Neurological Examination of Infants and Children

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Outline
• History
• Development
• The neurological examination
• Examining the head
• Pearls on examining infants
• Pearls on examining the older child

Normal Neurologic Growth and Development
• In addition to the routine questions asked during a neurologic interview, what additional questions are important for a complete pediatric neurology history?
  – antenatal
  – perinatal
  – neonatal complications
  – neurodevelopment
  – immunizations
  – behavior
  – family history
  – social history

Normal Neurologic Growth and Development
• Antenatal
  – maternal parity
  – previous miscarriages or abortions
  – illnesses during the pregnancy
  – maternal nutrition and supplementation
    – weight gain, uterine size
  – medications taken during pregnancy
    – prescription
    – over-the-counter
    – illicit drug abuse
    – alcohol abuse
    – cigarette use
  – toxic exposure
    – occupational
    – industrial
    – agricultural
    – irradiation
  – accidents and trauma
  – travel abroad
  – fetal movements
  – premature labor contractions
  – vaginal spotting or bleeding
  – premature rupture of the membranes

Normal Neurologic Growth and Development
• Perinatal
  – spontaneous or induced labor
  – duration of labor
  – fetal monitoring during labor
  – type of delivery
    – vertex
    – breech
    – forceps or vacuum assisted
    – failure to progress
    – fetal distress
  – type of anesthesia, if any
    – local
    – spinal
    – epidural
    – general
  – estimated gestational age at time of delivery
  – infant’s appearance at birth and need for resuscitation–Agar score if recalled
  – birth weight, length, frontooccipital circumference (FOC)

Normal Neurologic Growth and Development
• Neonatal complications
  – jaundice
  – temperature
  – breathing
  – feeding:
    – breast
    – bottle
    – tube
  – how long in hospital until released home
• Neurodevelopment
  – progressing or regressing
  – development of handedness

Normal Neurologic Growth and Development
• Attainment of major milestones
• Academic performance in school
• Immunizations
  – diphtheria–pertussis–tetanus
  – measles–mumps–rubella
  – bacille calmette–Guerin
  – hemophilus influenzae type B
• Varicella
• Hepatitis
• Behavior
  – peer relations
  – interpersonal skills
  – conduct
Normal Neurologic Growth and Development

- Family history
  - consanguinity
- Social history
  - intrafamilial psychosocial stressors
  - pets

Primitive Reflexes

<table>
<thead>
<tr>
<th>Reflex</th>
<th>Description</th>
<th>Appears (gestational age)</th>
<th>Disappears (age)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tonic neck</td>
<td>Turn head, ipsilateral arm and leg extension and contralateral arm and leg flexion</td>
<td>34 wk</td>
<td>6 mo</td>
</tr>
<tr>
<td>Landau</td>
<td>With ventral suspension, head, trunk, and hips should extend, legs should flex at knees</td>
<td>3 mo after birth</td>
<td>24 mo</td>
</tr>
<tr>
<td>Placing</td>
<td>When dorsal foot is brushed by bed/table, the knee should flex and foot lift as if to step</td>
<td>35 wk</td>
<td>6 wk</td>
</tr>
<tr>
<td>Parachute</td>
<td>In prone position baby is suddenly thrust to the floor, arms extend and adduct, fingers spread as if to break the fall</td>
<td>9 mo after birth</td>
<td>Persists</td>
</tr>
<tr>
<td>Babinski</td>
<td>Great toe dorsiflexes when lateral aspect of foot is stroked</td>
<td>Birth</td>
<td>10 mo</td>
</tr>
</tbody>
</table>

Age and Reflexes

0-28 weeks

<table>
<thead>
<tr>
<th>Age</th>
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</thead>
<tbody>
<tr>
<td>0-4 weeks</td>
<td>Flexed posture; Brief visual fixation and following; Preference for human face; Active Moro, stepping, placing, grasping, rooting</td>
</tr>
<tr>
<td>4 weeks</td>
<td>Legs extended; Tonic neck posture when supine; Following moving objects</td>
</tr>
<tr>
<td>8 weeks</td>
<td>Head level with ventral suspension; Tonic neck posture; Follows through 180 degrees; Social smile, coos, listens</td>
</tr>
<tr>
<td>12 weeks</td>
<td>Lifts head and chest off bed; Head above horizontal with ventral suspension; Listens to music</td>
</tr>
<tr>
<td>16 weeks</td>
<td>Symmetric posture; Reaches and grasps for objects; Hands in midline</td>
</tr>
<tr>
<td>28 weeks</td>
<td>Rolls over, sits briefly; Transfers objects hand to hand; Babbles, enjoys mirror</td>
</tr>
</tbody>
</table>

40 weeks – 2 years

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<th>Reflex</th>
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<tr>
<td>40 weeks</td>
<td>Pulls to stand; Crawls, pincer grasp; &quot;Mama&quot;, &quot;Dada&quot;; Peek-a-boo, pat-a-cake</td>
</tr>
<tr>
<td>12 months</td>
<td>Cruises or walks with one hand held; 2 or 3 single words</td>
</tr>
<tr>
<td>15 months</td>
<td>Walks independently; Tower of 2 cubes, Makes line with crayon; 2 word sentences</td>
</tr>
<tr>
<td>18 months</td>
<td>Runs, walks up stairs with one hand held; Explores drawers, wastebaskets; Tower of 3 cubes; 10 single words, names pictures; Identifies 1 or 2 body parts; Feeds self with fingers</td>
</tr>
<tr>
<td>2 years</td>
<td>Runs well, walks up and down stairs alone; Tower of 6 cubes; Imitates horizontal strokes on paper; 3-word sentences; Holds spoon well</td>
</tr>
</tbody>
</table>

3-5 years

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<tr>
<td>3 years</td>
<td>Walks up stairs alternating feet; Rides tricycle; Stands momentarily on one foot; Tower of 9 cubes and bridge of cubes; Knows name and sex; Counts 3 objects; Parallel play and washes hand</td>
</tr>
<tr>
<td>4 years</td>
<td>Hops on one foot; Throws ball overhand; Uses scissors; Copies cross and square on paper; Draws man with 2-4 parts; Counts 4 pennies accurately; Role playing; Goes to toilet alone</td>
</tr>
<tr>
<td>5 years</td>
<td>Skips; Copies triangle, names four colors; Counts 10 pennies; Dresses and undresses self</td>
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Age and Reflexes

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General Principles of the Neurological Exam: Neurologic diagnosis

- Neurologic diagnosis:
  - based almost completely on history
  - remainder is based on physical examination and additional testing

General Principles of the Neurological Exam: Assessment

- Assessment:
  - clear formulation of the problem that needs to be addressed
  - parts of the nervous system involved:
    - brain, spinal cord, peripheral nerves, neuromuscular system
  - onset and time course of the process:
    - acute and progressive
    - intermittent
    - chronic and static
    - chronic and progressive
  - need for urgency vs. specificity of intervention

General Principles of the Neurological Exam: Differential Diagnosis

- Differential diagnosis:
  - trauma
  - tumor
  - infection
  - intoxication
  - epilepsy
  - endocrine abnormality
  - demyelination
  - developmental dysgenesis
  - inflammatory/immune, vascular, psychogenic, metabolic, degenerative processes

General Principles of the Neurological Exam: Neurologic Emergencies

- Neurologic emergencies

Neurologic Examination: General Physical

- General Physical Examination:
  - note clues to:
    - genetic syndromes or malformations, especially:
      - head circumference
      - skull deformities
      - craniofacial dysmorphic features
      - ocular anomalies
      - malformation of the spine
      - neurocutaneous lesions
    - systemic signs of infection or other organ disease
    - signs of large molecular storage disease such as:
      - visceromegaly
      - corneal opacities
      - dysostosis multiplex
Neurologic Examination:
Mental Status

- Mental Status:
  - alertness
  - attention
  - behavior
  - language
  - orientation
  - memory
  - abstraction
  - judgment

Neurologic Examination:
Cranial Nerves

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<th>Function/region</th>
<th>Cranial nerve</th>
<th>Test/observation</th>
</tr>
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<tbody>
<tr>
<td>Eye movements</td>
<td>III, IV, VI</td>
<td>Range and quality of eye movements and eyelids saccades, pursuits, nystagmus, ptosis</td>
</tr>
<tr>
<td>Sensation</td>
<td>V</td>
<td>Corneal reflexes, facial sensation</td>
</tr>
<tr>
<td>Muscles of mastication</td>
<td>V</td>
<td>Clench teeth</td>
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<td>Facial strength</td>
<td>VII</td>
<td>Observe degree of expression of emotions, eye or lip closure strength</td>
</tr>
<tr>
<td>Hearing</td>
<td>VIII</td>
<td>Localize voice, attend to finger rub</td>
</tr>
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Neurologic Examination:
Motor: Muscle Bulk and Tone

- Motor:
  - Must evaluate relative to developmental norms, quality and functionality of movement
    - muscle bulk
    - tone: high, normal, low
      - axial tone:
        » observe posture while patient is supine, sitting, and standing and during vertical and horizontal suspension (infants)
Neurologic Examination:
Motor: Muscle Bulk and Tone

- limb tone:
  » assess resting posture and resistance to passive range of motion
  » note anatomic distribution of abnormalities, quality (rigid, spastic, cogwheel), and variability with voluntary activity and sleep
  » tone varies with wakefulness and voluntary purposeful movement

Neurologic Examination:
Motor: Strength

- Strength:
  – observe and describe activity such as rising from the floor
  – quantify
  • distance of broad jump
  • time to run 30 feet
  • time to climb stairs
  • 0/5: no movement
  • 1/5: palpable tightening only
  • 2/5: full range of movement in a gravity-neutral plane
  • 3/5: full range of movement against gravity, but not resistance
  • 4/5: subnormal strength (against resistance)
  • 5/5: normal strength (against resistance)

Neurologic Examination:
Movement Quality and Functionality

- Movement quality and functionality:
  – assess spontaneity, speed, accuracy, and smoothness of purposeful tasks, all relative to developmental norms
  – pyramidal tract dysfunction may occur with only subtle degrees of weakness:
    • diminished spontaneous movement
    • slowing of fine repetitive movements (finger tapping)
    • lack of postural persistence
    • loss of complex sequences of movement (writing, self-feeding)
  – note posture and mobility skills relative to developmental norms
  – note involuntary movements:
    • tremor
    • dystonia
    • chorea
    • athetosis
    • tics
    • myoclonus

Neurologic Examination:
Deep Tendon Reflexes

- Deep Tendon Reflexes:
  – most helpful in localizing other abnormalities
    • especially in the presence of weakness or asymmetry
  – Isolated abnormalities of reflexes, in the setting of normal strength and coordination, have little significance
  – Combined with weakness, brisk reflexes indicate upper motor neuron disorder
  – Absent reflexes reflect lower motor neuron or neuromuscular junction disorder

» least resistance to passive movement
» stiffness with active skills
» regional increases in tone suggesting cortical dysfunction: adducted thumbs, limited hand supination, equinus of feet
Neurologic Examination: Deep Tendon Reflexes

– In muscle disease, reflexes may be diminished but are usually detectable
– Selective reflex drop-out can help localize a spinal cord or root lesion

Neurologic Examination: Sensory

• Sensory:
  – primary disorders of sensation are rare in children, but the following tests may be useful in anatomic localization:
    • spinal cord dysfunction of discrete pathways
      • anterior cord:
        » pain and temperature sensation
      • posterior cord:
        » Romberg's test, vibratory and joint position sense

Neurologic Examination: Sensory

• transverse spinal cord dysfunction:
  • especially of concern if abnormal bowel or bladder function
  • use pinprick to identify level of impairment
• syringomyelia:
  • evaluate for decreased pain or temperature sensitivity bilaterally, with preserved proprioception at the level of the syrinx and preserved function below

Neurologic Examination: Sensory

• polyneuropathy:
  • look for proximal > distal gradient of loss of sensations, especially vibratory, pinprick
• mononeuropathies:
  • pinprick to localize area of anesthesia to territories of specific peripheral nerves

Neurologic Examination: Coordination

• Coordination:
  – evaluate general coordination while watching activities such as throwing a ball, dressing, playing video games
  – test rapid alternation and repetitive movements
    • finger to nose
    • heel to shin
    • walking and running

Examination of the Head

• Observation, palpation, measurement, auscultation, percussion, and transillumination should be included
• In the newborn, some degree of head molding is generally evident, and the sutures may be overriding or diastatic
  – infants born by elective cesarean section or breech presentation show no evidence of molding
  – molding resolves in the first few weeks of life
Examination of the Head

- Caput succedaneum
  - edema of the scalp
- Cephalohematoma
  - hemorrhage under the periosteum

Measurement of the Head

- Shape of the head may reveal clues to underlying processes.
- Size of the head is of particular importance in infants, since this is a reflection of intracranial contents.
- The measurement of head size used in clinical medicine is the occipital-frontal circumference.
- Record the largest reproducible measurement.
- Serial measurements are best, since they afford information on the rate of head growth as well as the head circumference at a particular time.

Frontal Occipital Circumference

- What is the average FOC for a term newborn?
  - Varies closely around 35 cm
- What is the rate of growth over the first year?
  - Average FOC growth:
    - 2 cm / month for first 3 months
    - 1 cm / month for next 3 months
    - 0.5 cm / month for the last 6 months

Pearls in the Examination of Infants

- Careful observation, undisturbed and at play
- Phenotypic appearance
- Symmetry or asymmetry of spontaneous movements
- Seizure activity
- Responsiveness
### Pearls in the Examination of Infants

- Careful general physical examination
  - examples of relevant findings include:
    - abdominal mass in an infant with proptosis suggests metastatic neuroblastoma
    - acute hemiplegia in an infant with cyanotic congenital heart disease suggests an intracranial vascular occlusion
    - acute hemiplegia in an older child more likely a brain abscess
    - congestive heart failure in an infant with macrocrania, a large intracranial arteriovenous malformation

### Pearls in the Examination of Older Children

- Have the child's parents in the room
- Keep several toys at hand
- Simple gait evaluation through observation
- Coordination can be tested during play
- Strength can be tested by having the child pull or push, climb or stand
- Test reflexes indirectly
- Sensation, particularly pain, should be left until last
- Do ophthalmoscopic testing early

### Other Observations in the Examination of Infants

- For the newborn much of the day is spent sleeping
- When awake, the neonate may stare but does not follow with the eyes
- The nature of the infant's cry can give hints of possible intracranial disease
- Drowsiness or irritability may be early evidence of intracranial disease

### Other Observations in the Examination of Older Children

- Cognitive and office neuropsychological testing may include:
  - spontaneous motor activity
  - praxis (verbal commands and imitation)
  - lateral dominance or preference
  - drawing
  - articulation of sounds
  - language
  - auditory discrimination and memory
  - reading and spelling
  - calculation
  - corporeal orientation
  - extracorporeal space orientation
  - These are an important adjunct to examination and complete testing is usually administered by clinical psychologists

### Other Observations in the Examination of Infants

- The older infant exhibits more awareness of the environs
  - They may be tested by observing responses to simple objects such as a key ring, rattle, block, ball, mirror, etc.
- Complete examination of social, adaptive, and language functions at one sitting is often impossible
  - Allowances must be made for circumstances such as fatigue, hunger, and intercurrent illness, which may modify the patient's responses
Outline

• History
• Development
• The neurological examination
• Examining the head
• Pearls on examining infants
• Pearls on examining the older child
• Try to have fun with the children and their families