GUIDELINES FOR BASIC PAEDIATRIC NEUROLOGICAL OBSERVATION

Neurosurgery Education and Outreach Network (NEON)

Version 1.0 | Critical Care Services Ontario | May 2016

CCSO Critical Care Services Ontario

This document is a product of Critical Care Services Ontario (CCSO)

The Guidelines for Basic Paediatric Neurological Observation are the result of a collaborative effort between CCSO, the Neurosurgery Education and Outreach Network (NEON) and Provincial Neurosurgery Ontario. CCSO supports system-wide improvements for Ontario's neurosurgical services through education and outreach across neurosurgical and non-neurosurgical centres. Aligned with the work of Provincial Neurosurgery Ontario, the goal of the guideline is to increase the knowledge and expertise of Ontario's nurses to support equitable and timely access to neurosurgical care and to help maintain the province's neurosurgical capacity.

These Guidelines are for the paediatric patient population. Adult guidelines are available by asking your designated neurosurgical educator and/or outreach representatives. They can also be accessed via the CCSO Website at www.criticalcareontario.ca.

How to Use This Document

This document provides direction for bedside neurological observation protocols for paediatric patients to ensure consistency within and across organizations. It was developed by a sub-group of clinical neurosurgical nurses and neurosurgical educators for Registered Nurses (RN) across Ontario that assesses patients' neurological status. These Guidelines are not meant to be exhaustive and its contents are recommended but not mandated for use. The Guidelines have been reviewed and approved by the Provincial Neurosurgery Ontario stakeholder board. RNs should use their clinical judgment and utilize other assessment parameters if determined necessary.

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Disclaimer: *The contents of these guidelines may change over time. Clinicians and hospital administrators should use sound judgment for individual patient encounters. Critical Care Services Ontario and Provincial Neurosurgery Ontario strongly recommend evidence-based practices.*

Acknowledgements

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*Please see **Appendix 5** for a list of the Neurosurgery Education and Outreach Network membership*

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Guidelines for Basic Paediatric Neurological Observation
Critical Care Services Ontario | May 2016

Introduction

In 2011, the Ministry of Health and Long Term Care committed 66 new nursing positions, including 22 Clinical Neurosurgical Outreach Nurse and Neurosurgical Nurse Educator positions, to support the management of specialized paediatric and adult neurosurgical patients.

The Neurosurgery Education and Outreach Network (NEON) was established in May 2013 to work in collaboration with Provincial Neurosurgery Ontario to support the educational component of recommendations to better integrate access to neurosurgical services in the province. Originally comprised of Nurse Educators and Program Directors from each of the province's adult neurosurgical centres, their work formed the foundation for an educational outreach program designed to provide a wide breadth of education to non-neurosurgical centres on neurosurgical patient's care across the continuum. The expanded network has grown to include Clinical Nurse Specialists, Advanced Practice Nurses and Nurse Practitioner's working in both adult and paediatric neurosurgery.

In parallel, the Ministry requested Critical Care Services Ontario (CCSO) to lead a planning process to develop a comprehensive neurosurgical system to meet the needs of adult and paediatric patients across Ontario. The advisory committee was co-chaired by Dr. Robert Bell, then President and CEO, University Health Network and Dr. James T. Rutka, Chair, Department of Surgery, University of Toronto. Their efforts resulted in a final report (December 2011) which outlined recommendations aimed at improving the access, quality and responsiveness of neurosurgical care. These recommendations are being implemented by the Provincial Neurosurgery Ontario committee supported by Critical Care Services Ontario (www.criticalcareontario.ca).

About this Document

These Guidelines were developed by the Neurosurgery Education and Outreach Network in order to document the processes associated with basic paediatric neurological assessments. The Guidelines provide direction for local development of bedside neurological observation protocols, in order to enhance existing skills and to ensure consistency of paediatric neurological assessment within and across different organizations. It is intended to enhance and build on current knowledge and skills. For the individual patient, this provides a baseline from which changes in the patient's neurological status may be identified, reported, and managed in a timely manner.

Neurological observation in the paediatric patient may be challenging as it is influenced by age and developmental stage spanning from birth to eighteen years. It is recorded to determine changes, both deterioration and improvement, in the neurological condition of a paediatric patient.

Neurological observation should be conducted on paediatric patients with an altered level of consciousness or those at risk.

The paediatric patient's neurological status is assessed according to and documented in a neurological observation record or an equivalent patient care record, providing a concise and accurate record of the assessment. (**Appendix 2:** Paediatric Neurological Observation Record).

The frequency of neurological assessments depends on the severity of the patient's illness and underlying condition and can range from every 15 minutes to every four to eight hours. The RN should use clinical judgment to determine the need for an increase in the frequency of neurological observations and whether observations should be expanded to include other assessment parameters. A MRP (most responsible provider) order is not necessary for the RN to increase the frequency of neurological assessments, which are within their scope of practice.

The main focus of the paediatric exam includes the completion of age-appropriate Glasgow Coma Scale and assessment of the intracranial pressure (ICP).

Definitions

Aniscoria

A condition characterized by unequal pupil size. This normal variation affects approximately 20% of the population.

Anterior Fontanel

Diamond-shaped membrane filled space located between the frontal and two parietal bones where the sagittal, metopic and coronal sutures conjoin. This is also commonly referred to as the 'soft spot' in infants and toddlers. There is variability as to when the anterior fontanel closes. Closure of the fontanel is influenced by brain growth, dural attachment, suture development and osteogenesis. The majority of anterior fontanels close by 18-24 months of age.

Consensual Constriction

Light shone in one eye, causes the opposite pupil to constrict.

Direct Constriction

Light shone in one eye causes the same pupil to constrict; light should move from the outer aspect of the eye, inward towards the pupil. This is a direct test of Cranial nerve III.

Fontanel

A fontanel is an anatomical feature of the infant skull whereby soft membranes cover the cranial bones. The two fontanels (anterior and posterior), fuse and close at various chronological ages, Generally the posterior fontanel closes by 8 weeks of age, whereas the anterior closes by 18-24 months of age.

Glasgow Coma Scale

The GCS is an adult assessment scale developed by Teasdale & Jennett (1974), which provides a standardized measure of the patient's level of consciousness by observing the patient's behaviour in response to a gradually increasing stimulus. This stimulus ranges from a less invasive stimulus (i.e. speaking to the child/patient), to the application of a painful stimulus (i.e. supraorbital pressure) in order to obtain a behavioural response. The scale contains three subscales: best eye opening response, best verbal response and best motor response. It has a collective maximum score of 15 indicating a fully alert and oriented child/person, and a minimum score of 3 indicating a comatose child/person. The GCS tools offered as reference have been modified to include the infant-child population.

Head Circumference

Refers to a measurement of an infant/child's head around the largest area, measuring above the eyebrows and ears around to the back of the head.

Intracranial Pressure (ICP)

Intracranial pressure (ICP) is the pressure exerted by the cerebrospinal fluid within the ventricle of the brain. It fluctuates as it responds to arterial pulsation and the respiratory cycle. Normal ICP pressure is between 0mm to 15 mm HG. Activities such as coughing, sneezing and straining (Valsalva maneuver) result in transient increases in ICP. Basic understanding of the pathophysiology related to intracranial pressure is the Monroe-Kellie hypothesis. This hypothesis states that the skull is a rigid compartment filled to capacity with brain, blood and CSF. The volume of these three components remains nearly constant. ICP changes can be reflective of a change in this dynamic.

Level of Consciousness

The measurement of an infant/child's level of awareness and arousal and their ability to respond to environment stimuli.

Most Responsible Physician/Provider

The provider who has primary responsibility and accountability for the care of a patient within the hospital.

Painful Stimuli

In the absence of any spontaneous movements assessing the patient's paediatric neurological status may include applying either a peripheral painful stimuli to elicit eye opening or central painful stimuli in order to elicit a motor response. When applying a painful stimulus, a nurse may use any of the techniques described under procedures on page 19 of this guide.

Pupillary Response

A test of the function of cranial nerve II & III. Changes in the pupil size, equality and/or reaction may be an indicator of changes in intracranial dynamics. This could be caused by a number of neurological and metabolic conditions, such as increased intracranial pressure (ICP), brainstem damage, anoxia, ischemia or oculomotor nerve compression.

Sun-setting

Eyes appear to be looking downwards as a result of compression of the vertical gaze center. Compression results in upwards gaze paresis. Please review sun-setting picture on page 14 of this guide.

Vital Signs

Vital signs include respiratory rate and pattern, oxygen saturation, heart rate, blood pressure, and temperature. Changes in vital signs in the paediatric patient with neurological problems may be an indicator of neurological deterioration, in particular for patients with brainstem pathology, increased ICP or pain.

Overview of the Guidelines for Basic Paediatric Neurological Observation and Assessment

This document provides direction to complete a basic paediatric neurological observation and assessment in the acute care setting. The key components include assessing:

- Level of Consciousness (LOC) using the modified Paediatric Glasgow Coma Scale (GCS)
- Intracranial Pressure
- Pupillary Response
- Limb Movement/Strength
- Vital Signs

When assessing a paediatric patient it is important to consider the following:

- Careful observation of the child
- Obtaining a thorough developmental history
- Knowledge of developmental norms/milestones (Table 1)
- Knowledge of primitive reflexes in newborns and infants (Table 2)
- Ability to adapt the assessment process as required

Basic Paediatric Pearls to help with your assessment:

- Always speak with parent/caregivers for information regarding the best verbal and motor responses.
- The guidelines are suggested and are based on chronological age. Special considerations are required for premature infants or children with developmental delay. The child's neurological and developmental baseline should be confirmed with the infant or child's parents or caregiver.
- Changes in vital signs related to neurological deterioration are often a late sign of deterioration.
- Changes to pupils, LOC, and motor strength/symmetry are typically observed first highlighting the importance of using the Glasgow Coma Scale as part of the first line neurological observation.

Table 1: Developmental Milestones

Age	Milestones
2 months	Follows objects with eyes, coos, lifts head from prone, smiles responsively
4 months	Hands open, brings objects to mouth, laughs, turns toward voice, sits supported with head control, rolls to supine
6 months	Palmer grasp, babbles, sits independently, stands with hands held, reaches for toys
9 months	Pincer grasp, says mama/dada nonspecifically, pulls to stand, feeds self, waves bye-bye
12 months	2-4 words, stands independently, walks with one hand held, points to indicate wants
15 months	Scribbles, 4-6 words, walks independently, drinks from a cup, imitates
18 months	Turns pages of a book, 10-20 words, walks up steps, points to 4 body parts, feeds self with a spoon
2 years	Solves single piece puzzles, combines 2-3 words, jumps, kicks a ball, removes coat, verbalizes wants
2 ½ years	Imitates horizontal and vertical lines, names all body parts, rides trike, pulls up pants, washes and dries hands
3 years	Copies circle, names 2 colours, gives full name and age, throws ball overhand, walks upstairs alternating feet, toilet trained, puts on shirt
3 ½ years	Copies cross, stands on one foot for 2-3 seconds, associative play
4 years	Counts 4 objects, identifies some numbers and letters, understands prepositions, hops on one foot, dresses with little assistance
4 ½ years	Copies square, understands opposites, broad jumps 24 inches, bosses and criticizes, shows off
5 years	Prints first name, counts 10 objects, asks meaning of words, skips, ties shoes

Table 2: Primitive Reflexes

Reflex	Method	Response	Age
Palmar grasp	Place index finger in the palm of the infant	Grasps examiner's finger	Birth to 2 months
Rooting	Lightly stroke the cheek at the side of the mouth	Turns head towards stimulus and opens mouth	Birth to 3 months
Placing	The bottom of the foot is placed on the edge of the exam table	Flexes the legs at the hips and knees causing lifting of the foot	Birth to 6 weeks
Stepping	Hold infant up and place feet on exam table	Automatic quick stepping/ walking movement	Birth to 4 months
Moro	In supine position, lift head up then rapidly allow it to drop back 30° below level of trunk	Symmetrical abduction and flexion of the upper extremities	Birth to 6 months
Babinski	Stimulate the lateral aspect of the sole, moving from heel to ball of foot	Flexion of great toe and fanning of other toes	Birth to 2 years
Tonic neck	Rotate the infants head to one side for 15 seconds	Extension of arm on the chin side and flexion on the occipital side (fencing posture)	2-6 months
Landau	Hold infant in prone horizontal position and flex head down	Flexion of legs and trunk	3-24 months
Parachute	Hold infant in prone position and thrust towards exam table	Extension and abduction of arms and extension of wrists so that hands are placed on table and support the child's weight	Begins at 7 months

(Navigating Neuroscience Nursing: A Canadian Perspective 2012-Chapter 2)

Assessing Level of Consciousness

The Glasgow Coma Scale is used to determine the level of consciousness in both children and adults. It assesses the patients' ability to provide three activities:

1. Eye opening
2. Motor response
3. Verbal response

Each activity is given a score. The scores are added together giving a range from 3- 15. In children less than 5 years of age adaptations are necessary and an adapted Paediatric Glasgow Coma Scale is commonly used. The scores are summarized as follows:

Paediatric Glasgow Coma Scale

Eye-Opening Response		
Score	**> 1 Year**	**< 1 Year**
4	Spontaneous	Spontaneous
3	To verbal command	To shout
2	To pain	To pain
1	None	None

Motor Response		
Score	**> 1 Year**	**< 1 Year**
6	Obeys commands	Displays spontaneous response
5	Localizes pain	Localizes pain
4	Withdraws from pain	Withdraws from pain
3	Displays abnormal flexion to pain (decorticate rigidity)	Displays abnormal flexion to pain (decorticate rigidity)
2	Displays abnormal extension to pain (decerebrate rigidity)	Displays abnormal extension to pain |(decerebrate rigidity)
1	None	None

Verbal Response			
Score	**> 5 Years**	**2–5 Years**	**0–23 Months**
5	Is oriented and converses	Uses appropriate words and phrases	Babbles, coos appropriately
4	Conversation is confused	Uses inappropriate words	Cries, but is consolable
3	Words are inappropriate	Cries or screams persistently to pain	Cries or screams persistently to pain
2	Sounds are incomprehensible	Grunts or moans to pain	Grunts or moans to pain
2	Sounds are incomprehensible	Grunts or moans to pain	Grunts or moans to pain
1	None	None	None

Modified Paediatric Glasgow Coma Scale

	Eyes Opening		Best Motor Response		Best Verbal Response		
	>1 year	**< 1Year**	**>1 year**	**< 1Year**	**>5 years**	**2-5 years**	**0-23 months**
6	---	---	Obeys	Displays spontaneous response	---	---	---
5	---	---	Localizes to pain	Localizes to pain	Oriented and converses	Appropriate words/ phrases	Smiles/coos/ cries appropriately
4	Spontaneously	Spontaneously	Flexion-Withdrawal	Flexion-Withdrawal	Disoriented and converses	Inappropriate words	Cries
3	To verbal command	To shout	Flexion-Abnormal (decorticate rigidity)	Flexion-Abnormal (decorticate rigidity)	Inappropriate words	Cries and or screams	Inappropriate crying and/or screaming
2	To pain	To pain	Extension (decerebrate rigidity)	Extension (decerebrate rigidity)	Incomprehensible words	Grunts	Grunts
1	No response	No response	No response	No response	No response	No response	No response

GCS reference: Modified from Teasdale G, Jennett B 1974- American Academy of Pediatrics

Note: A score of 13+ indicates a mild brain injury, 9-12 indicates a moderate brain injury and 8-3 indicates a severe brain injury.

Documentation Pearl

- If you are unable to complete a component of the GCS as a result of paralysis, sedation, language barrier, hearing impairment, etc. ensure to document your findings in your nursing/inter-professional notes.
- If eyes are swollen shut score 1C (eye opening).
- If one eye is closed/swollen, document the response from the functioning eye.
- In the presence of an ETT or tracheostomy, score 1T (best verbal command).

When assessing level of consciousness in Paediatric patients it is important to:

- Speak to parents/caregivers for information regarding the best verbal and motor responses.
- Use age appropriate parameters specific to infants and children less than 5 years of age.
- Understand that special considerations are required for premature infants or children with developmental delays.
- Confirm child's developmental baseline with parents/caregivers.

Scores for Best Eye Opening Response:

Score 4 - patients eyes open spontaneously with no prompting.
Score 3 - patient opens eyes to verbal command or shouting
-speak in a normal voice initially and then in a louder voice as needed
- consider hearing impairments/medications/sedation
Score 2 - patient opens eyes to pain
Score 1 - no response

Scores for Best Motor Response:

- Best arm response should be documented, and all limbs should be unrestrained
- Avoid asking the child 'to squeeze your fingers', or 'open your eyes'

Score 6: Obeys commands i.e. 'show me your thumb or two fingers'

- Infant 0-23 months- moves spontaneously and purposely
- Toddler 2-5 years- obeys commands
- Child >5 years- obeys commands

Score 5: Localizes to pain, patients purposely moves toward the source to remove painful stimuli (see section on painful stimuli)

- Infant 0-23 months- withdraws to touch
- Toddler 2-5 years- localizes to pain
- Child >5 years- localizes to pain

Score 4: Flexion withdrawal, patient flexes away from painful stimuli with no attempt to withdraw from painful stimuli

- Infant 0-23 months- withdraws to central pain
- Toddler 2-5 years- flexes in response to pain, not localizing
- Child >5 years- flexion withdrawal localizing to pain but unable to remove source

Score 3: Abnormal flexion to pain involves shoulder adduction and wrist flexion making a fist

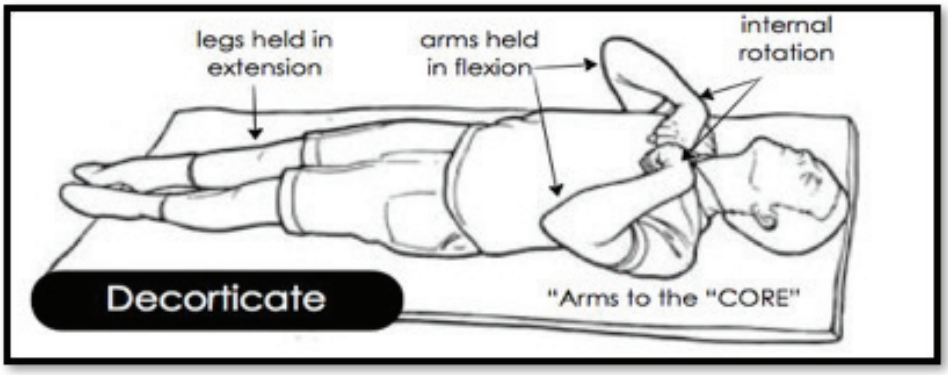
- Infant 0-23 months- abnormal flexion (decorticate posturing)
- Toddler 2-5 years- abnormal flexion to pain (decorticate posturing)
- Child >5 years- abnormal flexion to pain (decorticate posturing)

Score 2: Abnormal extension to pain involves extending the limb at the elbow adduction of the shoulder flexion of the wrist while fingers either make a fist or extend

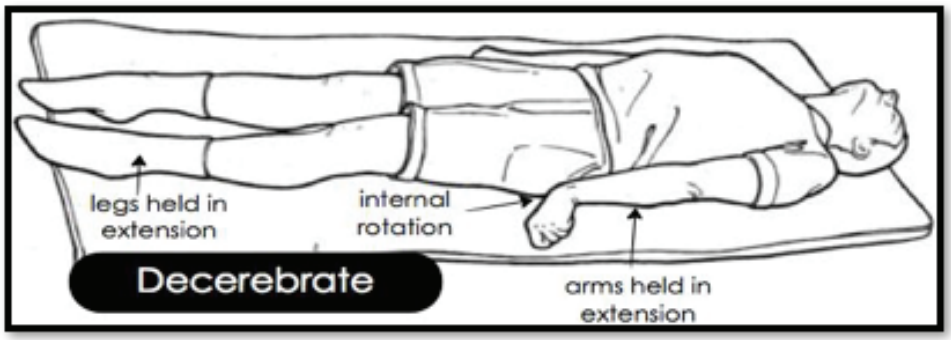
- Infant 0-23 months- abnormal extension to pain (decerebrate posturing)
- Toddler 2-5 years- abnormal extension to pain (decerebrate posturing)
- Child >5 years- abnormal extension to pain (decerebrate posturing)

Score 1: No response

Abnormal Flexion to Pain (Decorticate Posturing)



Extension to Pain (Decerebrate Posturing)
(CueFlash, 2011)



Scores for Best Verbal Response:

Score 5: Patient is oriented to person, place, and time

- Infant 0-23 months- smiles and coos with interaction
- Toddler 2-5 years- appropriate words and phrases
- Child >5 years- oriented to person, place and time

Score 4: patient is confused

- Infant 0-23 months-cries and inconsolable
- Toddler 2-5 years- inappropriate words
- Child >5 years- disoriented and converses

Score 3: Inappropriate words, not contextual

- Infant 0-23months- persistent inappropriate crying and/or high pitched cry
- Toddler 2-5 years- persistent crying and/or screaming
- Child>5 years- inappropriate words

Score 2: Incomprehensible sounds, does not articulate words

- Infant 0-23 months- grunts, agitated, restless
- Toddler 2-5 years- grunts
- Child>5 years- incomprehensible sounds

Score 1: No verbal response to any stimuli

Painful Stimuli

When assessing the patient's level of consciousness, sound and pain stimuli are used. When using any stimuli start with a minimal amount, increasing to elicit a response. Auditory stimulus should be used first to evaluate a patient's level of consciousness. A painful stimulus is used for unconscious patients or patients with a decreasing level of consciousness.

Withdrawal from pain is considered a noteworthy finding in the unconscious patient. Response to the stimuli is either (i) purposeful, (ii) non purposeful or (iii) unresponsive.

A purposeful response is one in which the patient pushes away the examiner, winces and withdraws the affected body part away from the stimulus. In a non-purposeful response the patient is not able to remove the stimulus or move away from the stimulus. An unresponsive patient does not respond at all to the stimulus.

Techniques to Elicit a Pain Response

Peripheral Pain Response

Interphalangeal joint pressure:

- Apply pressure with a pen/pencil to the lateral outer aspect of the proximal or distal interphalangeal joint (lateral aspect of the patient's finger or toe). Apply the painful stimulus for 10 to15 seconds to elicit a response. Document the response.

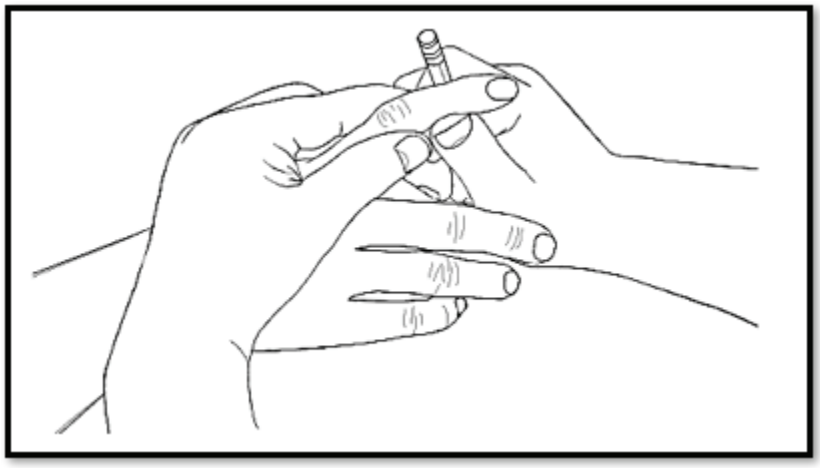


Image Courtesy of Sunnybrook Health Sciences Centre

Caution! A peripheral painful stimulus may elicit a spinal reflex, causing flexion of tested limb. A spinal reflex is not an indication of intact brain function.

Central Pain response

Sternal Rub:

- Commonly used as a central stimulus in paediatrics. A single-fisted hand is used with the knuckles lightly applied to the infant/child's sternum. Pressure should be maintained for 15 seconds.

Trapezius twist:

- Using the thumb and two fingers as pincers, feel for the mass of the trapezius muscle located at the angle where the neck and the shoulder meet. Take hold of about two inches of muscle and twist. Apply gradually increasing pressure for 10 to 20 seconds to elicit a response. Document the response.

Note: High level spinal cord injuries may interfere with assessment using Trapezius twist. This test should not be utilized on un-cleared cervical spines.

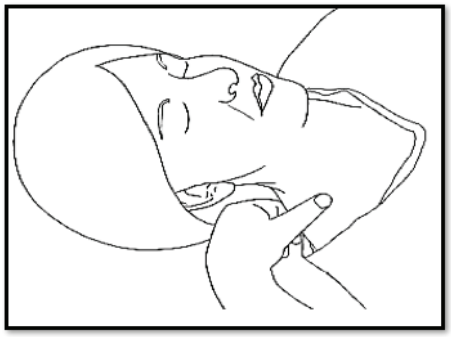


Image Courtesy of Sunnybrook Health Sciences Centre

Supra-orbital pressure:

- Place the flat of the thumb on the supra-orbital ridge (small notch below the inner part of eyebrow) while the hand rests on the head of the patient. Apply gradually increasing pressure for 10 to 20 seconds to elicit a response. Document the response.

Note: Supra-orbital pressure is NOT to be used with facial trauma including orbital, skull or facial fractures, frontal craniotomies.

Image Courtesy of Sunnybrook Health Sciences Centre

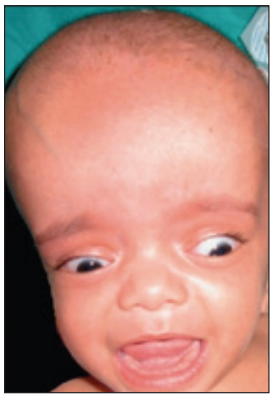
RED FLAG: If a painful stimulus is required to arouse the child, this may be an indicator of the neurological emergency and requires immediate assessment by the MRP.

Assessment of Intracranial Pressure

Intracranial pressure is based upon on clinical symptoms and exam. The signs of ICP vary depending on the age of the child. The anterior fontanel is primarily used for the assessment of ICP for infants less than 12 months of age.

Signs and Symptoms of Increased Intracranial Pressure

For infants (0-12 months) and toddlers (1-3 yrs), signs of increased ICP may include:	**For older children, signs of increased ICP may include:**
• Macrocephaly 'Sun-setting eyes' Eyes that look downward and do not cross midline when assessing the vertical gaze. • Bulging and fullness of the anterior fontanel • Frontal bossing • Distended head veins • Increased sleepiness • Vomiting • Irritability • Not meeting Developmental milestones • Increasing Head Circumference	• Headache • Drowsiness • Irritability • Nausea and/or vomiting • Ataxia • A change in thinking or concentration • Poor performance at school • Not meeting developmental milestones or loosing milestones



Sun-setting Eyes
(Venkataramana, 2011)

Bulging Fontanel
(Beyond Achondroplasia, 2013)

Frontal Bossing
(US Federal Government, 2008)

Assessment of the Anterior Fontanel

1. The anterior fontanel is to be observed and palpated while the infant is in an upright position and in a quiet state. Examination of the fontanel varies depending on the infant's position and activity. If the infant's fontanel is examined when the infant is in a lying position or is crying, the fontanel normally bulges.

2. The anterior fontanel is assessed by running your fingers over the infant's skull where the frontal and parietal bones meet.

3. It is important to document on the size of the fontanel and whether the fontanel is soft, flat, full or bulging. The anterior fontanel should be soft and flat. The fontanel may also be found to be pulsatile and slightly sunken. It is abnormal for the fontanel to be full or bulging when the child is upright and quiet.

4. When assessing the fontanel it is important to comment on the sutures surrounding the fontanel. Splayed sutures with a full fontanel are indicative of increased intracranial pressure.

Note: For the infant, sun-setting can be an indication of increased ICP. Sun-setting is described as the eyes appearing to look only downward with the sclera prominent over the iris.

For an infant, the anterior fontanel and head circumference need to be monitored for signs of increased ICP. In infants, because the skull is not fused, an increasing head circumference and full fontanel are indicators of an issue relating to CSF absorption and/or production. The infants skull should also be assessed for distended veins and frontal bossing which are other clinical features associated with increased intracranial pressure in an infant.

Assessing Head Circumference

When a baby is first born their skull is malleable and not fused. Head circumference (HC) is measured and is indication of brain growth. Head circumference measurements are plotted on a HC chart and compared to previous measurements. Head circumference is measured with a measuring tape around the widest part of the child's skull. The head circumference measurement should be plotted on a head circumference growth chart and compared to previous measurements. (***Appendix 3:*** WHO Growth Chart).

Skull growth is an indication of brain growth and cerebral spinal fluid (CSF) dynamics. Therefore head circumference measurements that cross percentiles on a head circumference chart and a full fontanel are indications of **increased ICP** in an infant. The average head circumference at birth is 35 cm and head circumference increases one centimeter a month up until the age of 1 year.

Pearl: Changes in head circumference is one key sign for increased ICP in infants and children from 0-2years of age. In children older than 2 years of age, a head circumference should be done routinely as part of the neurological assessment but is not the primary indicator of increasing ICP.

Assessment of Pupils

- Assess pupil size, equality and reaction.
- Check pupils in ambient light prior to assessing reaction, in order to observe the size of the pupil. The size of the pupil adjusted to ambient light is the pupil size recorded.
- Since not every person has equal pupils, assess and document a baseline for each individual patient. This may be obtained by the parent/caregiver.
- Ensure that an accurate patient history has been taken, including eye/pupil abnormalities.
- Instruct the patient to look forward. If unconscious, RN to open patients eyes by lifting the eyelids looking for midline status.
- Use a concentrated light source (e.g., penlight/ophthalmoscope/otoscope/flashlight) in a dimly lit room (turn off ambient light to attain a response) and assess for:
    - Direct constriction: Move the light from the outer aspect of the eye inward toward the pupil. The pupil should constrict. Repeat for the other eye.
    - Consensual constriction: Shine the light into one pupil and observe the other pupil for constriction. Repeat for the other eye.

Examine each pupil in sequence for any constriction to direct and consensual illumination.
Record a "+" symbol if the pupil reacts, a "–"symbol if the pupil does not react.

RED FLAG: If pupils change from baseline or NO pupillary constriction is observed, this may indicate deterioration in a patient's condition. Follow up by increasing the frequency of monitoring, informing the MRP and/or calling the Rapid Response Team or equivalent as per organizational defined criteria.

Assessment of Limb Movement and Muscle Strength

Limb muscle strength is tested to observe for any sign of asymmetry between limbs, and may provide information about the possible anatomical location of any intracranial pathological process or dysfunction.

In a patient who obeys commands:

1. Assess the patient's ability to move limbs against gravity and resistance in response to a command.
2. Ensure accurate baseline history of limb movement and muscle strength is obtained from the parent/caregiver.
3. Assess and document each limb separately.
4. Observe for symmetry noting differences from side to side.
    - Arms: Assess for straight arm lift, elbow flexion and extension.
    - Legs: Assess for leg extension, plantar flexion and dorsiflexion.

In a patient who does not obey commands:

1. Assess and document symmetry and strength of each un-restrained limb movement based on assessment of motor function for GCS (i.e. by observing patient's spontaneous movements or patient's response to central pain).

Document the best response of each limb separately on the Paediatric Neurological Observation Record. A number of different motor strength scales are being used depending on organizational preference and the age of the patient. Below is a paediatric example of one such scale.

Documentation:

Grade	Description
5	Limb moves against full resistance.
4	Limb moves against moderate resistance, but strength is diminished.
3	Limb may move against minimal resistance or against gravity, e.g., if the patient lifts the arm off a surface and it immediately drops back.
2	Limb moves on a horizontal surface with the inability to lift against gravity.
1	Limb or muscle flickers.
0	No movement is observed.

Assessment of Vital Signs

Vital signs should be assessed routinely in a patient with a neurological diagnosis. Parameters for normal paediatric values are listed in the chart below.

Paediatric Vital Signs

Obtain and document vital signs as per the Neurological Observation Record or an equivalent patient care record.

Preterm Infants

Gestational Age	Heart Rate (beats/min)	Respiratory Rate (breaths/min)	Blood Pressure (mmHg)
24 weeks	100-180	40-60	25-55/15-35
28 weeks			30-60/18-38
32 weeks			35-65/22-40
36 weeks			40-75/25-45
40 weeks			45-80/33-52

0-18 Years

Age	Heart Rate (beats/min)	Respiratory Rate (breaths/min)	Blood Pressure (mmHg)
0-1 month	93-182	26-65	45-80/33-52
1-3 months	120-178	28-55	65-85/35-55
3-6 months	107-197	22-52	70-90/35-65
6-12 months	108-178	22-52	80-100/40-65
1-3 years	90-152	20-50	80-100/40-70
4-7 years	65-138	20-30	80-115/40-80
>8 years	62-130	14-26	85-145/45-90

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When assessing vital signs they need to be considered individually and in relationship to previous recordings.

- Changes in vital signs are typically late signs of increased intracranial pressure.
- Bradycardia can occur as a late sign of progressive increased intracranial pressure.
- Bradycardia, hypertension and bradypnea are called the Cushing Triad and indicate pressure on the medullary centre of the brain.

The respiratory rate is important because it provides early information about malfunction in a specific area of the brain. The respiratory system of the brain is made of neurons in the reticular substance of the medualla and pons. Injury or pressure to the respiratory systems will indicate injury or pressure on the brain stem.

Appendix 1: The Glasgow Coma Scale (GCS) (Modified for infants and children)

1. Assess the following three aspects of behaviour to determine level of consciousness and document the best response as outlined below
2. Record the best score possible in each of the categories

Modified Paediatric Glasgow Coma Scale

	Eyes Opening		Best Motor Response		Best Verbal Response		
	>1 year	< 1Year	>1 year	< 1Year	>5 years	2-5 years	0-23 months
6	---	---	Obeys	Displays spontaneous response	---	---	---
5	---	---	Localizes to pain	Localizes to pain	Oriented and converses	Appropriate words/ phrases	Smiles/coos/ cries appropriately
4	Spontaneously	Spontaneously	Flexion-Withdrawal	Flexion-Withdrawal	Disoriented and converses	Inappropriate words	Cries
3	To verbal command	To shout	Flexion-Abnormal (decorticate rigidity)	Flexion-Abnormal (decorticate rigidity)	Inappropriate words	Cries and or screams	Inappropriate crying and/or screaming
2	To pain	To pain	Extension (decerebrate rigidity)	Extension (decerebrate rigidity)	Incomprehensible words	Grunts	Grunts
1	No response	No response	No response	No response	No response	No response	No response

GCS reference: Modified from Teasdale G, Jennett B 1974- American Academy of Pediatrics

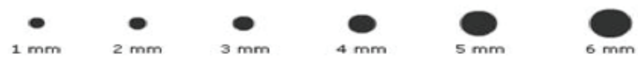
* Peripheral Painful Stimulus: apply pressure with pen to lateral distal phalanx of 2nd or 3rd finger

** Central Painful Stimulus:

- Sternal Rub: single-fisted knuckle is lightly applied to the sternum
- Trapezius Squeeze (pinch muscle between back of shoulder and neck with fingers [***if no spinal injury suspected]
- Supra- orbital pressure (place knuckle or pen into notch of the supra orbital ridge under eyebrow [***if no facial trauma]
- Jaw margin pressure (pressure applied to angle of the jaw [corner of maxillary and mandibular junction]

Appendix 2: Paediatric Neurological Observation Record

Example of an Assessment Tool:



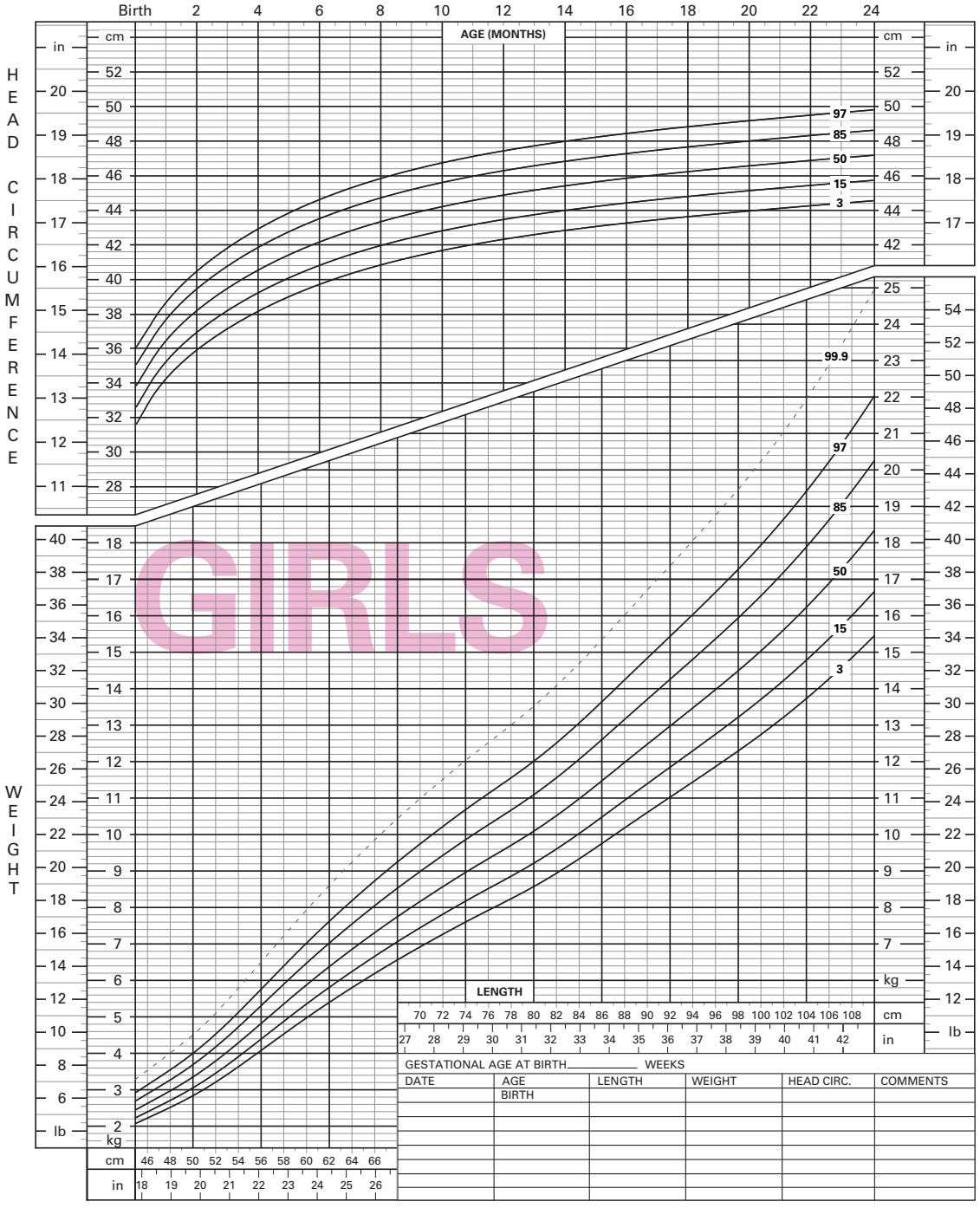
IMPRINT OR ENTER DETAILS BY HAND

Today's Date (Month):		
Time:		
Initials:		
PUPILS: Use the above pupil size legend to indicate size in mm; Also note reactivity to light for each eye		
++ = reactive + = sluggish 0 = absent	Right Eye	Size mm
		Reaction
	Left Eye	Size mm
		Reaction
NOTE: Changes in vital signs could indicate a deteriorating neurological status. Also see vital signs on patient flow sheet		
GLASGOW COMA SCALE: Using the coma scale below, select corresponding assessment number in each category, then total		
Eye Opening	4	Spontaneously
	3	To verbal command
	2	To pain
	1	No response
Best Verbal Response	5	Oriented
	4	Confused
	3	Inappropriate words
	2	Incomprehensible sounds
	1	No verbal response
Best Motor Response	6	Obeys commands
	5	Localizes to pain
	4	Flexion-withdrawal
	3	Abnormal flexion
	2	Abnormal extension
	1	No motor response
TOTAL GCS (3 – 15)		
LIMB STRENGTH		
N = Normal W = Weak A = Absent Sp = Spastic	Arm Strength	Right Arm
		Left Arm
	Leg Strength	Right Leg
		Left Leg
Presence of Pronator Drift (L = left R = right)		

Modified Paediatric Glasgow Coma Scale

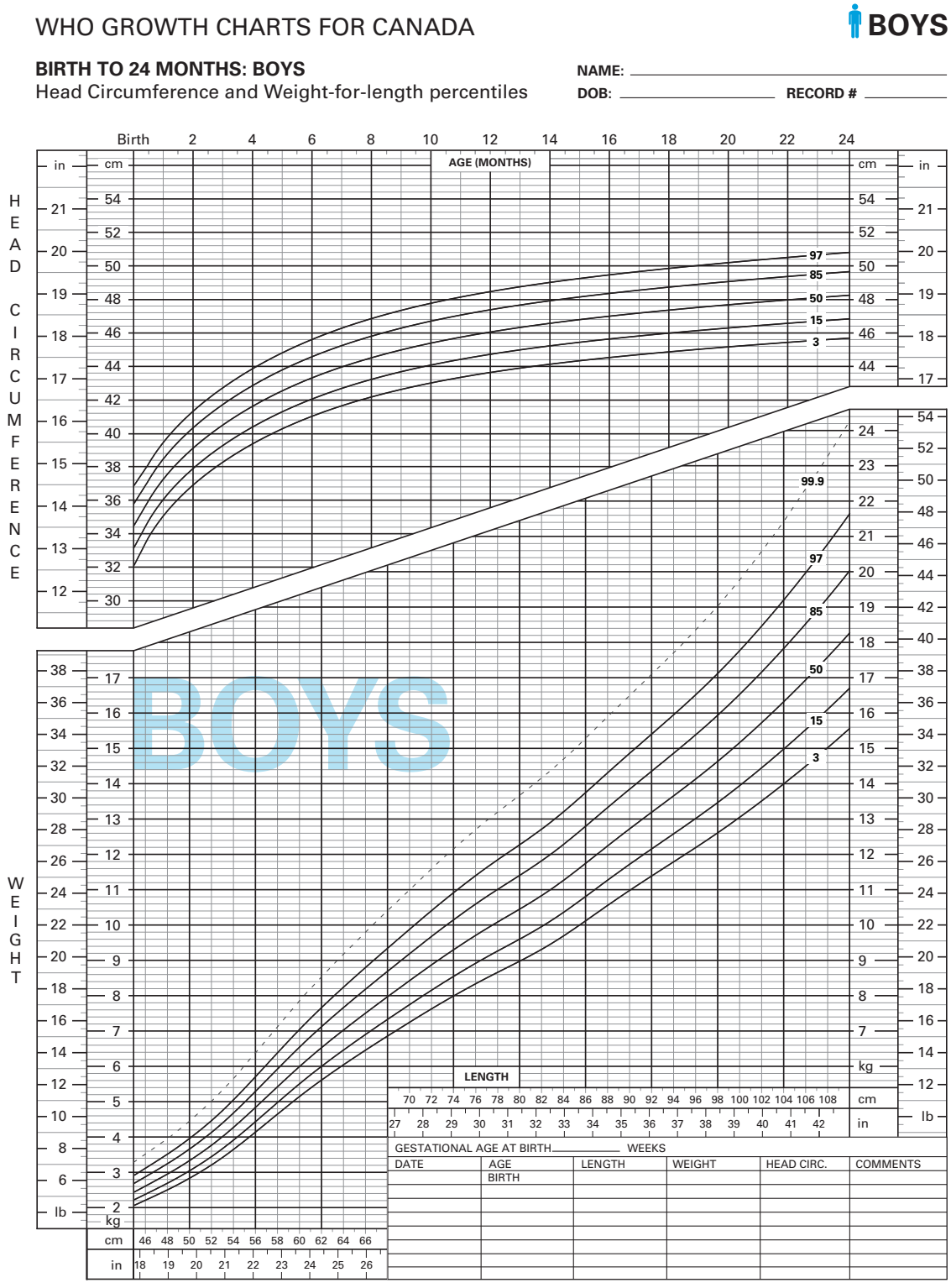
	Eyes Opening		Best Motor Response		Best Verbal Response		
	>1 year	< 1Year	>1 year	< 1Year	>5 years	2-5 years	0-23 months
6	---	---	Obeys	Displays spontaneous response	---	---	---
5	---	---	Localizes to pain	Localizes to pain	Oriented and converses	Appropriate words/ phrases	Smiles/coos/ cries appropriately
4	Spontaneously	Spontaneously	Flexion-Withdrawal	Flexion-Withdrawal	Disoriented and converses	Inappropriate words	Cries
3	To verbal command	To shout	Flexion-Abnormal (decorticate rigidity)	Flexion-Abnormal (decorticate rigidity)	Inappropriate words	Cries and or screams	Inappropriate crying and/or screaming
2	To pain	To pain	Extension (decerebrate rigidity)	Extension (decerebrate rigidity)	Incomprehensible words	Grunts	Grunts
1	No response	No response	No response	No response	No response	No response	No response

Appendix 3a: WHO Growth Chart (Girls)



SOURCE: Based on World Health Organization (WHO) Child Growth Standards (2006) and WHO Reference (2007) and adapted for Canada by Canadian Paediatric Society, Canadian Pediatric Endocrine Group, College of Family Physicians of Canada, Community Health Nurses of Canada and Dietitians of Canada.

Appendix 3b: WHO Growth Chart (Boys)



SOURCE: Based on World Health Organization (WHO) Child Growth Standards (2006) and WHO Reference (2007) and adapted for Canada by Canadian Paediatric Society, Canadian Pediatric Endocrine Group, College of Family Physicians of Canada, Community Health Nurses of Canada and Dietitians of Canada.

Appendix 4: Paediatric Vital Signs

Obtain and document vital signs as per the Neurological Observation Record or an equivalent patient care record.

Preterm Infants

Gestational Age	Heart Rate (beats/min)	Respiratory Rate (breaths/min)	Blood Pressure (mmHg)
24 weeks	100-180	40-60	25-55/15-35
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36 weeks			40-75/25-45
40 weeks			45-80/33-52

0-18 Years

Age	Heart Rate (beats/min)	Respiratory Rate (breaths/min)	Blood Pressure (mmHg)
0-1 month	93-182	26-65	45-80/33-52
1-3 months	120-178	28-55	65-85/35-55
3-6 months	107-197	22-52	70-90/35-65
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1-3 years	90-152	20-50	80-100/40-70
4-7 years	65-138	20-30	80-115/40-80
>8 years	62-130	14-26	85-145/45-90

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Appendix 5: Neurosurgery Education and Outreach Network Membership

Name	Representation	Organization
Sean Hopkins (Co-Chair)	Neurosurgery Nurse Educator	Windsor Regional Hospital - Ouellette site Windsor
Lisa Beck (Co-Chair)	Administrative Director	Thunder Bay Regional Health Sciences
Brenda Bousfield	Neurosurgery Nurse Educator	Hamilton Health Sciences
Jennifer Phillipchuck	Clinical Outreach Specialist	Hamilton Health Sciences
Kristen Postma	Clinical Outreach Specialist	Hamilton Health Sciences
Louise Macrae	Administrative Director	Hamilton Health Sciences
Lisa Weiler	Neurosurgery Nurse Educator	Health Sciences North
Karin Ruddy	Clinical Outreach Specialist	Health Sciences North
Lindsay Roach	Clinical Outreach Specialist	Health Sciences North
Debbie Gray	Administrative Director	Health Sciences North
Marnie Cranston	Neurosurgery Nurse Educator	Kingston General Hospital
Nicole Chenier-Hogan	Clinical Outreach Specialist	Kingston General Hospital
Richard Jewitt	Administrative Director	Kingston General Hospital
Kimberly Salway	Clinical Outreach Specialist	London Health Sciences Centre
Jill Craven	Administrative Director	London Health Sciences Centre
Jean Morrow	Neurosurgery Nurse Educator	London Health Sciences Centre
Monica Olanski	Administrative Director	London Health Sciences Centre
Tina Petrelli	Paediatric Clinical Outreach Specialist	McMaster Children's Hospital
Denise Ouellette	Neurosurgery Nurse Educator	St. Michael's Hospital
Chrisanthi Lefkimmiatis	Clinical Outreach Specialist	St. Michael's Hospital
Sonya Canzian	Administrative Director	St. Michael's Hospital
Lars Kure	Neurosurgery Nurse Educator	Sunnybrook Health Sciences
Catherine Morash	Clinical Outreach Specialist	Sunnybrook Health Sciences
Debra Carew	Administrative Director	Sunnybrook Health Sciences
Elisabeth White	Paediatric Clinical Outreach Specialist	The Hospital for Sick Children
Liz Ferguson	Administrative Lead	The Hospital for Sick Children
Raizha Gramcko	Neurosurgery Nurse Educator	The Ottawa Hospital
Jennifer Payne	Neurosurgery Nurse Educator	The Ottawa Hospital
Dianna Hughes	Clinical Outreach Specialist	The Ottawa Hospital
Fred Beauchemin	Administrative Director	The Ottawa Hospital

Name	Representation	Organization
Chad Johnson	Neurosurgery Nurse Educator	Thunder Bay Regional Health Sciences
Kim Belluz	Clinical Outreach Specialist	Thunder Bay Regional Health Sciences
Marcella Veenman-Mulde	Clinical Outreach Specialist	Trillium Health Partners
Beverly Espedido	Neurosurgery Nurse Educator	Trillium Health Partners
Dawn Tymianski	Clinical Outreach Specialist	University Health Network
Janet Newton	Administrative Director	University Health Network
Charmaine Arulvarathan	Neurosurgery Nurse Educator	University Health Network
Janet Reddam	Administrative Director	Windsor Regional Hospital - Ouellette site Windsor

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