W)
❑ hyperinsulinism: treat with diazoxide

DEHYDRATION

Table 26. Assessment of Dehydration

Point of Assessment	Method
Volume deficit	history, physical examination
Osmolar disturbance	serum Na^+
Acid-base disturbance	blood pH, pCO_2, bicarbonate
Potassium	serum K^+
Renal function	BUN, creatinine, urine specific gravity/osmolality, urine sediment

Types of Dehydration

- ❑ isotonic (80%): Na^+ = 130-150 mEq/L
- ❑ hyponatremic/hypotonic (5%): Na^+ < 130 mEq/L
- ❑ hypernatremic/hypertonic (15%): Na^+ > 150 mEq/L

Table 27. Assessment of Severity of Dehydration

	Mild	Moderate	Severe
Pulse (HR)	normal, full	rapid	rapid, weak
Blood Pressure (BP)	normal	normal-low	shock
Urine Output (UO)	decreased	markedly decreased	anuria
Oral Mucosa	slightly dry	dry	parched
Anterior Fontanelle	normal	sunken	markedly sunken
Eyes	normal	sunken	markedly sunken
Skin Turgor	normal	decreased	tenting
Skin	normal	cool	cool, mottled, acrocyanosis
% loss of Pre-Illness Body Weight			
≤ 2 years	5%	10%	15%
> 2 years	3%	6%	9%

FLUID AND ELECTROLYTE THERAPY

Principles of Treatment

- ❑ provision of maintenance daily fluid and electrolyte requirements (see Table 28)
- ❑ replacement of deficit fluids and electrolytes
- ❑ replacement of ongoing losses

Table 28. Maintenance Fluid and Electrolyte Requirements

Body Weight	100:50:20 Rule (24 hour maintenance fluids)	4:2:1 Rule (hourly rate of maintenance fluids)
1-10 kg	100 cc/kg/day	4 cc/kg/hr
11-20 kg	50 cc/kg/day	2 cc/kg/hr
> 20 kg	20 cc/kg/day	1 cc/kg/hr

Electrolyte Requirements
Na^+: 3 mEq/kg/day
K^+: 2 mEq/kg/day
Cl^-: 3 mEq/kg/day

Common IV Fluids

- ❑ first year of life: D5W/0.2 NS + 20 mEq KCl/L
- ❑ children: 2/3 1/3 + 20 mEq KCl/L
- ❑ NS: as bolus to restore circulation in very dehydrated child

Table 29. Correction of Fluid and Electrolyte Deficits

Dehydration[1]	5%	10%	Rate
Isotonic	Na^+ 4-5 mmol/kg K^+ 4-5 mmol/kg	Na^+ 8-10 mmol/kg	1/2 deficit over 1st 8 hours, then 1/2 over 16 hours
Hypotonic[2] (Na < 130 mmol/L)	Na^+ 5-6 mmol/kg K^+ 3 mmol/kg	Na^+ 10-12 mmol/kg K^+ 5 mmol/kg	If Na^+ ± 105, correct as above If Na^+ < 105, correct by 20 mmol/L maximum over 0.5-4 hours with hypertonic saline
Hypertonic (Na^+ > 150 mmol/L)	Na^+ 2-4 mmol/kg K^+ 2-4 mmol/kg	Na^+ 2-4 mmol/kg K^+ 2-4 mmol/kg	Correct over 48-72 hours Do not allow serum Na^+ to drop faster than 10-15 mmol/L/day[3]

Note: [1]For all types dehydration, H_2O for 5% dehydration = 50ml/kg; for 10% dehydration = 100 ml/kg
[2]To calculate exact deficit: $[Na^+]$ deficit = ($[Na^+]$target – $[Na^+]$actual) x body weight (kg) x total body H_2O (L/kg)
[3]To lower serum Na^+ by a predictable amount, remember: 4 ml/kg of free H_2O lowers serum Na^+ by 1 mmol/L

Table 30. Common Manifestations of Renal Disaese

Neonate	
Flank Mass	Dysplasia, polycystic disease, hydronephrosis, tumour
Hematuria	Asphyxia, malformation, trauma, renal vein thrombosis
Anuria/oliguria	Agenesis, obstruction, asphyxia
Child and Adolescent	
Cola/red-coloured urine	Hemoglobinuria (hemolysis) Myoglobinuria (rhabdomyolysis) Pigmenturia, Hematuria
Gross Hematuria	Glomerulonephritis, benign hematuria, trauma, cystitis, tumour
Edema	Nephrotic syndrome, nephritis, acute/chronic renal failure Cardiac or liver disease
Hypertension	Acute glomerulonephritis, renal failure, dysplasia, coarctation of aorta, drugs
Polyuria	DM, central and nephrogenic diabetes insipidus, hypercalcemiapolyuric renal failure
Oliguria	Dehydration, acute tubular necrosis (ATN), interstitial nephritis
Urgency	Urinary tract infection (UTI), vaginitis

HEMATURIA

- ❑ urological
  - isolated hematuria (no significant protein, cells or casts)
- ❑ nephrological
  - hematuria with significant protein, cells or casts

Asymptomatic Microscopic Hematuria

- ❑ definition
  - 5-10 RBC/HPF of centrifuged urine
- ❑ usually found on routine screening
- ❑ dipsticks are very sensitive, but have a high false positive rate
  - 5% of school-aged children on single test but <1% on repeated testing
- ❑ benign recurrent hematuria in 2/3 of cases
  - sporadic or familial
  - no associated proteinuria

Gross Hematuria
❑ etiology (see Figure 4)
❑ urinalysis
- renal source
  - cola/tea-coloured urine
  - casts, proteinuria, dysmorphic RBC's
  - associated symptoms and signs (i.e. edema, azotemia, hypertension)
- post-renal source
  - bright red urine
  - initial and terminal stream hematuria
  - clots
  - normal RBC morphology, < 2+ proteinuria, no casts
- very large renal bleeding can look like a lower urinary tract bleed

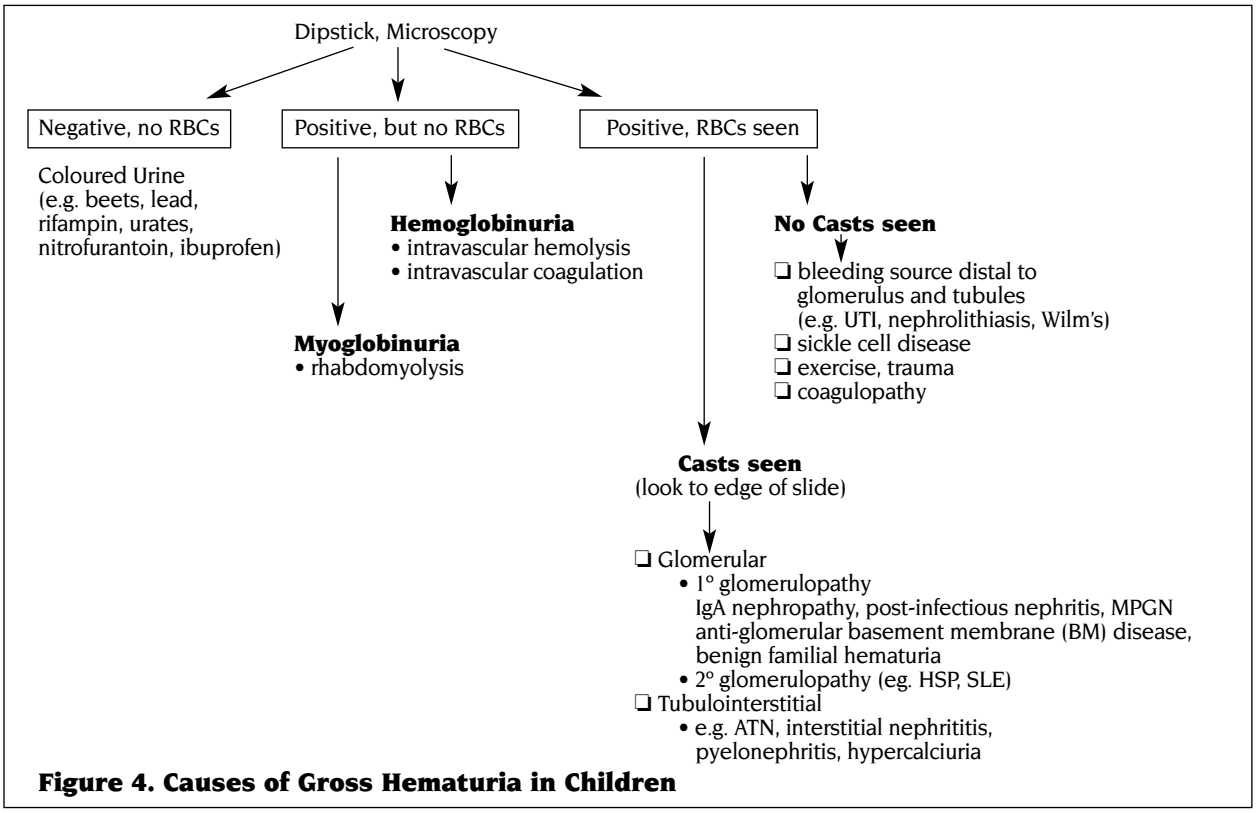


Figure 4. Causes of Gross Hematuria in Children

PROTEINURIA
❑ definition
- qualitative: 1+ in dilute, 2+ in concentrated urine (specific gravity > 1.015)
- quantitative: 4 mg/m2/h on timed urine (> 40 mg/m2/hr is nephrotic range)

❑ transient: due to fever, dehydration, exercise, seizures, stress
❑ persistent
- orthostatic (more common in adolescents)
- glomerular (e.g. nephrotic syndrome, glomerulonephritis)
- tubulointerstitial (e.g. Fanconi syndrome, ATN)
- structural abnormalities of urinary tract (e.g. hydronephrosis)

HEMOLYTIC UREMIC SYNDROME (HUS)
❑ acquired renal insufficiency
❑ triad: uremia, thrombocytopenia, microangiopathic hemolytic anemia
❑ more common from 6 months to 4 years old
❑ etiology: E. *coli* O157:H7 verotoxin ("hamburger disease") or Shigella toxin causes endothelial damage
❑ prodrome of bloody diarrhea 5-7 days before onset of renal insufficiency
❑ history: weakness, lethargy, oliguria
❑ physical exam: pallor, jaundice (hemolysis), edema, petechiae, hypertension
❑ investigations: CBC, platelets, blood smear, urinalysis, BUN, creatinine
❑ prognosis: 5-10% mortality, 10-30% kidney damage
❑ supportive treatment, dialysis if severe; steroids not helpful, antibiotics not indicated

NEPHRITIC SYNDROME

- ❑ acute, subacute or chronic
  - hematuria with RBC casts, proteinuria (< 50 mg/kg/day, not nephrotic-range), azotemia, hypertension
  - renal failure (oliguria)
- ❑ post-streptococcal glomerulonephritis
  - most common in children, especially in 4-8 year olds, M > F
  - occurs 1-3 weeks following Group A β hemolytic Strep infection
  - diffuse, proliferative glomerulonephritis
  - diagnosed by elevated serum antibody titres against Strep antigens, low C3
  - 95% of children recover completely within 1-2 weeks
  - 5-10% have persistent hematuria
- ❑ management of post-infectious glomerulonephritis
  - symptomatic treatment: fluid restriction, antihypertensives, diuretics
  - in severe cases: dialysis may be necessary

Table 31. Major Causes of Acute Glomerulonephritis (GMN)

	Decreased C3	Normal C3
Renal	Post-infectious GMN Membranoproliferative Type 1 (50-80%) Type 2 (> 80%)	IgA Nephropathy Idiopathic rapidly progressive GMN Anti-GBM disease
Systemic	SLE Spontaneous bacterial endocarditis (SBE) Shunt nephritis Cryoglobulinemia	Polyarteritis nodosa (PAN) Wegener's granulomatosis Goodpasture's syndrome Henoch-Schönlein purpura (HSP)

NEPHROTIC SYNDROME

- ❑ severe proteinuria (> 50 mg/kg/day, or > 40 mg/m2/hr) hypoalbuminemia (< 25 g/L), edema, hyperlipidemia
- ❑ diarrhea (intestinal edema) or respiratory distress (pulmonary edema, pleural effusion) may also be present
- ❑ histopathology
  - minimal change disease (76%)
  - focal segmental glomerular sclerosis (FSGS) (7%)
  - membranous glomerulonephritis (8%)
  - membranoproliferative glomerulonephritis (5%)
- ❑ minimal change disease
  - peak occurrence between 2-6 years old, 80% relapse
  - 90% are steroid-responsive
- ❑ treatment
  - salt and water restriction
  - diuretics may be required
  - prednisone for 8 weeks; if no response, renal biopsy may be required
  - frequent relapses or steroid resistance may require immunosuppressive cytotoxic agents
- ❑ children with nephrotic syndrome are at risk for:
  - infections (peritonitis, cellulitis)
  - hypercoagulability (pulmonary embolism (PE), renal vein thrombosis)
  - side effects of drugs (diuretics, steroids, immunosuppressants)
  - hypotension, shock, renal failure

SEIZURE DISORDERS (see Neurology Chapter)

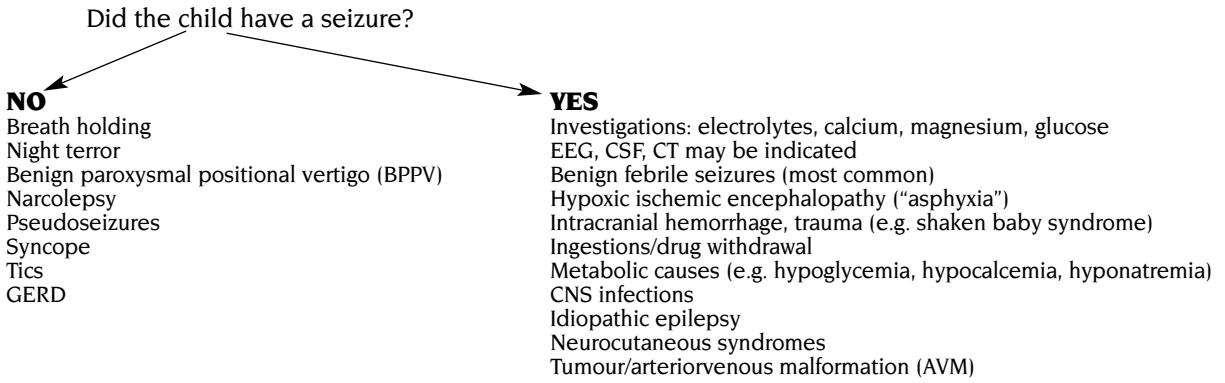


Figure 5. Approach to the Child with a Suspected Convulsive Disorder

Generalized and Partial Seizures

- ❑ generalized tonic-clonic is most common form of non-febrile seizures
- ❑ absence seizures occur in 6-20% of epileptic children, uncommon < 4 years or > 25 years of age
- ❑ partial seizures constitute 40-60% of epileptic activity

Childhood Epileptic Syndromes

- ❑ infantile spasms
  - onset 4-8 months
  - brief, repeated contractions of neck, trunk and extremities (flexion and extension) lasting 10-30 seconds
  - occur in clusters; often associated with developmental delay
  - 40% unknown etiology; may have good response to treatment
  - 60% due to metabolic or developmental abnormalities, encephalopathies, or are associated with neurocutaneous syndromes; these have poor response to treatment
  - typical EEG: hypsarrhythmia
  - treatment includes ACTH, vigabatrin
- ❑ Lennox-Gastaut
  - onset commonly < 5 years of age
  - characterized by multiple seizure types, with frequent status epilepticus
  - seen with underlying encephalopathy and brain malformations
  - treatment includes valproic acid, benzodiazepines and ketogenic diet; however, response often poor
- ❑ juvenile myoclonic epilepsy (Janz)
  - adolescent onset (12-16 years of age); autosomal dominant with variable penetrance
  - myoclonus particularly in morning, frequently presents as generalized tonic-clonic seizures
  - requires lifelong valproic acid; prognosis excellent
- ❑ benign epilepsy of childhood with rolandic spikes (BECRS)
  - onset peaks at 5-10 years of age, 16% of all non-febrile seizures
  - focal motor seizures involving tongue, mouth and face, usually occurring in sleep-wake transition states
  - remains conscious but aphasic post-ictally
  - remits spontaneously in adolescence; no sequelae

Treatment

- ❑ treat with drug appropriate to seizure type
- ❑ start with one drug and increase dosage until seizures controlled
- ❑ if no effect, switch over to another before adding a second anticonvulsant
- ❑ education for patient and parents
  - privileges and precautions in daily life (e.g. buddy system)
- ❑ continue anticonvulsant treatment until patient free of seizures for 2 years or more

Table 32. Anticonvulsive Treatment by Seizure Type

Seizure Type	Treatment
absence	ethosuximide or valproic acid if > 2 years
generalized tonic-clonic	phenobarbital in first 12 months, carbamazepine after
myoclonic	ethosuximide, valproic acid, primidone, clonazepam
partial seizures	carbamazepine or phenytoin (Gabapentin, Lamotrigine, Vigabatrin as add-on therapy)

BENIGN FEBRILE SEIZURES

- ❑ most common cause of seizure in children
- ❑ 3-5% of all children, M > F

Characteristics

- ❑ age 6 months - 6 years
- ❑ thought to be associated with initial rapid rise in temperature
- ❑ no neurologic abnormalities or developmental delay before or after seizure
- ❑ no evidence of CNS infection/inflammation before or after seizure
- ❑ no history of non-febrile seizures
- ❑ most common seizure type is brief generalized tonic-clonic

Typical Febrile Seizure

- ❑ duration < 15 minutes (95% < 5 minutes)
- ❑ generalized, symmetric
- ❑ does not recur in a 24 hour period

Atypical Febrile Seizure

- ❑ any of the following features
  - focal origin
  - > 15 minute duration, multiple (> 1 in 24 hours)
  - followed by transient neurologic deficit

Risk Factors for Recurrence

- ❑ 33% chance of recurrence, most recur within 1 year
- ❑ age of onset < 1 year
  - 50% chance of recurrence if < 1 year
  - 28% chance of recurrence if > 1 year
- ❑ family history of febrile seizures or epilepsy
- ❑ low body temperature at time of seizure
- ❑ shorter duration of fever (<24 hours) before onset of seizure
- ❑ risk of epilepsy is < 5%; risk factors include developmental and/or neurological abnormalities of child prior to seizures, family history of non-febrile seizures and an atypical initial seizure

Workup

- ❑ history: determine focus of fever, description of seizure, meds, trauma history, development, family history
- ❑ exam: LOC, signs of meningitis, neurologic exam
- ❑ rule out meningitis – do LP if suspect meningitis
- ❑ EEG not warranted unless atypical febrile seizure or abnormal neurologic findings
- ❑ investigations unnecessary except for determining focus of fever

Management

- ❑ COUNSELLING AND REASSURANCE TO PATIENT AND PARENTS
- ❑ antipyretics (e.g. acetaminophen), fluids for comfort (will not prevent seizure)
- ❑ prophylaxis not recommended
- ❑ if high risk for recurrent or prolonged seizures, have rectal or sublingual Ativan at home

RECURRENT HEADACHE (see Neurology Chapter)

Assessment

- ❑ if unremarkable history, and neurological and general physical exam is negative, likely diagnosis is migraine or tension-type headache
- ❑ obtain CT or MRI if history or physical reveals red flags
- ❑ inquire about level of disability, academic performance, after-school activities

Differential Diagnosis

- ❑ migraine, cluster
- ❑ psychogenic factors or stress
- ❑ organic causes
  - with or without increased ICP
- ❑ others
  - refractive errors, strabismus, sinusitis, malocclusion of the teeth

Migraine

- ❑ 4-5% of school-aged children
- ❑ prevalence F:M = 2:1 after puberty
- ❑ heterogeneous autosomal-dominant inheritance with incomplete penetrance

- ❑ types
  - common (without aura)
  - classic (with aura)
  - complicated: e.g. basilar, hemiplegic, ophthalmoplegic
- ❑ clinical features
  - in infancy, symptoms include spells of irritability, sleepiness, pallor, and vomiting
  - in a young child, symptoms include periodic headache with nausea and vomiting relieved by rest
  - often bilateral headache in kids with 1 of photophobia, phonophobia
- ❑ treatment
  - early analgesia and rest in quiet, dark room
  - non-pharmacological treatment and prophylaxis: biofeedback techniques, acupuncture, white flower oil, exercise, avoid triggers (eg. poor sleep, stress, cheese, chocolate)
  - pharmacological prophylaxis: β-blockers, antihistamines, antidepressants, calcium channel blockers (CCB), anticonvulsants
- ❑ prognosis
  - over 50% of children undergo spontaneous prolonged remission after 10 years of age

Tension or Stress Headaches
- ❑ usually consists of bilateral pressing tightness anywhere on the cranium or suboccipital region, hurting or aching in quality, non-throbbing
- ❑ lasts 30 minutes to days, waxes and wanes, may build in intensity during the day
- ❑ no nausea/vomiting, not aggravated by routine physical activity
- ❑ most children have insight into the origin of headache: poor self-image, fear of school failure
- ❑ associated features: sudden mood changes, disturbed sleep, fatigue, withdrawal from social activities
  - chronic systemic signs e.g. weight loss, fever, anorexia, focal neural signs
- ❑ treatment
  - reassurance and explanation about how stress may cause a headache
  - mild analgesia
  - supportive counseling

Organic Headaches
- ❑ organic etiology often suggested with occipital headache
- ❑ with increased ICP
  - etiology: brain tumours, hydrocephalus, meningitis, encephalitis, cerebral abscess, pseudotumour cerebri, subdural hematoma,
  - characteristics: diffuse early morning headaches, early morning vomiting, headache worsened by increased ICP (cough, sneeze, straining during bowel movement (BM)); as ICP increases, headache is constant and child is lethargic and irritable
- ❑ without increased ICP
  - etiology: cerebral arteriovenous malformation (AVM's), aneurysm, collagen vascular diseases, subarachnoid hemorrhage, stroke

HYPOTONIA
- ❑ decreased resistance to movement – "floppy baby"
- ❑ proper assessment of tone requires accurate determination of gestational age
- ❑ history – obstetrical/perinatal, family, exposures, regression in milestones
- ❑ evaluate
  - spontaneous posture (spontaneous movement, movement against gravity) important in evaluation of muscle weakness
  - joint mobility (hyperextensibility)
  - shaking of limbs
  - postural maneuvers
- ❑ postural maneuvers
  - traction response – pull to sit and look for flexion of arms to counteract traction; no response at < 33 weeks GA
  - axillary suspension – suspend infant by holding at axilla and lifting; hypotonic babies will slip through the grasp because of low shoulder girdle tone
  - ventral suspension – infant is prone and supported under the abdomen by one hand; infant should be able to hold up extremities; inverted "U" posturing demonstrates hypotonia, i.e. baby will drape self over examiner's arm
- ❑ investigations
  - rule out systemic disorders
  - blood glucose
  - enhanced CT of brain
  - peripheral CK, EMG, muscle biopsy
  - chromosome analysis, genetic testing

Differential Diagnosis
- ❑ central
  - chromosomal (e.g. Down syndrome, Prader-Willi)
  - metabolic (e.g. hypoglycemia, kernicterus)
  - perinatal problems (e.g. asphyxia, ICH)
  - endocrine (e.g. hypothyroidism, hypopituitarism)
  - infections (e.g. TORCH)
  - CNS malformations
  - dysmorphic syndromes
- ❑ peripheral
  - motor neuron (e.g. spinal muscular atrophy, polio)
  - peripheral nerve (e.g. Guillain-Barré)
  - neuromuscular junction (e.g. myasthenia gravis)
  - muscle fibres (e.g. muscular dystrophy, myotonic dystrophy)

CEREBRAL PALSY
- ❑ a symptom complex, NOT a disease
- ❑ nonprogressive central motor impairment syndrome due to insult to or anomaly of the immature CNS
- ❑ association with low birth weight babies
- ❑ incidence: 1.5-2.5:1,000 live births (developing countries)
- ❑ extent of intellectual impairment varies
- ❑ life expectancy is dependent on the degree of mobility and intellectual impairment, not on severity of CNS lesion

Types
- ❑ spastic (pyramidal)
  - diplegia: lower limbs > upper limbs; often due to interventricular hemorrhage or periventricular leukomalacia
  - hemiplegia: one-sided paralysis
  - quadraplegia
- ❑ non-spastic (extrapyramidal)
  - choreoathetoid (kernicterus)
  - dystonic (fluctuating high/low tone)
  - hypotonic
  - ataxic
  - mixed

Etiology
- ❑ often obscure, no definite etiology identified in 1/3 of cases
  - only 10% related to intrapartum asphyxia
  - 10% due to postnatal insult (infections, asphyxia and trauma)

Other Signs
- ❑ swallowing incoordination - aspiration
- ❑ microcephaly (25%)
- ❑ seizures
- ❑ mental retardation, learning disabilities
- ❑ delay in motor milestones

Investigations
- ❑ may include metabolics, chromosome studies, serology, neuroimaging, evoked potentials, EEG (if seizures), ophthalmology, audiology

Treatment
- ❑ maximize potential through multidisciplinary services; important for family to be connected with various support systems
- ❑ orthopedic management (e.g. dislocations, contractures, rhizotomy)
- ❑ management of symptoms: spasticity (baclofen), constipation (stool softeners)

NEUROCUTANEOUS SYNDROMES
- ❑ characterized by tendency to form tumours of CNS, PNS, viscera and skin

Neurofibromatosis (NF) Type I
- ❑ cafe-au-lait spots, axillary freckles, Lisch nodules of the iris, neurofibromas, boney lesions, FH
- ❑ seizures, scoliosis, optic glioma

Neurofibromatosis (NF) Type II
- ❑ NF type I lesions not present
- ❑ associated with brain tumours
- ❑ bilateral acoustic neuromas are diagnostic

Sturge-Weber Syndrome
- ❑ port-wine nevus syndrome in V-1 distribution with associated angiomatous malformations of brain, seizures, contralateral hemiparesis

Tuberous Sclerosis
- ❑ adenoma sebaceum, "ash leaf" hypopigmentation, cardiac rhabdomyomas, kidney angioleiomyomas, mental retardation and seizures

ONCOLOGY

- ❑ cancer is second most common cause of death in children after 1 year of age (injuries are #1)
- ❑ usually occur sporadically, but increased risk with
  - chromosomal syndromes
  - prior malignancy
  - neurocutaneous syndromes
  - immunodeficiency syndromes
  - family history
  - exposure to radiation, chemicals, biologic agents
- ❑ leukemia is most common type of pediatric malignancy (25-35%)
- ❑ brain tumours are second most common malignancy in children (20%)
- ❑ some malignancies may be more prevalent in certain age groups
  - newborns: neuroblastoma, congenital leukemia
  - infancy and childhood: leukemia, neuroblastoma, Wilms' tumour, retinoblastoma
  - adolescence: lymphoma, gonadal tumours, bone tumours

LEUKEMIA (see Hematology Chapter)

- ❑ most common childhood malignancy
- ❑ heterogenous group of diseases: acute lymphoblastic leukemia (ALL) (80%), acute myeloblastic leukemia (AML) (15%) and chronic myelogenous leukemia (CML) (5%) **(see Colour Atlas H13, H11, H10)**
- ❑ etiology: mostly unknown; EBV associated with African Burkitt lymphoma, retrovirus with T cell leukemia
- ❑ signs and symptoms: due to infiltration of leukemic cells into bone marrow (bone pain, anemia, neutropenia, thrombocytopenia) and into tissues (lymphadenopathy, hepatosplenomegaly, CNS manifestations)
- ❑ prognosis: low-risk - 90% long-term remission, high-risk - 70% long-term remission

Table 33. Prognostic Indicators in Childhood Acute Lymphocytic Leukemia (ALL)

	Good	Poor
age	2-10 years	<2 or >10 years
ethnicity	white	black
sex	female	male
lymphadenopathy	no	yes
hepatosplenomegaly	no	yes
mediastinal mass	no	yes
initial WBC	< 20 x 10^9/L	> 20 x 10^9/L
hemoglobin	> 100 g/L	< 100 g/L
LDH	low	high
lymphoblasts	typical	undifferentiated
hyperploidy	yes	no
translocation	no	yes
early response to treatment	yes	no

LYMPHOMA (see Hematology Chapter)

- ❑ third most common childhood tumour
- ❑ Hodgkin's lymphoma
  - older children (age > 15), similar to adult Hodgkin's
  - presents with painless, firm lymphadenopathy **(see Colour Atlas H15)**
  - B symptoms only in 30% of children
- ❑ non-Hodgkin's lymphoma
  - younger children (7-11 years)
  - rapidly growing tumour with distant metastases
  - signs and symptoms related to disease site, most commonly abdomen, chest (mediastinal mass), head and neck region

BRAIN TUMOURS (see Neurosurgery Chapter)

- ❑ predominantly infratentorial involving cerebellum, midbrain, brainstem
- ❑ glial (cerebellar astrocytomas most common) or primitive neuroectodermal (medulloblastoma)
- ❑ signs and symptoms
  - infratentorial: vomiting, morning headache, increased head circumference, ataxia, diplopia, nystagmus, papilledema
  - supratentorial: focal deficits, seizure, long tract signs
- ❑ evaluation
  - history, physical exam including complete neurological exam
  - CT and/or MRI of head as indicated

WILMS' TUMOUR (NEPHROBLASTOMA)

- ❑ usually diagnosed between 2 and 5 years of age
  - most common primary renal neoplasm of childhood
  - M=F
- ❑ differential diagnosis
  - hydronephrosis, polycystic kidney disease, renal cell carcinoma, neuroblastoma

Presentation

- ❑ 80% present with asymptomatic, large, unilateral abdominal mass
- ❑ may also present with hypertension, hematuria, intestinal obstruction
- ❑ many have pulmonary metastases at time of primary diagnosis

Associated Congenital Abnormalities

- ❑ WAGR syndrome (Wilms' tumour, Aniridia, genital anomalies, mental retardation)
  - 11p13 deletion
- ❑ Beckwith-Wiedemann syndrome
  - characterized by enlargement of body organs, hemihypertrophy, renal medullary cysts, and adrenal cytomegaly
  - also at increased risk for developing hepatoblastoma, adrenocortical tumours, rhabdomyosarcomas, and pancreatic tumours
- ❑ Denys-Drash syndrome
  - characterized by gonadal dysgenesis and nephropathy leading to renal failure

Management

- ❑ nephrectomy
- ❑ staging, chemotherapy, radiation
- ❑ generally good prognosis (~90% long-term survival)

NEUROBLASTOMA

- ❑ most common cancer occurring in first year of life
- ❑ neural crest cell tumour arising from sympathetic tissues
  - adrenal medulla (45%)
  - sympathetic chain (25% retroperitoneal, 20% posterior mediastinal, 4% pelvis, 4% neck)
- ❑ most common malignancy in infancy

Presentation

- ❑ can originate from any site in sympathetic nervous system, presenting as neck mass, chest mass, abdominal mass (most common site is adrenal gland)
- ❑ direct extension: spinal cord compression, Horner syndrome
- ❑ metastases are common at presentation
  - periorbital ecchymoses, bone pain, hepatomegaly, "blueberry muffin" skin nodules
- ❑ paraneoplastic: hypertension, headache, palpitation, sweating (from excessive catecholamines; diarrhea, hypokalemia, FTT (from VIP secretion), opsomyoclonus

Diagnosis and Staging

- ❑ LFTs, renal function tests, serum ferritin
- ❑ urine VMA, HVA
- ❑ CT scan chest and abdomen, bone scan
- ❑ bone marrow exam - for neuroblastoma cells in "rosettes"
- ❑ tissue biopsy

Good Prognostic Factors

- ❑ "age and stage" are important determinants of outcome
  - < 1 year old, female
  - stage I, II, IV-S disease
- ❑ primary site: posterior mediastinum and neck
- ❑ low serum ferritin
- ❑ tumour cell markers
  - VMA/HVA ratio > 1
  - aneuploidy
  - absent N-myc oncogene amplification
  - high levels of Trk A gene expression

Management

- ❑ surgery, radiation, chemotherapy +/– bone marrow transplantation

RHABDOMYOSARCOMA

- ❑ third most common extracranial solid tumor of children (after neuroblastoma/Wilms tumour)
- ❑ no clear predisposing risk factors
- ❑ common sites of origin are strctures of the head and neck, GU tract and extremities
- ❑ presentation: firm, painless mass
- ❑ metastases to lung, bone marrow and bones
- ❑ evaluation: MRI or CT scan of primary site, CT chest, bone scan, bilateral bone marrow aspirates and biopsies
- ❑ treatment: multidrug chemotherapy and surgery

RESPIROLOGY

UPPER RESPIRATORY TRACT DISEASES (see Otolaryngology Chapter)

- ❑ Laryngotracheobronchitis (Croup)
- ❑ Epiglottitis **(see Colour Atlas P4)**
- ❑ Foreign Body (FB) Aspiration **(see Colour Atlas P6)**
- ❑ Subglottic Stenosis
- ❑ Laryngomalacia

LOWER RESPIRATORY TRACT DISEASES

- ❑ obstruction of airways below thoracic inlet, produces more expiratory symptoms
- ❑ classic symptom: wheezing

Differential Diagnosis of Wheezing

- ❑ asthma: recurrent wheezing episodes
- ❑ pneumonia: fever, cough, malaise
- ❑ bronchiolitis: first episode of wheezing (see Bronchiolitis section)
- ❑ CF: prolonged wheezing unresponsive to therapy
- ❑ foreign body aspiration: sudden onset wheezing and coughing
- ❑ gastroesophageal reflux with aspiration: feeding difficulties
- ❑ congestive heart failure: associated FTT

BRONCHIOLITIS

- ❑ defined as the first episode of wheezing associated with URI and signs of respiratory distress
- ❑ common, affects 15% of children in first 2 years of life
- ❑ peak incidence at 6 months, often in late fall and winter
- ❑ occurs in children prone to airway reactivity, i.e. increased incidence of asthma

Etiology

- ❑ respiratory syncytial virus (RSV) (75%)
- ❑ Parainfluenza, Influenza, Adenovirus

Clinical Features

- ❑ prodrome of URI with cough and fever
- ❑ feeding difficulties, irritability
- ❑ wheezing, respiratory distress, tachypnea, tachycardia, retractions, poor air entry
- ❑ children with chronic lung disease, severe CHD and immunodeficiency have a more severe course of the illness

Diagnosis

- ❑ CXR (only needed in severe disease, poor response to therapy, chronic episode)
  - air trapping, peribronchial thickening, atelectasis, increased linear markings
- ❑ nasopharyngeal swab
  - direct detection of viral antigen (immunofluorescence)

Management

- ❑ mild distress
  - supportive: oral or IV hydration, antipyretics for fever
  - humidified O_2 (maintain O_2 sat>92%)
  - inhaled bronchodilator (Ventolin) 0.03 cc in 3 ml NS by mask, q20 min, and then q1 hour – stop if no response
- ❑ moderate to severe distress
  - as above
  - rarely, intubation and ventilation
  - Atrovent and steroids are not effective
  - consider ribavirin in high risk groups: BPD, CHD, congenital lung disease, immunodeficient
- ❑ monthly RSV Ig also offers some protection against severe disease to high risk groups
  - case fatality rate < 1%
- ❑ indications for hospitalization
  - hypoxia: O2 saturation < 92%
  - persistent resting tachypnea > 60/minute and retractions after several Ventolin masks
  - past history of chronic lung disease, hemodynamically significant cardiac disease, neuromuscular problem, immunocompromised
  - young infants < 3 months old (unless extremely mild)
- significant feeding problems
  - social problem, i.e. inadequate care at home

PNEUMONIA

Clinical Features
- ❑ incidence is greatest in first year of life
- ❑ fever, cough, crackles
- ❑ tachypnea, tachycardia, respiratory distress
- ❑ bacterial cause has more acute onset, but viral cause is more common
- ❑ abnormal CXR

Etiology

Table 34. Common Causes of Pneumonia at Different Ages

Age	Bacterial	Viral	Others
neonates	GBS E. *Coli*	CMV Herpes virus	M*ycoplasma* U*reaplasma*
1-3 months	S. *aureus* H. *influenzae* S. *pneumoniae*	CMV, RSV Influenza virus Parainfluenza virus	C*hlamydia trachomatis* U*reaplasma*
3 months - 5 years	S. *pneumoniae* S. *aureus* H. *influenzae*	RSV Adenovirus Influenza virus	TB
> 5 years	S. *pneumoniae* H. *influenzae*	Influenza virus	M*ycoplasma pneumonia* (most common) C*hlamydia pneumonia* TB

Management
- ❑ supportive treatment: hydration, antipyretics, humidified O2
- ❑ IV or PO antibiotics
  - newborn
    - ampicillin and gentamicin +/– erythromycin
  - 1-3 months
    - ampicillin +/– erythromycin
  - 3 months - 5 years
    - severe: IV ampicillin
    - mild: PO amoxicillin
  - > 5 years
    - erythromycin

ASTHMA
- ❑ characterized by airway hyperreactivity, bronchospasm and inflammation, reversible small airway obstruction
- ❑ very common illness which presents most often in early childhood
- ❑ associated with other atopic diseases such as allergic rhinitis or eczema

Clinical Features
- ❑ episodic bouts of
  - wheezing
  - cough: at night, early morning, with activity
  - tachypnea
  - dyspnea
  - tachycardia

Triggers
- ❑ URI (viral or M*ycoplasma*)
- ❑ weather (cold exposure, humidity changes)
- ❑ allergens (pets), irritants (cigarette smoke)
- ❑ exercise, emotional stress
- ❑ drugs (aspirin, β-blockers)

Classification
- ❑ mild asthma
  - occasional attacks of wheezing or coughing (< 2 per week)
  - symptoms respond quickly to inhaled bronchodilator
- ❑ moderate asthma
  - more frequent episodes with symptoms persisting and chronic cough
  - decreased exercise tolerance
- ❑ severe asthma
  - daily and nocturnal symptoms
  - frequent ER visits and hospitalizations

Management
- ❑ acute
  - O_2: to keep O_2 saturation > 92%
  - fluids: if dehydrated
  - β2-agonists: salbutamol (Ventolin) 0.03 cc/kg in 3 cc NS q 20 minutes minutes by mask until improvement, then masks q hourly if necessary
  - ipratropium bromide (Atrovent) if severe: 1 cc added to each of first 3 Ventolin masks
  - steroids: prednisone 2 mg/kg in ER, then 1 mg/kg po od x 4 days
    - in severe disease, give steroids immediately since onset of action is slow (4 hours)
- ❑ indications for hospitalization
  - initial O_2 saturation < 92%
  - past history of life-threatening asthma (ICU admission)
  - unable to stabilize with q4 Ventolin masks
  - concern over environmental issues or family's ability to cope
- ❑ chronic
  - education, emotional support, avoidance of environmental allergens or irritants, development of an "action plan"
  - exercise program (e.g. swimming)
  - monitoring of respiratory function with peak flow meter (improves compliance and allows modification of medication)
  - PFTs for children > 6 years
  - patients with moderate or severe asthma will need regular prophylaxis in addition to bronchodilators (e.g. daily inhaled steroids, long-acting β-agonists, anticholinergics, sodium cromoglycate, theophylline)

CYSTIC FIBROSIS (CF) (see Respirology Chapter)
- ❑ autosomal recessive
- ❑ 1 in 3,000 live births, mostly Caucasians
- ❑ mutation in transmembrane conductance regulator of chloride
- ❑ CFTR gene found on chromosome 7 (F508 mutation in 70%)

Clinical Features
- ❑ neonatal
  - meconium ileus
  - prolonged jaundice
  - antenatal bowel perforation
- ❑ infancy
  - pancreatic insufficiency with steatorrhea and FTT (but voracious appetite)
- ❑ childhood
  - anemia, hypoproteinemia, hyponatremia
  - heat prostration
  - recurrent chest infections or wheezing (S. *aureus*, P. *aeruginosa*, H. *influenzae*)
  - hemoptysis
  - nasal polyps (associated with milder disease)
  - distal intestinal obstruction syndrome, rectal prolapse
  - clubbing of fingers
- ❑ older patients
  - chronic obstructive pulmonary disease (COPD)
  - infertility

Complications
- ❑ respiratory failure
- ❑ pneumothorax (poor prognostic sign)
- ❑ cor pulmonale (late)
- ❑ pancreatic fibrosis with diabetes mellitus
- ❑ gallstones
- ❑ cirrhosis with portal hypertension
- ❑ infertility
- ❑ early death (current median survival is 30 years)

Diagnosis
- ❑ sweat chloride test x 2 (> 60 mEq/L)
  - false positive tests: malnutrition, Celiac disease, adrenal insufficiency, anorexia nervosa, hypothyroidism, nephrogenic diabetes insipidus, nephrotic syndrome
  - false negative tests: peripheral edema, cloxacillin, glycogen storage disease, hypoparathyroidism, atopic dermatitis, Klinefelter syndrome, hypogammaglobulinemia
- ❑ pancreatic dysfunction - determined by 3-day fecal fat collection
- ❑ genetics - useful where sweat chloride test is equivocal
- ❑ prenatal screening for high risk families

Management
- ❑ nutritional counseling
  - high calorie diet
  - pancreatic enzyme replacements
  - fat soluble vitamin supplements
- ❑ management of chest disease
  - physiotherapy, postural drainage
  - exercise
  - bronchodilators
  - antibiotics: depends on sputum C&S (e.g. cephalosporin, cloxacillin, ciprofloxacin, inhaled tobramycin)
  - lung transplantation
- ❑ genetic counseling

RHEUMATOLOGY

EVALUATION OF LIMB PAIN (see Orthopedics Chapter)

History
- ❑ pain: onset, duration, location, character, intensity, frequency, aggravating/alleviating factors, limitations in daily activity
- ❑ trauma, injury
- ❑ morning stiffness, limp, swelling/redness of joints, heat
- ❑ general: fever, rash, fatigue, weight loss, cough, chest pain, hair loss
- ❑ family history: arthritis, psoriasis, IBD, bleeding disorders

Physical Exam
- ❑ complete physical exam
- ❑ all joints: inspection, palpation, range of motion
- ❑ gait, leg length discrepancy
- ❑ tenderness over tendons or tendon insertion sites
- ❑ muscle weakness or atrophy

Investigations
- ❑ CBC, differential, blood smear, ESR
- ❑ X-rays of painful joints/limbs
- ❑ as indicated: ANA, RF, PTT, sickle cell prep, viral serology, immunoglobulins, complement, urinalysis, synovial analysis and culture, Tb test, ASO titre (antistreptolysin O)

Table 35. Differential Diagnosis of Limb Pain

Cause	< 3 years	3-10 years	> 10 years
Trauma	x	x	x
Infectious			
septic arthritis	x	x	x
osteomyelitis	x	x	x
Inflammatory			
transient synovitis		x	
JRA	x	x	x
seronegative spondyloarthropathy			x
SLE			x
dermatomyositis (DMY)			x
HSP		x	
Anatomic/Orthopedic			
Legg-Calve-Perthes disease		x	x
slipped capital femoral epiphysis			x
Osgood-Schlatter disease			x
Neoplastic			
leukemia	x	x	x
neuroblastoma	x	x	x
bone tumours		x	x
Hematologic			
hemophilia	x	x	x
sickle cell anemia	x	x	x
Pain syndromes			
growing pains		x	
fibromyalgia			x
reflex sympathetic dystrophy			x

GROWING PAINS

- ❑ age 2-12 years, M=F
- ❑ pain
  - poorly localized (usually affecting shins, rarely calves)
  - usually bilateral
  - occurs in evening or awakens child at night
  - responds to reassurance, massage or analgesics
  - resolves completely in the morning
- ❑ no associated systemic symptoms (e.g. fever)
- ❑ normal physical examination
- ❑ lab investigations not necessary if typical presentation

JUVENILE RHEUMATOID ARTHRITIS (JRA)

- ❑ a heterogenous group of conditions characterized by a persistent arthritis in childhood
- ❑ diagnosis
  - arthritis in at least one joint
  - lasts for at least 6 weeks
  - onset before the age of 16
  - other causes of arthritis excluded
- ❑ classification
  - defined by features/number of joints affected in the first 6 months of onset
  - systemic onset - fever at onset with arthritis appearing later
  - pauciarticular - 4 or less joints involved
  - polyarticular - 5 or more joints involved
- ❑ prognosis: worst prognosis with systemic onset and polyarticular course
  - outcome of most children is favourable
  - best prognosis in young female with pauciarticular disease

Systemic (Still's Disease)

- ❑ high spiking fever (= 38.5°C) for at least 2 weeks
- ❑ extra-articular features: erythematous "salmon-coloured" maculopapular rash, lymphadenopathy, hepatosplenomegaly, leukocytosis, thrombocytosis, anemia, serositis (pericarditis, pleuritis)
- ❑ arthritis may occur weeks to months later

Table 36. Juvenile Arthritis Classification

	Systemic	Pauciarticular		Polyarticular	
		Type I	Type II	RF neg	RF pos
Sex predominance	M=F	80% F	90% M	90% F	80% F
Age of onset	any	< 5	> 8	< 5	> 8
Rheumatoid factor (RF)	neg	neg	neg	neg	100%
ANA	neg	60%	neg	25%	75%
HLA-B27	neg	neg	75%	neg	neg
Eye involvement	neg	20%	neg	10-20%	neg
% of patients	20	30	15	25	10

Pauciarticular

- ❑ Type I
  - most common subtype, peak age 2 years
  - usually involves large joints: knee, ankle or elbow, rarely shoulder or hip
  - often resolves without permanent sequelae
  - prone to chronic iridocyclitis and uveitis, which, if untreated may lead to permanent visual damage
  - slit lamp exam should be done early in child presenting with joint swelling and then every 3 months if ANA positive
- ❑ Type II
  - at onset, there is an asymmetrical peripheral arthritis usually confined to joints below the waist (hip, knees, ankles, feet)
  - enthesitis (inflammation at tendon insertion sites) of Achilles tendon, patellar tendon, plantar fascia
  - seronegative spondyloarthropathy may develop later in life
  - family history of spondyloarthropathy, IBD or psoriasis

Polyarticular

- ❑ RF Negative
  - often involves small joints of hands and feet, temporomandibular joint, sternoclavicular joint, distal interphalangeal joints (DIP), cervical spine
  - patients who are ANA positive are prone to chronic uveitis

❑ RF Positive
- similar to the aggressive form of adult rheumatoid arthritis
- severe, rapidly destructive, symmetrical arthritis of large and small joints
- associated with rheumatoid nodules at pressure points (elbows, knees)
- unremitting disease, persists into adulthood

Management
❑ children may complain very little about their pain and disability
❑ night splints to prevent development of contractures secondary to guarding and disuse
❑ exercise to maintain range of motion (ROM) and muscle strength
❑ multidisciplinary approach with OT/PT, social work, orthopedics, ophthalmology, rheumatology
❑ first line drug therapy: NSAIDs
❑ other options
- methotrexate
- corticosteroids - intra-articular, systemic, or topical eye drops
- hydrochloroquine
- sulfasalazine
- gold
- new biologic agents (etanercept: anti-TNF)

HENOCH-SCHÖNLEIN PURPURA (HSP)
❑ most common vasculitis of childhood
❑ peak incidence 4-10 years, M > F
❑ recurrence in about one third of patients
❑ often have history of URTI 1-3 weeks before onset of symptoms
❑ features
- skin: palpable, non-thrombocytopenic purpura in lower extremities and buttocks, edema, scrotal swelling
- joints: arthritis/arthralgia involving large joints
- GI: abdominal pain, GI bleeding, intussusception
- renal: IgA nephropathy, hematuria, proteinuria, hypertension, acute renal failure in <5%, progressive renal failure in another 5%

❑ management
- symptomatic, corticosteroids may relieve abdominal pain
- monitor for renal disease, may persist for a few years

❑ prognosis: self-limited disease in 90%

KAWASAKI DISEASE
❑ acute vasculitis of unknown etiology
❑ most common cause of acquired heart disease in children
❑ peak age < 5 years, Orientals > Blacks > Causasians, M > F

Diagnostic Criteria
❑ fever persisting 5 days or more AND
❑ 4 of the following features
1. bilateral nonpurulent conjunctivitis
2. red fissured lips, strawberry tongue, erythema of oropharynx
3. changes of the peripheral extremities
   - acute phase: erythema, edema of hands and feet, groin peeling
   - subacute phase: peeling from tips of fingers and toes
4. polymorphous rash
5. cervical lymphadenopathy > 1.5 cm in diameter

❑ exclusion of other diseases (e.g. scarlet fever, measles)
❑ atypical Kawasaki disease: less than 5 of 6 diagnostic features but coronary artery involvement

Associated Features
❑ acute phase (as long as fever persists, about 10 days)
- most of diagnostic criteria present
- irritability, aseptic meningitis, myocarditis, pericarditis, CHF, diarrhea, gallbladder hydrops, pancreatitis, urethritis

❑ subacute phase (resolution of fever, peeling of skin, usually days 11-21)
- arthritis

❑ convalescent phase (lasts until ESR and platelets normalize, > 21 days)
- coronary artery aneurysms, aneurysm rupture, myocardial infarction (MI), CHF, arthritis may persist

Complications
❑ coronary artery vasculitis with aneurysm formation occurs in 20-25% of untreated children, 4-8% if receive IVIG within 10 days of fever
- 50% of aneurysms regress within 2 years
- 20% develop stenosis with risk of MI

❑ risk factors for coronary disease: male, age < 1 or > 9 years, fever >10 days, thrombocytosis, leukocytosis
❑ children may have endothelial dysfunction with risk of early coronary artery disease (CAD)

Management
❑ high (anti-inflammatory) dose of ASA while febrile
❑ low (anti-platelet) dose of ASA in subacute phase
❑ IV immunoglobulin (2 g/kg) reduces coronary aneurysm formation
❑ follow up with periodic 2D-echocardiograms

URINARY TRACT INFECTION (UTI)

- ❑ newborns - more common in males (especially if uncircumcised)
- ❑ children - more common in females due to straight short urethra

Etiology

- ❑ E. *coli* serotypes from bowel flora (most common)
- ❑ others: *Klebsiella*, *Proteus*, *enterococci*, S. *saprophyticus*

Risk Factors

- ❑ female (after 2 years), neurogenic bladder, reflux, genitourinary (GU) tract abnormalities, diabetes, immunocompromised, uncircumcised male

Complications

- ❑ children 2 months to 2 years are at greatest risk of renal damage from UTI

Clinical Features

- ❑ neonates: feeding difficulties, fever, vomiting, jaundice, FTT
- ❑ preschool: fever, increased frequency, urgency, dysuria, abdominal pain, vomiting
- ❑ school-age: fever, enuresis, increased frequency, urgency, dysuria, flank pain

Diagnosis

- ❑ febrile infant < 2 months requires full septic work-up (see Infectious Diseases section)
- ❑ unexplained fever in child 2 months to 2 years of age —> consider UTI (see Figure 6)

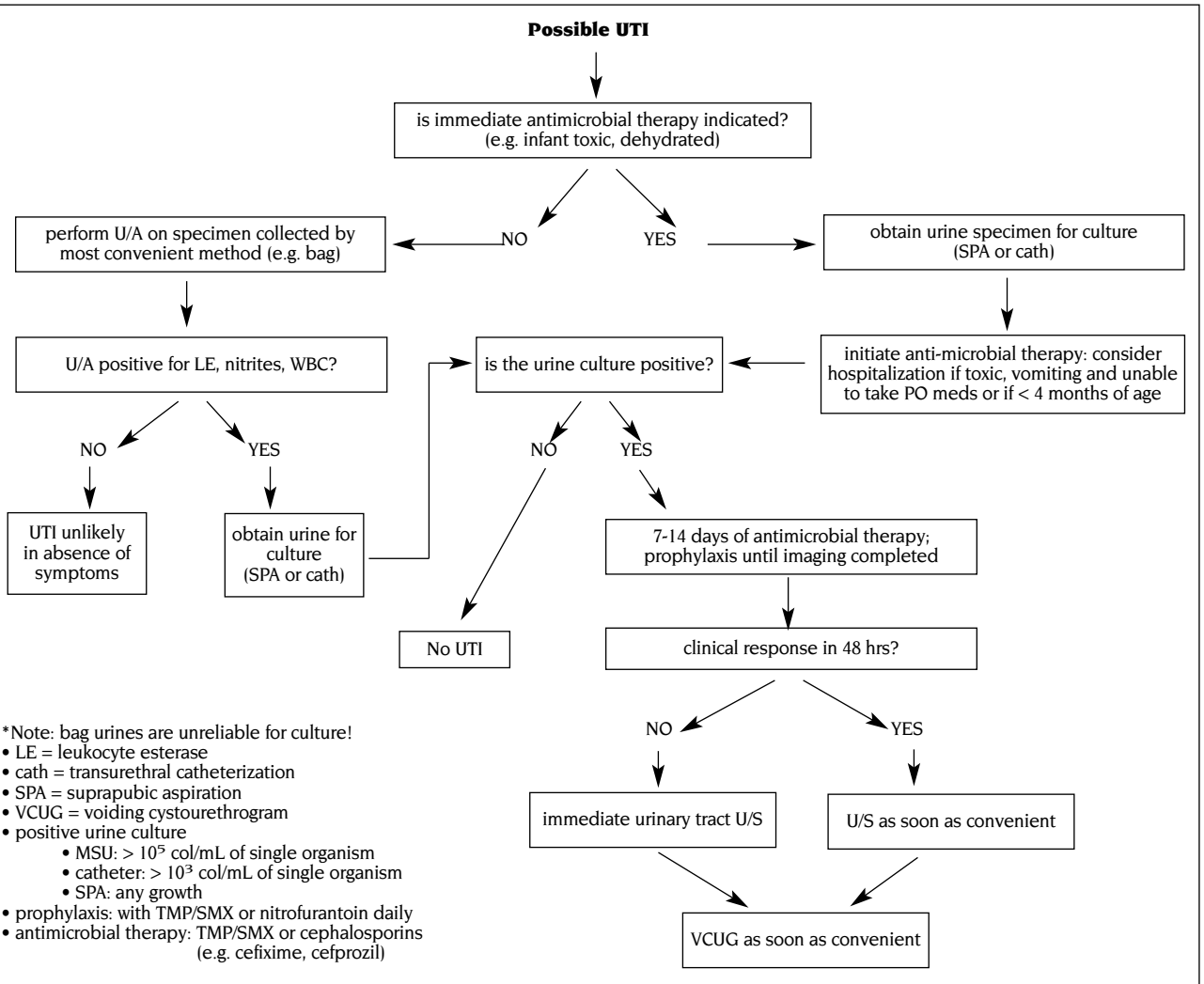


Figure 6. Diagnosis and Management of UTI in Children 2 months - 2 years

Reference: *Pediatrics, Vol.* 103, *April* 1999, *pp.* 843-852.

URINARY TRACT OBSTRUCTION

Posterior Urethral Valves
- ❑ 1:50,000
- ❑ most common obstructive urethral lesion in male infants
- ❑ mucosal folds at the distal prostatic urethra
- ❑ presents with obstructive symptoms, UTI, flank masses, urinary ascites if renal pelvis ruptures
- ❑ now detected antenatally: hydronephrosis, pulmonary hypoplasia
- ❑ diagnosis: U/S, VCUG
- ❑ treatment: destruction of valves

Ureteropelvic Junction (UPJ) Obstruction
- ❑ most common ureteric abnormality in children
- ❑ usually in boys, on the left, 10-15% bilateral
- ❑ etiology: segment of ureter lacking peristaltic activity, congenital narrowing, muscular bands, external compression
- ❑ presentation: abdominal mass in newborn (hydronephrosis)
- ❑ diagnosis: U/S, renal scan +/– furosemide
- ❑ treatment: surgical correction with good prognosis

VESICOURETERAL REFLUX (VUR)
- ❑ retrograde flow of urine from bladder to ureters and kidneys
- ❑ genetic predisposition: 30-50% increased risk to sibling
- ❑ pathophysiology
  - primary reflux: intrinsic anatomic abnormalities of ureterovesical junction
  - secondary reflux: pathology altering function of ureterovesical junction (i.e. neurogenic bladder, posterior urethral valves)
- ❑ symptoms of
  - UTI, pyelonephritis
- ❑ diagnosis: voiding cystourethrogram (VCUG)
- ❑ staging: via VCUG
  - Grade I - ureters only fill
  - Grade II - ureters and pelvis fill
  - Grade III - ureters and pelvis fill, some dilatation
  - Grade IV - ureters, pelvis and calices fill, significant dilatation
  - Grade V - ureters, pelvis, and calices fill, major dilatation and tortuosity
- ❑ complications: pyelonephritis, recurrent UTI, reflux nephropathy (renal scarring or thinning), hypertension, end stage renal disease
- ❑ management
  - prophylactic antibiotics (amoxicillin in neonate, TMP/SMX, nitrofurantoin)
  - observe with repeat VCUG, U/S, urine cultures
  - monitor renal function
    - Stage I-III: more than 80% resolve with time
    - Stage IV and greater: surgical intervention
- ❑ surgery rarely required

GENITAL ABNORMALITIES (see Urology Chapter)

Hypospadias
- ❑ 1:500 newborns
- ❑ urethral meatus opens on the ventral side of the penis, proximal to the glans
- ❑ may be associated with chordee (ventral curvature of penile shaft), undescended testicles, inguinal hernia
- ❑ if severe, distinguish from ambiguous genitalia, and rule out other GU abnormalities
- ❑ do not circumcise; foreskin used for surgical repair
- ❑ treatment: repair is often between 13-15 months of age

Epispadias
- ❑ urethral meatus opens on the dorsum of the penis, at point along the glans or shaft

Phimosis
- ❑ inability to retract prepuce by 3 years of age
- ❑ congenital or a consequence of inflammation
- ❑ application of steroid cream t.i.d. x 1 month may loosen phimotic ring
- ❑ if severe, requires circumcision or surgical enlargement of opening

Cryptorchidism
- ❑ arrested descent of testicles in natural path to scrotum
- ❑ common (30%) in premature, 3-4% of full term babies
- ❑ most descend by 3 months; no spontaneous descent after > 1 year old
- ❑ sequelae: trauma (inguinal testes), torsion, malignancy (40x risk), infertility
- ❑ differential: retractile, ectopic, atrophic testes, intersex state
- ❑ undescended testes: may palpate in inguinal canal but unable to milk down into scrotum
- ❑ retractile testes: parents may have seen them in scrotum, can milk them down with warm hands/warm room
- ❑ investigations
    - hCG stimulation to induce descent and to assess testicular function, serum testosterone, U/S, CT, surgical exploration, karyotype
- ❑ treatment: orchidopexy by 2 years of age

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