

*In the name of God*

# Neurology Sequence

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# Neurology Sequence

**A**lerting signs

**C**ore steps

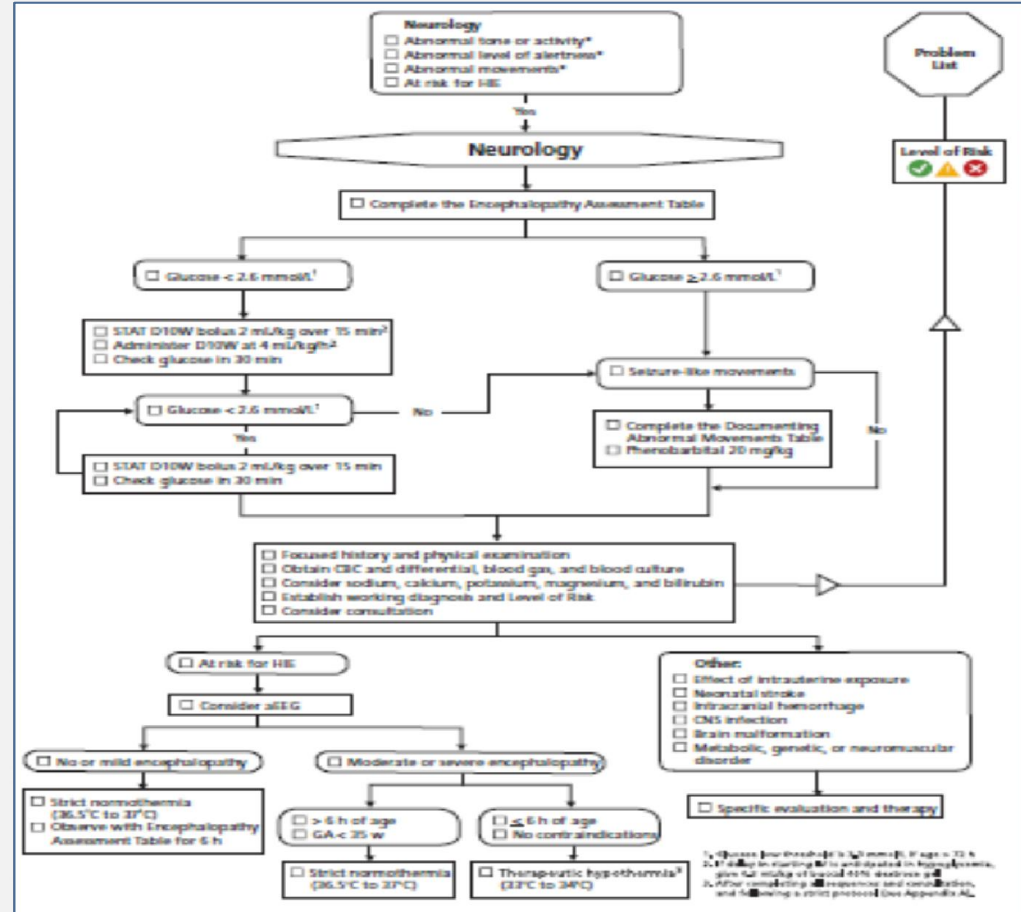
**O**rganization of care

**R**esponse

**N**ext steps

**S**pecific diagnosis

**S**pecific management



# Educational objectives

- Identify infants needing **neurologic stabilization**.
- Apply the **ACoRN** Neurology Sequence.
- Recognize and assess
  - **abnormal tone and activity**
  - **abnormal level of alertness**
- Recognize and manage
  - **abnormal movements**
  - **neonatal encephalopathy**
- Identify hypoxic ischemic encephalopathy (**HIE**)
- Manage newborns that may benefit from **therapeutic hypothermia**.

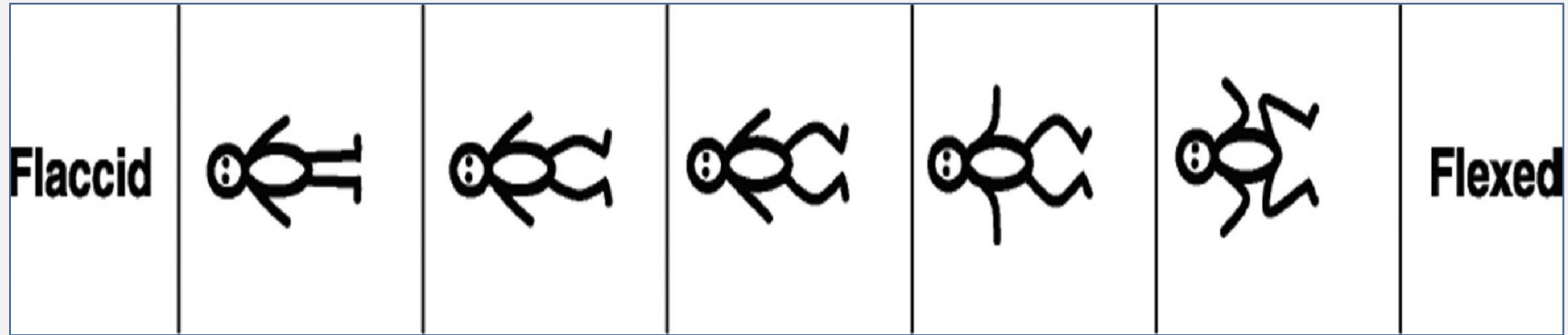
# Alerting Signs

## Neurology

- ☐ Abnormal tone or activity\*
- ☐ Abnormal level of alertness\*
- ☐ Abnormal movements\*
- ☐ At risk for HIE

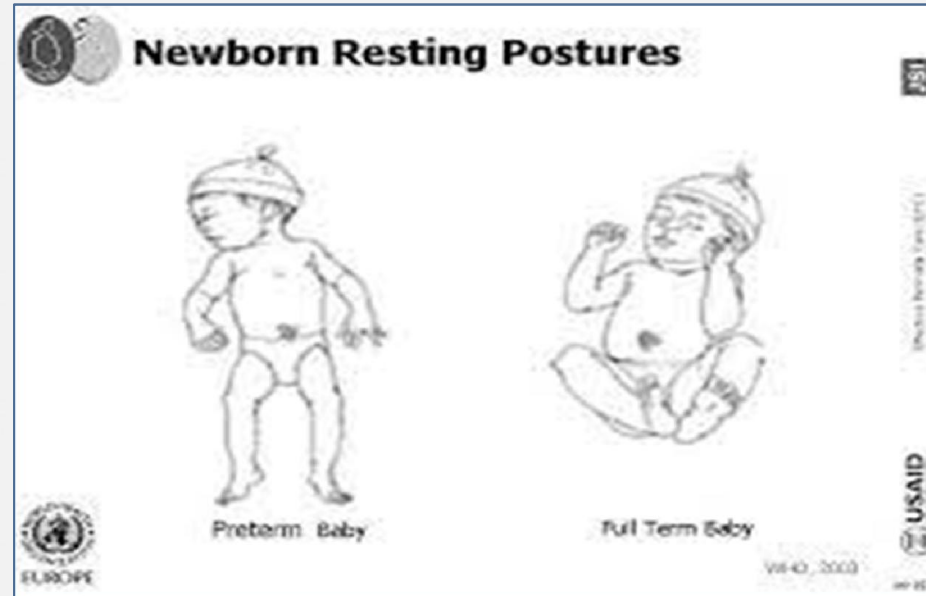
# Abnormal tone or activity

## Resting posture



# Abnormal tone or activity

Resting posture





Resting posture 1

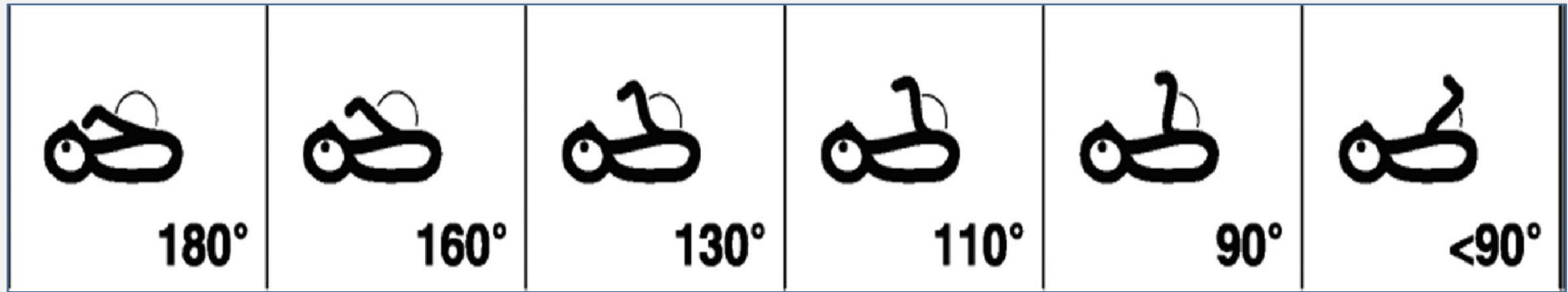


Resting posture 1



# Abnormal tone or activity

## Popliteal angle





# Abnormal tone or activity

## Pull-to-sit manoeuvre



With **normal tone**, an infant's head is balanced over the torso in the sitting position.



With **increased extensor tone**, an infant's head is hyperextended and cannot drop forward.



With **decreased tone**, an infant's head lags in extension and then drops forward.



Pull- to- sit manoeuvre 2



# Abnormal tone or activity

## Ventral suspension



Head droops,  
back greatly  
arched, limbs  
dangle



Head slightly  
raised, back less  
curved



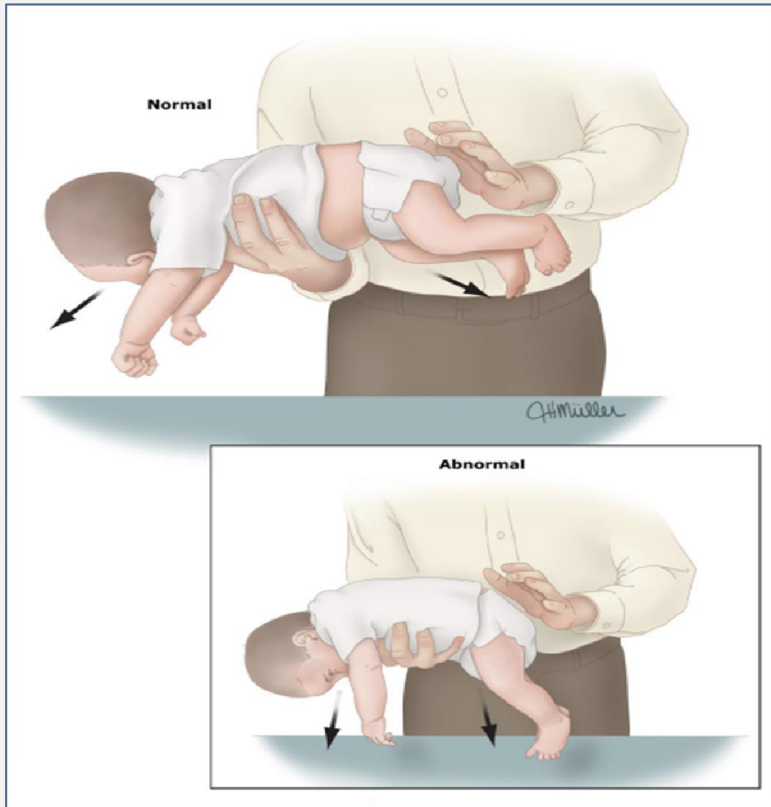
Head raised but  
not to body axis  
back slightly  
curved



Head in line with  
body axis, back  
straight



Head raised above  
body axis, back  
straight



Ventral suspension 3

# Possible reasons for abnormal tone

- Neonatal encephalopathy
- Sepsis
- Hypoglycemia
- Hypermagnesemia, due to administration of magnesium sulfate to the mother
- Intracranial hemorrhage
- Spinal cord injury
- Neonatal abstinence syndrome (NAS) or neonatal opiate withdrawal (NOW)
- Chromosomal abnormality
- Congenital CNS disorders
- Inborn errors of metabolism
- Neuromuscular disorders
- Drugs/ anesthesia

# Abnormal level of alertness

- Term and late preterm infants have sleep– wake cycles after 36 weeks of age
- The recognition of abnormal levels of alertness is important because they are **the most common neurologic abnormalities** observed in the neonatal period.
- **Hyperalertness** may be an early sign of CNS irritability.
  - exaggerated responses to normal stimuli, such as sound and touch
- The presentation of an infant with **decreased level of alertness** is more worrisome.
  - **‘stupor’ and ‘coma’**



# Abnormal movements

1

**Jitteriness  
or  
'tremors'**

2

**Seizure**

# Abnormal movements

## Distinguishing jitteriness from seizure activity

Observation	Jitteriness	Seizures
Alert	Yes	Impaired
Abnormal gaze or eye movement	No	Yes
Movements exquisitely sensitive to stimuli	Yes	No
Predominant movement	Oscillatory tremor	Clonic jerking
Movements cease with passive flexion	Yes	No
Autonomic changes (e.g., tachycardia, increase in blood pressure, or apnea)	No	Yes
Often migrates from one body area to another	No	Yes

# Abnormal movements

## Common causes of jitteriness

Hypoglycemia	Discussed in ACoRN Chapter 7, Fluid and Glucose
Hypocalcemia	Low serum calcium (ionized calcium $\leq 1.0$ mmol/L or total serum calcium $\leq 2.25$ mmol/L) as a result of poor intake, induced alkalosis, prematurity, or a metabolic disorder
Neonatal abstinence syndrome/Neonatal opioid withdrawal	Opioids (heroin, methadone, morphine, and related drugs) used during pregnancy. Intrauterine exposure to CNS stimulants, CNS depressants, hallucinogens, antidepressants (SSRIs and SNRIs), and other licit (e.g., nicotine) or illicit drugs, can also cause neurologic symptoms and abnormal behaviours in the neonatal period
CNS irritability	Due to brain malformation, hemorrhage, encephalopathy, or CNS stimulants

# Abnormal movements

**Jitteriness** can be so severe that it is confused with a clonic seizure. Jitteriness can be **normal** or **abnormal**.

**Seizures** in the newborn almost always arise from a **pathological cause**.

# Abnormal movements

Recurrent apnea in the late preterm or term infant may be considered a manifestation of seizures.

# Abnormal movements

## Common types of seizures

Type (% Frequency)	Characteristics
Subtle (30%)	<ul style="list-style-type: none"><li>• Horizontal tonic deviation of the eyes, with or without jerking movements</li><li>• Repetitive blinking or staring episodes</li><li>• Chewing, lip-smacking, or drooling</li><li>• 'Bicycling' of the legs and other rhythmic-appearing, purposeless movements</li><li>• Apnea</li><li>• Sudden tachycardia at rest, or increase in blood pressure, or decrease in SpO<sub>2</sub></li><li>• Posturing</li></ul>
Clonic (25%)	<ul style="list-style-type: none"><li>• Rhythmic, slow movements (1 to 3 jerks/sec) involving the face and/or the upper and/or lower extremities on one side of the body (therefore called focal)<ul style="list-style-type: none"><li>◦ The infant is usually conscious during focal seizures.</li></ul></li><li>• Course, jerking movements of one or two limbs that migrate to the contralateral part of the body (therefore called multifocal) in a nonorderly fashion<ul style="list-style-type: none"><li>◦ When movements generalize to involve both sides of the body, loss of consciousness usually occurs.</li></ul></li></ul>
Tonic (20%)	<ul style="list-style-type: none"><li>• Sustained, rigid posturing of a limb or asymmetric posturing of the trunk or neck (focal), with or without tonic eye deviation</li><li>• Premature infants may develop generalized tonic seizures that include flexion or extension of the neck, trunk, and upper extremities, and extension of the lower extremities (similar to decorticate or decerebrate posturing), with or without autonomic phenomena.</li></ul>
Myoclonic (25%)	<ul style="list-style-type: none"><li>• Rapid contractions of flexor muscles in one limb (focal), several parts of the body (multifocal), or the whole body (generalized)<ul style="list-style-type: none"><li>◦ In 'benign sleep myoclonus', which usually disappears by 6 months of age with no sequelae, any of the three forms can be present. This condition is characterized by immediate cessation of abnormal movements with arousal.</li></ul></li></ul>

# Abnormal movements

## Common causes of seizures

Age	Cause
At birth	<ul style="list-style-type: none"><li>• Acute drug withdrawal caused by naloxone administration to the infant of a narcotic-using mother</li><li>• Local anesthetic injected into fetal scalp during pudendal block</li></ul>
Day 1	<ul style="list-style-type: none"><li>• HIE seizures usually present in the first 6 to 24 h</li><li>• Hypoglycemia</li><li>• Metabolic abnormalities (e.g., hypocalcemia)</li><li>• Trauma, including subdural hemorrhage</li></ul>
Day 2 to 3	<ul style="list-style-type: none"><li>• NAS/NOW</li><li>• Neonatal stroke</li><li>• Metabolic disturbances</li><li>• Inborn errors of metabolism—may present with seizures, hypotonia, and altered consciousness, often with other abnormalities such as hypoglycemia, metabolic acidosis, and hyperammonemia</li><li>• Meningitis/encephalitis</li><li>• Subarachnoid hemorrhage</li></ul>
Day 3 to 7	<ul style="list-style-type: none"><li>• Neonatal stroke</li><li>• Hypocalcemia</li><li>• Brain malformation</li><li>• Meningitis/encephalitis</li><li>• NAS/NOW due to methadone withdrawal</li></ul>
Day 7	<ul style="list-style-type: none"><li>• Meningitis/encephalitis</li></ul>

# Alerting Signs

- **Neonatal encephalopathy** is a condition in term and late preterm infants that describes a constellation of abnormal clinical findings—including a combination of abnormal tone, reflexes, level of alertness, feeding, respiration, and/ or seizures—that may evolve over hours or days.



# Alerting Signs

Possible causes of neonatal encephalopathy include:

- HIE
- Central nervous system (CNS) infections, such as Group B Streptococcus meningitis or herpes simplex virus (HSV) encephalitis
- Inborn errors of metabolism
- Intracranial hemorrhage.

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# Alerting Signs

- HIE is the most common cause of neonatal encephalopathy. The clinical signs of HIE evolve over the first several hours and even days after birth.

# Alerting Signs

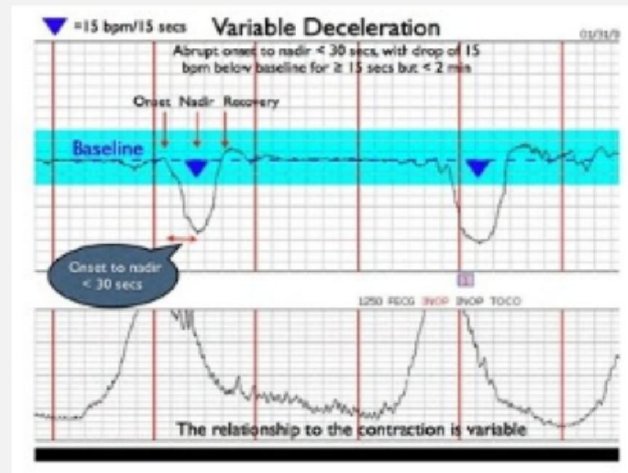
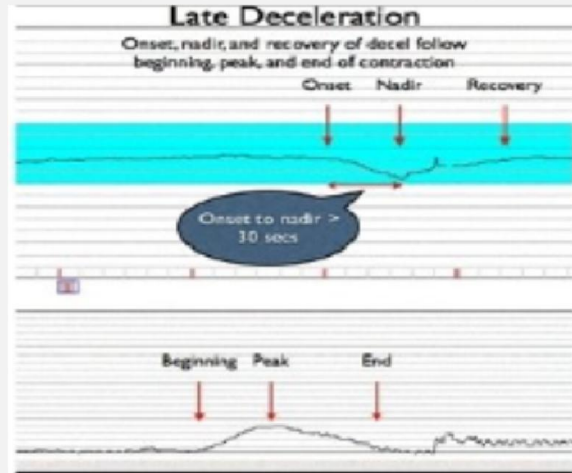
- It is critical to identify infants presenting with abnormal neurologic Alerting Signs who are also **at risk for HIE**

# Newborns at risk for HIE

- Fetal HR monitoring abnormalities, such as late decelerations, complicated variable decelerations, minimal or absent variability, and bradycardia.
- Evidence or suspicion of bleeding from placental abruption, fetal hemorrhage, cord occlusion or cord prolapse

# Newborns at risk for HIE

- Fetal HR monitoring abnormalities, such as late decelerations, complicated variable decelerations, minimal or absent variability, and bradycardia.



# Newborns at risk for HIE

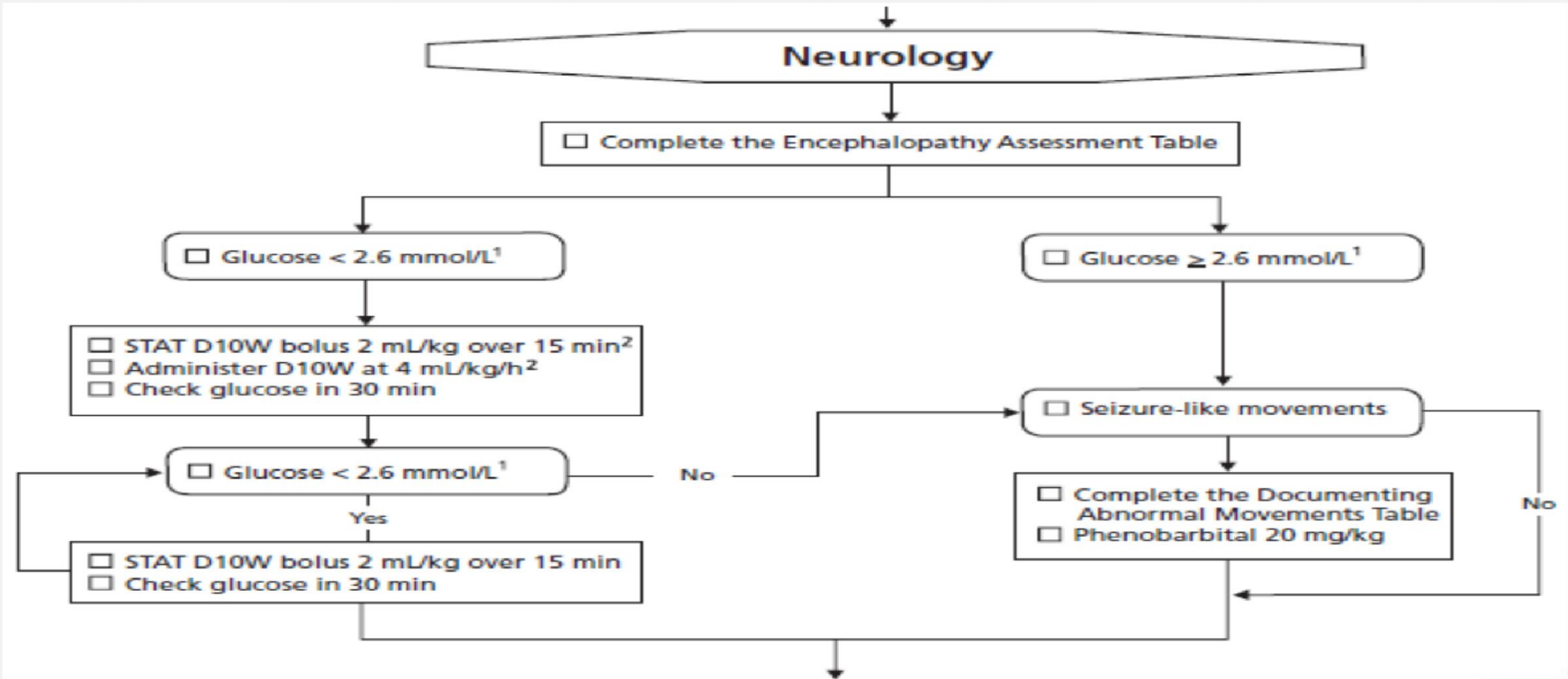
- These infants are often depressed at birth and require more prolonged resuscitation. They are further identified using the following signs:
  - An Apgar score of 0-3 for 5 min or longer or of 0-5 for 10 min or longer
  - An umbilical cord ABG
    - pH < 7.15
    - base deficit  $\geq 10$  mmol/ L
    - or lactate greater > 5 mmol/ L

# Alerting Signs

## Neurology

- ☐ Abnormal tone or activity\*
- ☐ Abnormal level of alertness\*
- ☐ Abnormal movements\*
- ☐ At risk for HIE

# Neurology Sequence





# Neurology Sequence -Core Steps

## Encephalopathy Assessment

Category	Normal	Mild	Moderate	Severe
Level of alertness	<input type="checkbox"/> Alert, normal sleep–wake cycles	<input type="checkbox"/> Hyperalert	<input type="checkbox"/> Lethargy	<input type="checkbox"/> Stupor or coma
Spontaneous activity	<input type="checkbox"/> Normal	<input type="checkbox"/> Normal	<input type="checkbox"/> Decreased activity	<input type="checkbox"/> No activity
Posture	<input type="checkbox"/> Flexed	<input type="checkbox"/> Mild distal flexion	<input type="checkbox"/> Arms flexed, legs extended (decorticate)	<input type="checkbox"/> Arms and legs extended (decerebrate)
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Primitive reflexes	<input type="checkbox"/> Normal suck and Moro	<input type="checkbox"/> Weak suck, strong Moro	<input type="checkbox"/> Weak suck, incomplete Moro	<input type="checkbox"/> Absent suck, absent Moro
Autonomic (one of)				
Pupils	<input type="checkbox"/> Reactive	<input type="checkbox"/> Dilated reactive	<input type="checkbox"/> Constricted	<input type="checkbox"/> Dilated or nonreactive
Heart rate	<input type="checkbox"/> Normal	<input type="checkbox"/> Tachycardia	<input type="checkbox"/> Bradycardia	<input type="checkbox"/> Variable heart rate
Respirations	<input type="checkbox"/> Normal	<input type="checkbox"/> Normal	<input type="checkbox"/> Periodic breathing	<input type="checkbox"/> Apnea
Seizures	<input type="checkbox"/> None	<input type="checkbox"/> None	<input type="checkbox"/> Common	<input type="checkbox"/> Uncommon

# Core Steps

Criteria for moderate or severe encephalopathy are met when infants present with at least one 'moderate' or 'severe' finding in three or more categories, or if they present with seizures.

# Organization of Care

- Blood glucose level and, subsequently,
- Whether the infant presents with a seizure- like event or other ACoRN Neurology Alerting Signs

# Response

- Symptomatic hypoglycemia
  - Establishing a continuous infusion of D10W is essential because a D10W bolus or dextrose gel only remains in the circulation for about 15 to 30 min, depending on the infant's rate of glucose utilization

# Response



- Seizure- like movements

- The clinical diagnosis of seizures is unreliable in newborns. **Electroclinical dissociation**— defined as abnormal movements without epileptiform discharges on EEG, and epileptiform EEG without abnormal movements— is common in newborns and increases after anticonvulsants have been administered.
- **Start phenobarbital.** The usual loading dose of phenobarbital is 20 mg/ kg IV, given slowly over 20 min

# Next Steps

- Focused history
- Focused physical examination
- Diagnostic tests

# Next Steps

- **Diagnostic tests**

1. **Complete blood count and differential**

- Acute anemia from blood loss, polycythemia, or sepsis

2. **Blood gas**

- To rule out metabolic acidosis

3. **Blood culture**

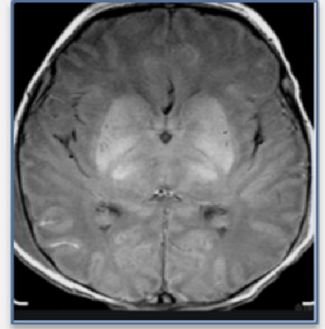
- Lumbar puncture (LP) /CSF for HSV and enterovirus

4. **Blood chemistry**

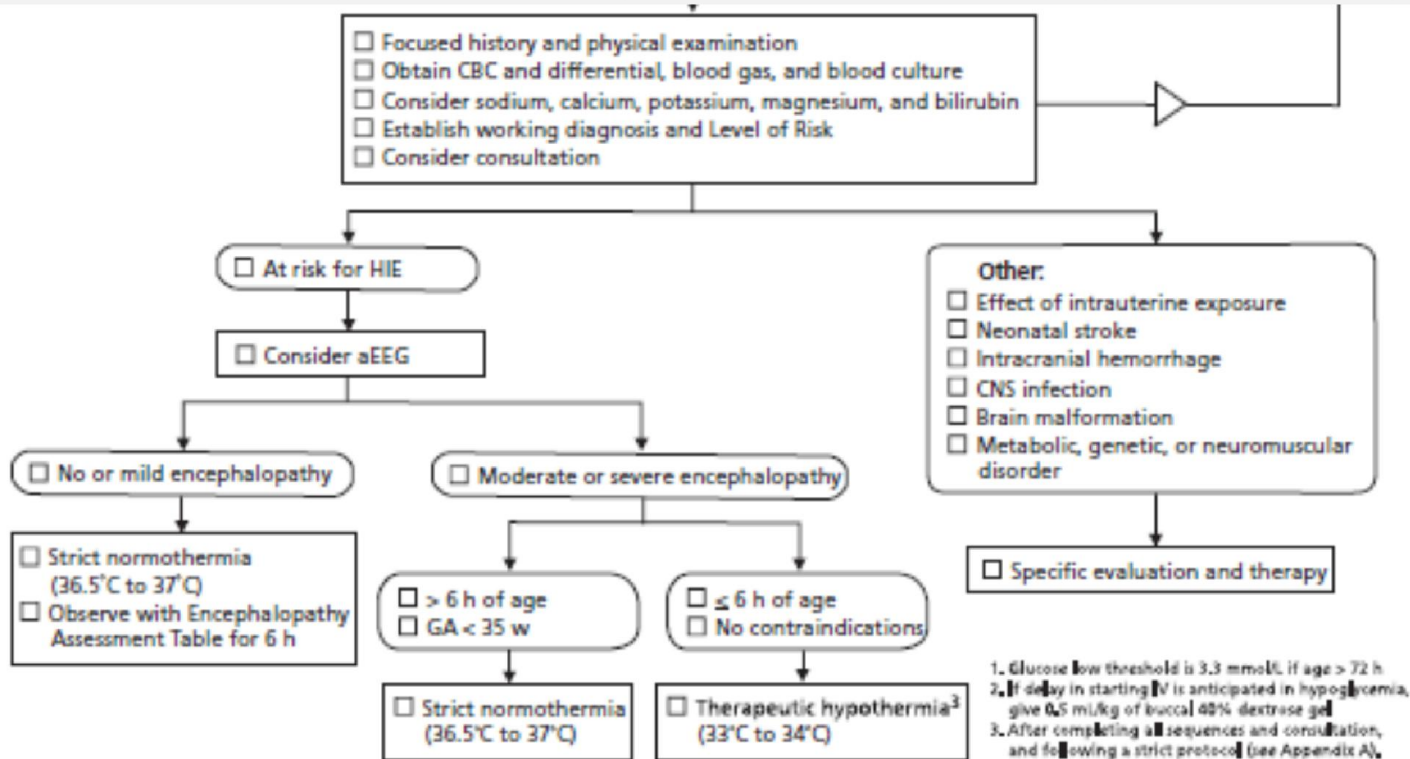
- Sodium, calcium, potassium, and magnesium levels
- Serum bilirubin (bilirubin encephalopathy)

- **Specific Diagnosis**

- Neuroimaging, such as a **MRI scan**, is useful for diagnostic and prognostic assessment



# Neurology Sequence





# Diagnosis and Management

In infants greater than 35 weeks GA with moderate to severe HIE, neurodevelopmental outcome can be improved by initiating therapeutic hypothermia within 6 hours of birth.



# Diagnosis and Management

- **Therapeutic hypothermia for HIE:**

To qualify for therapeutic hypothermia, the newborn should be 35 weeks GA or greater and meet either treatment **criteria A or B** and also meet **criteria C**:

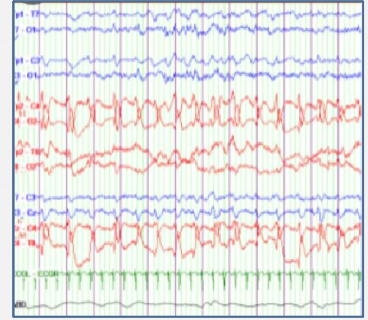
- **Criteria A:** Cord PH less than or equal to 7.0 or base deficit greater than or equal to 16, or
- **Criteria B:** PH 7.01 to 7.15 or base deficit 10 to 15.9 on cord gas or blood gas within 1 h of age, and
  - History of acute perinatal event (e.g., cord prolapse, placental abruption, or uterine rupture) and
  - Apgar score less than or equal to 5 at 10 min, or at least 10 min of positive- pressure ventilation and
- **Criteria C:** Evidence of moderate or severe encephalopathy, as demonstrated either by the presence of seizures or by observing at least one sign in three or more of the ‘moderate’ or ‘severe’ columns of the Encephalopathy Assessment Table

# Management

- Outcome of HIE:
  - Most infants with mild HIE have normal outcomes.
  - In moderate HIE, death is uncommon but long- term sequelae develop in approximately 25% to 30% of survivors.
  - Most infants with severe HIE will die or live with significant long- term sequelae

# Management

- Risk factors for long- term sequelae(HIE) :
  - Persistent abnormalities on EEG
  - Seizures that persist or are difficult to control
  - An abnormal neurologic examination beyond 1 week post-birth or at time of discharge
  - An inability to feed by mouth that requires prolonged gavage feeding.
- MRI scan is useful for diagnostic and prognostic assessment



# Other diagnosis

- Neonatal abstinence syndrome (NAS)/neonatal opiate withdrawal syndrome (NOWS)

- **W** wakefulness
- **I** irritability, increased tone, increased Moro reflex
- **T** tremulousness (jittery), temperature instability, tachypnea
- **H** hyperactivity, high- pitched cry, hiccups, hypersensitivity to sound, hyperreflexia
- **D** diarrhea (explosive), diaphoresis, disorganized suck
- **R** runny nose, regurgitation, respiratory distress, rub marks



# Neonatal abstinence syndrome (NAS) / neonatal opiate withdrawal syndrome (NOWS)

- **A** apnea, autonomic dysfunction (change in HR and RR)
- **W** weight loss
- **A** alkalosis (respiratory)
- **L** lacrimation (tearing of eyes) and lethargy
- **S** snuffles, sneezing, seizures

# Infant's NAS score

Neonatal abstinence syndrome score

System	Signs and symptoms	Score	Time					Comments
			10:15					
Central nervous system	Excessive high-pitched cry	2	2					
	Continuous high-pitched cry	3						
	Sleeps < 1 h after feeding	3	3					
	Sleeps < 2 h after feeding	2						
	Sleeps < 3 h after feeding	1						
	Hyperactive Moro reflex	2	2					
	Markedly hyperactive Moro reflex	3						
	Tremors disturbed	2	3					
	Mild tremors undisturbed	3						
	Moderate-to-severe tremors undisturbed	4						
	Increased muscle tone	2						
	Excoriation (specify area)	1						
Metabolic Vasomotor Respiratory	Myoclonic jerks	3						
	Generalized convulsions	5						
	Sweating	1						
	Fever 37.5°C to 38.3°C	1						
	Fever > 38.4°C	2						
	Frequent yawning > 4 sec/ interval	1	1					
	Mottling	1						
	Nasal stuffiness	1	1					
	Frequent sneezing > 4 × /interval	1	1					
	Nasal flaring	2						
GI	Respiratory rate > 60/min	1						
	Respiratory rate > 60/min + retractions	2						
	Excessive sucking	1						
	Poor feeding	1	1					
	Regurgitation	2						
	Projectile vomiting	3						
	Loose stools	2						
	Watery stools	3						
Total Score			14					
Scorer's initials			AS					

# Neonatal abstinence syndrome (NAS) / neonatal opiate withdrawal syndrome (NOWS)

- **Non-Pharmacological intervention :**

- Loosely swaddled.
- Handled gently.
- Cared for skin-to-skin with parents.
- Placed in a quiet, dimly lit environment.
- Fed frequently to ensure adequate fluid and caloric intake.
- Encouraged to breastfeed, unless HIV- positive mother or there is documented polydrug use.
- Observed for seizures.





# Neonatal abstinence syndrome (NAS) / neonatal opiate withdrawal syndrome (NOWS)

- **Pharmacological intervention** is usually considered after **ruling out** other medical conditions in infants who show the following signs despite receiving supportive environmental measures:
  - Inconsolable crying
  - Poor sleep
  - Persistent tremors or jitteriness when undisturbed
  - Poor weight gain or excessive weight loss ( $> 10\%$ ).

# Neonatal abstinence syndrome (NAS) / neonatal opiate withdrawal syndrome (NOWS)

- Pharmacological intervention
  - The drug of choice is oral morphine.
  - Start morphine in accordance with your regional protocol.
  - The initial dose is titrated up or down based on the infant's response. Some infants require treatment for 4 weeks or longer

# Other diagnosis

- Neonatal stroke
- Intracranial hemorrhage
- CNS infections
- Brain malformations
- Metabolic, genetic, or neuromuscular disorders

## Level of Risk: Neurology

In the ACoRN Neurology Sequence, level of risk is based on abnormal findings on the Encephalopathy Assessment Table, the presence of seizure-like movements, and risk for developing hypoxic ischemic encephalopathy (HIE).



### Green:

- Normal findings on Encephalopathy Assessment Table
- No risk factors for HIE



### Yellow:

- Mild abnormalities based on Encephalopathy Assessment Table
- Risk factors for HIE

**Infants at a Yellow Level of Risk require increased levels of attention and consultation. Transfer is required if needs exceed site capabilities.**



### Red:

- Moderate to severe findings based on Encephalopathy Assessment Table
- Seizure-like movements
- Infant meets criteria for active HIE management

**Infants at a Red Level of Risk require level 3 care. Transfer is required if needs exceed site capabilities.**

# Questions



# Case 1

- You have just been informed that your patient, a mother in her second pregnancy, has delivered a baby by **urgent C/S at 37 weeks GA**, following a **head- on collision** in a motor vehicle.
- The mother has **wakened** from her anesthetic and is doing well. She has no injuries related to the accident, but **her baby required resuscitation**.
- You know from your **prenatal care** of the mother that she is healthy. You arrive when the baby is **1 h old**. She is on a radiant warmer in the observation nursery area

# Case 1

- She is breathing regularly and without difficulty, her vital signs (RR, HR, BP, SpO<sub>2</sub>) are **normal**, and she is pink in room air.
- HR : 130, RR: 40, mean BP: 48, and Taxillary: 36.8°C. Her weight is 3500 g. Her blood glucose is 3.5 mmol/ L.
- The nurse tells you the baby's **tone appears low**. You observe her lying with **arms and legs extended**.

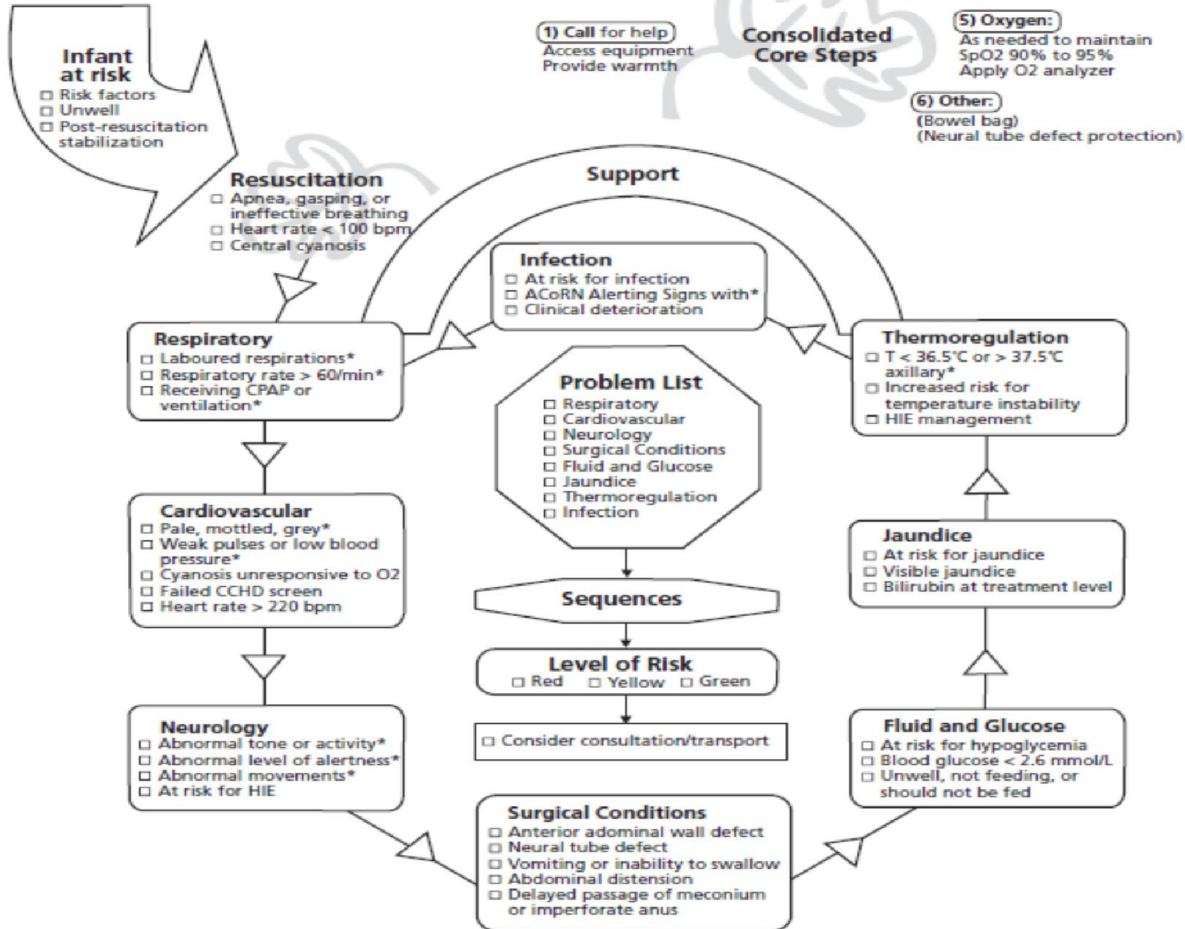
# Case 1

- The baby is easily roused.  
Rooting is absent but suck, grasp, and Moro reflexes are present.
- She is lying on the warmer with minimal flexion of her extremities.
- You see no abnormal movement suggestive of seizures, and the baby is not jittery at this time.

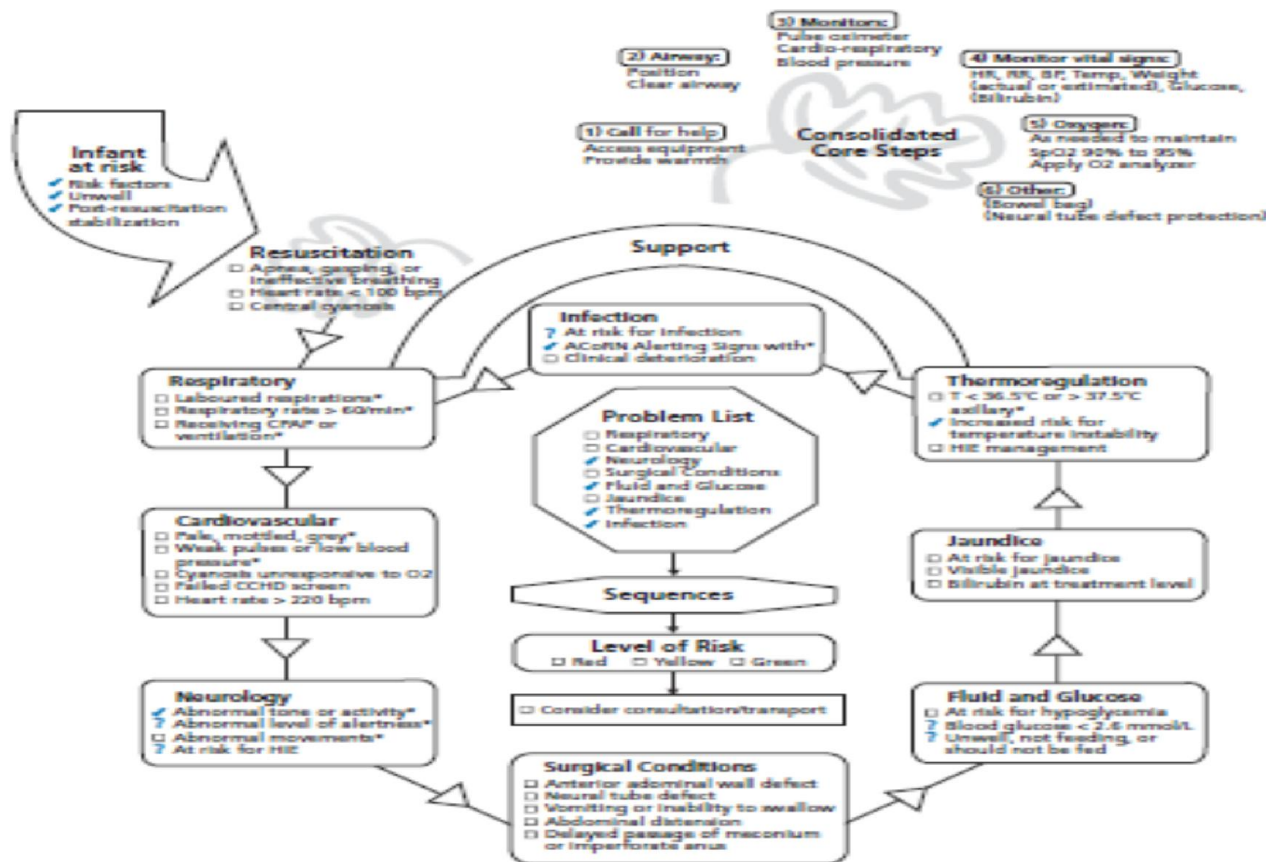


# Case 1

- Which sequence was identified?
- Which Alerting Signs would you mark? Why?



1. Complete the ACoRN Primary Survey and Consolidated Core Steps, and generate a Problem List.



# Alerting Signs

## Neurology

- ☐ Abnormal tone or activity\*
- ☐ Abnormal level of alertness\*
- ☐ Abnormal movements\*
- ☐ At risk for HIE

# Alerting Signs

## Neurology

- ✓ Abnormal tone or activity\*
- ? Abnormal level of alertness\*
- Abnormal movements\*
- ? At risk for HIE

- More information is needed about this baby's risk for HIE and level of alertness (?’s), but she has abnormal tone, requiring further stabilization (✓) in the Neurology Sequence.
- Under Fluid and Glucose, we do not yet know her blood glucose (?), and we are not sure whether her neurologic status is appropriate for feeding (?).
- She is at increased risk for thermoregulatory issues (✓) because she is on a radiant warmer.
- The baby has Alerting Signs with an asterisk (\*), indicating the need to consider infection.

- **History :**

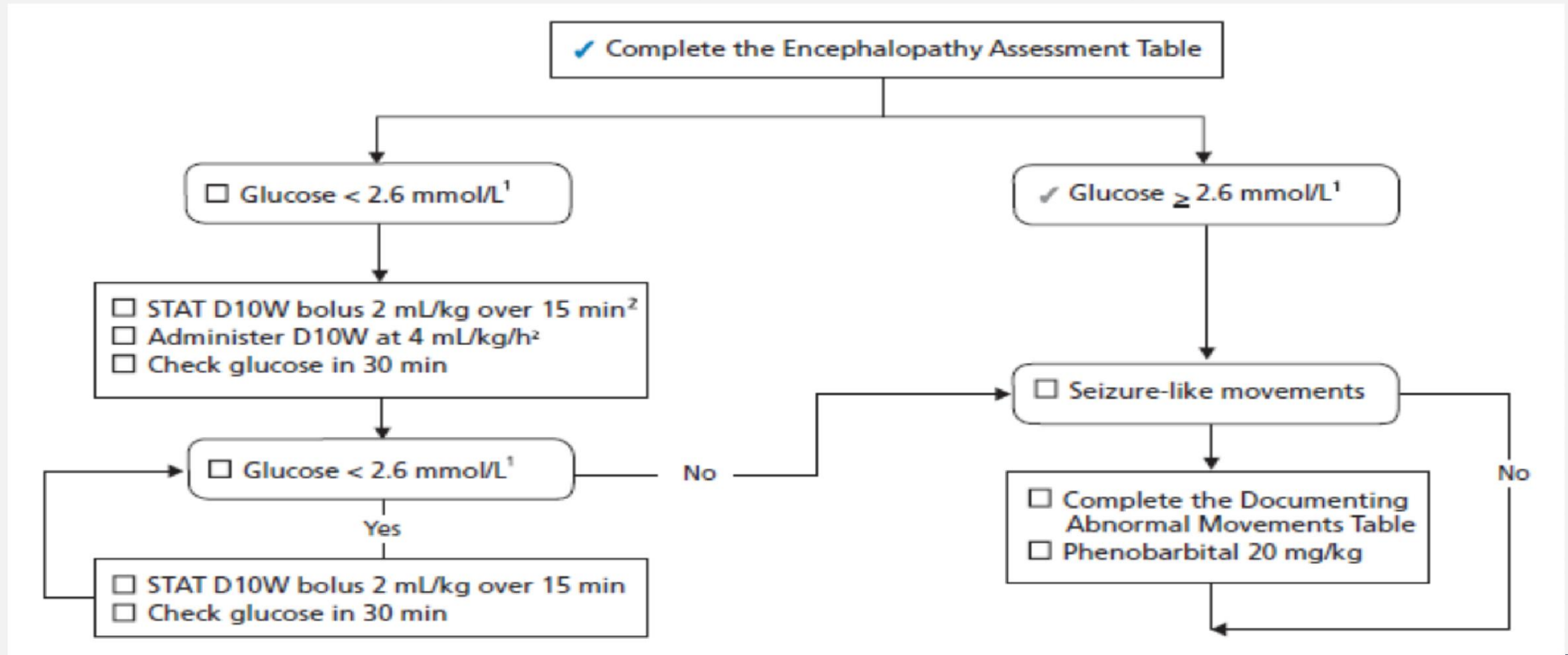
- The initial fetal HR tracing showed late decelerations and minimal variability.
- A scalp pH was unobtainable because the cervix was closed,
- The obstetrician opted to proceed with Caesarean section. A cord blood gas was obtained at time of birth.
- Apgar scores were 1 at 1 min, 3 at 5 min, and 5 at 10 min. The baby required bag- and- mask ventilation for 11 min, after which she began to breathe spontaneously

- **Physical examination:**

- The baby continues to breathe regularly at 54 breaths/ min. HR is 160 bpm, the pulses are easy to palpate over the femoral arteries, and BP is normal
- The baby's appearance, growth parameters, and head circumference are normal.
- Suck, grasp, and Moro reflexes are all present.
- You see no abnormal movement suggestive of seizures and the baby is not jittery at this time.
- While checking for abnormal tone, you note that the baby's popliteal angle is 130°. Also, the pull- to- sit manoeuvre shows her head has a moderate lag in extension. On ventral suspension, her head is raised but not to the body axis, and her back is slightly curved.



# How do you Organize Care for this infant?



# Encephalopathy Assessment Table

Category	Normal	Mild	Moderate	Severe
Level of alertness	<input type="checkbox"/> Alert, normal sleep–wake cycles	<input type="checkbox"/> Hyperalert	<input type="checkbox"/> Lethargy	<input type="checkbox"/> Stupor or coma
Spontaneous activity	<input type="checkbox"/> Normal	<input type="checkbox"/> Normal	<input type="checkbox"/> Decreased activity	<input type="checkbox"/> No activity
Posture	<input type="checkbox"/> Flexed	<input type="checkbox"/> Mild distal flexion	<input type="checkbox"/> Arms flexed, legs extended (decorticate)	<input type="checkbox"/> Arms and legs extended (decerebrate)
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Respirations	<input type="checkbox"/> Normal	<input type="checkbox"/> Normal	<input type="checkbox"/> Periodic breathing	<input type="checkbox"/> Apnea
Seizures	<input type="checkbox"/> None	<input type="checkbox"/> None	<input type="checkbox"/> Common	<input type="checkbox"/> Uncommon

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Seizures	✓ None	<input type="checkbox"/> None	<input type="checkbox"/> Common	<input type="checkbox"/> Uncommon

Your assessment is that she **does not show** signs of moderate or severe encephalopathy.

- The baby presented with abnormal tone and blood glucose of 3.5 mmol/ L. **Organization of Care is based on** normal blood glucose levels *and* absence of seizure- like movements, and you proceed to Next Steps.

How would you describe these blood gas results?  
Is there need for immediate intervention?

- You learn that the cord arterial pH was 6.98, with a base deficit of 18 mmol/L.

- |   |  |
|---|--|
| <input type="checkbox"/> Respiratory acidosis | <input type="checkbox"/> Respiratory alkalosis |
| <input type="checkbox"/> Metabolic acidosis   | <input type="checkbox"/> Metabolic alkalosis   |

How would you describe these blood gas results? Is there need for immediate intervention?

- ☐ Respiratory acidosis    ☐ Respiratory alkalosis
- ✓ Metabolic acidosis    ☐ Metabolic alkalosis

Therefore, there is **no need** at this time to consider treating the metabolic acidosis indicated by the base deficit of 18 mmol/ L.

With **adequate cardiorespiratory function**, you anticipate that metabolic acidosis will gradually resolve on its own.

What **five key pieces** of information obtained from your focused history assist with a provisional diagnosis?

1)

2)

3)

4)

5)

What **five key pieces** of information obtained from your focused history assist with a provisional diagnosis?

- 1) Late decelerations and minimal variability on the electronic fetal monitoring tracing.
- 2) Apgar scores of 1 at 1 min, 3 at 5 min, and 5 at 10 min.
- 3) Requirement for bag and mask ventilation for 11 minutes.
- 4) Persistent hypotonia.
- 5) Cord gases— acidosis and increased base deficit.



How do you determine whether this baby should be orally fed?

- In consultation with the transport coordinating physician, you decide to keep the baby **NPO and start IV fluids**

# How do you determine whether this baby should be orally fed?

- An infant should not be fed **unless** level of alertness is normal, the airway protective reflexes (gag and cough) are present, and the suck– swallow mechanism is mature.
- If not feeding, blood glucose should be monitored closely.

# Questions



## Case 2— (continued from Case 1)

- The baby is now 2 h old. An intravenous with D10W at 3 mL/ kg/ h is infusing. She is lying quietly in her incubator, breathing easily, and remains pink in room air.
- You take a BP reading (normal) and auscultate heart and lungs. The HR is 120 bpm and regular. Blood glucose has remained  $> 3.3$  mmol/ L.
- You notice the baby's **left arm starting to twitch rhythmically**. Observing her movements carefully, you see rhythmic, coarse, jerky movements in all extremities which do not stop when held. Also, **her eyes deviate to the left**, and she has a glazed look. The episode lasts **20 seconds**.

# 1. Is this baby having a seizure?

- ☐ Yes ☐ No

# 1. Is this baby having a seizure?

- ☒ Yes ☐ No

## 2. Which of the following signs are associated with seizures?

- ☐ A glazed look.
- ☐ Eye deviation.
- ☐ Abnormal movements precipitated by doing BP.
- ☐ Fine oscillatory tremors.
- ☐ Inability to suppress movements with flexion.
- ☐ Generalization of abnormal movements to all extremities

## 2. Which of the following signs are associated with seizures?

- ✓ A glazed look.
- ✓ Eye deviation.
- ☐ Abnormal movements precipitated by doing BP.
- ☐ Fine oscillatory tremors.
- ✓ Inability to suppress movements with flexion.
- ✓ Generalization of abnormal movements to all extremities



### 3. How would you complete the Encephalopathy Assessment Table now?

- Now her **SpO2 is 92%** in room air, the airway is clear, and there are no abnormalities on auscultation of the chest.
- The blood glucose done at the bedside is 3.9 mmol/ L.
- On focused neurologic assessment, the baby is **lethargic and hypotonic, and spontaneous activity has decreased.**
- Her posture is in mild distal flexion. She has a weak suck and incomplete Moro reflex. Her pupils are small but reactive to light. Respiration is regular and airway secretions minimal.

### 3. How would you complete the Encephalopathy Assessment Table now?

Category	Normal	Mild	Moderate	Severe
Level of alertness	<input type="checkbox"/> Alert, normal sleep wake cycles	<input type="checkbox"/> Hyperalert	<input checked="" type="checkbox"/> Lethargy	<input type="checkbox"/> Stupor or coma
Spontaneous activity	<input type="checkbox"/> Normal	<input type="checkbox"/> Normal	<input checked="" type="checkbox"/> Decreased activity	<input type="checkbox"/> No activity
Posture	<input type="checkbox"/> Flexed	<input checked="" type="checkbox"/> Mild distal flexion	<input type="checkbox"/> Arms flexed, legs extended (decorticate)	<input type="checkbox"/> Arms and legs extended (decerebrate)
Tone	<input type="checkbox"/> Normal	<input type="checkbox"/> Normal to mild hypotonia	<input checked="" type="checkbox"/> Hypotonic	<input type="checkbox"/> Flaccid
Primitive reflexes	<input type="checkbox"/> Normal suck and Moro	<input type="checkbox"/> Weak suck, strong Moro	<input checked="" type="checkbox"/> Weak suck, incomplete Moro	<input type="checkbox"/> Absent suck, absent Moro
Autonomic (one of)				
Pupils	<input type="checkbox"/> Reactive	<input type="checkbox"/> Dilated reactive	<input checked="" type="checkbox"/> Constricted	<input type="checkbox"/> Dilated or nonreactive
Heart rate	<input checked="" type="checkbox"/> Normal	<input type="checkbox"/> Tachycardia	<input type="checkbox"/> Bradycardia	<input type="checkbox"/> Variable heart rate
Respirations	<input checked="" type="checkbox"/> Normal	<input type="checkbox"/> Normal	<input type="checkbox"/> Periodic breathing	<input type="checkbox"/> Apnea
Seizures	<input type="checkbox"/> None	<input type="checkbox"/> None	<input checked="" type="checkbox"/> Common	<input type="checkbox"/> Uncommon

The table now indicates the baby has several signs of [moderate encephalopathy, including seizures](#).

4. How much **phenobarbital** will you give and how will you direct your staff to give it?

- 20 mg/ kg intravenously,  $20 \text{ mg/ kg} \times 3.5 \text{ kg} = 70 \text{ mg}$ , IV over 20 min (maximum rate = 1 mg/ kg/ min).

5. Based on the information collected so far, how would you describe the seizure this baby is having?

Time/ duration	Suppress by holding	Origin/ spread	Eye/ mouth movements	Level of alertness	Autonomic changes	Other signs

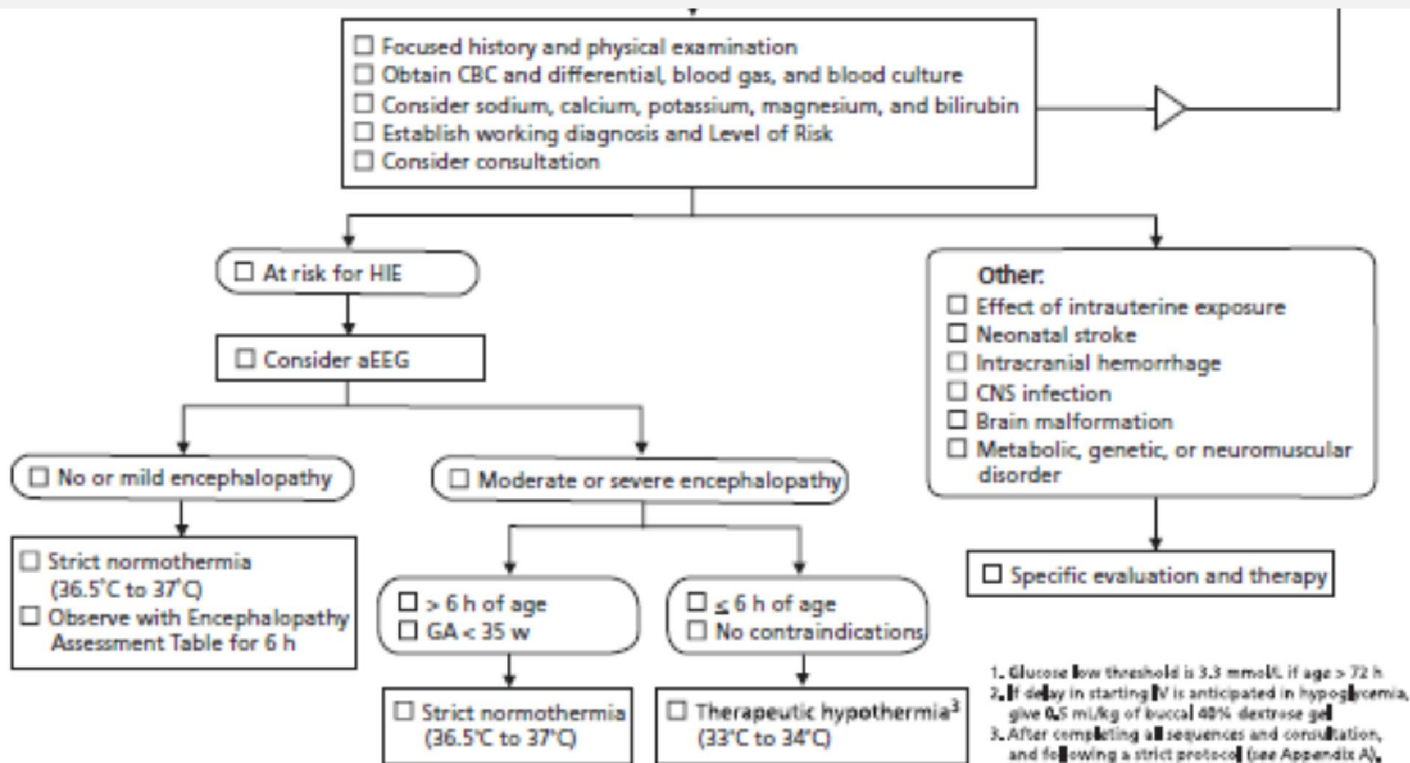
5. Based on the information collected so far, how would you describe the seizure this baby is having?

Time/ duration	Suppress by holding	Origin/ spread	Eye/ mouth movements	Level of alertness	Autonomic changes	Other signs
09:00 at 2 h of age Lasted 20 sec	No	Left arm, then all extremities	Eyes deviated to left	Glazed look	No	No

In combination with Table 5.6, you document the seizure as clonic, multifocal, and subtle and note the time and duration of seizure activity

- With the presence of seizures in the setting of risk factors for HIE, the categorization of moderate encephalopathy can now be made.
- You place a second **call to the referral centre**, and they agree with the diagnosis of HIE.
- The baby qualifies for **therapeutic hypothermia**:
  - there is moderate encephalopathy
  - her gestational age is 37 weeks, and she is 2 h old.
- Discussion ensues as to whether passive cooling for therapeutic hypothermia should be initiated before arrival of the transport team.
- Review your regional hypothermia protocol and ACoRN Appendix A

# Neurology Sequence



# What information would you convey to parents at this point?

- Their question cannot be answered immediately with certainty.
- Not all babies with seizures/ encephalopathy develop long- term sequelae.
- Further tests and observation of her condition in hospital will help determine the degree of CNS injury and level of risk for long- term sequelae.
- Long- term outcome will only be certain as development is observed over time.



# Questions

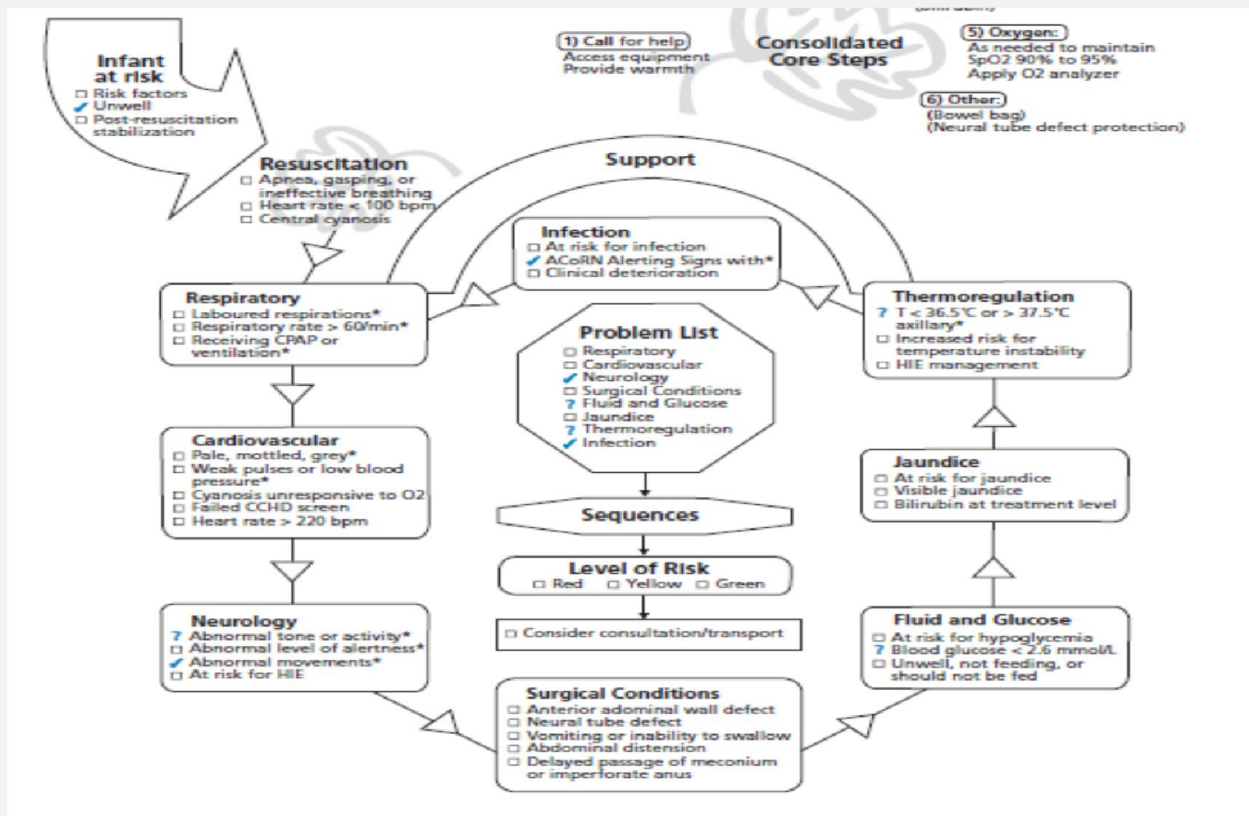


## Case 3— Baby born to a mother who reported using an illicit substance

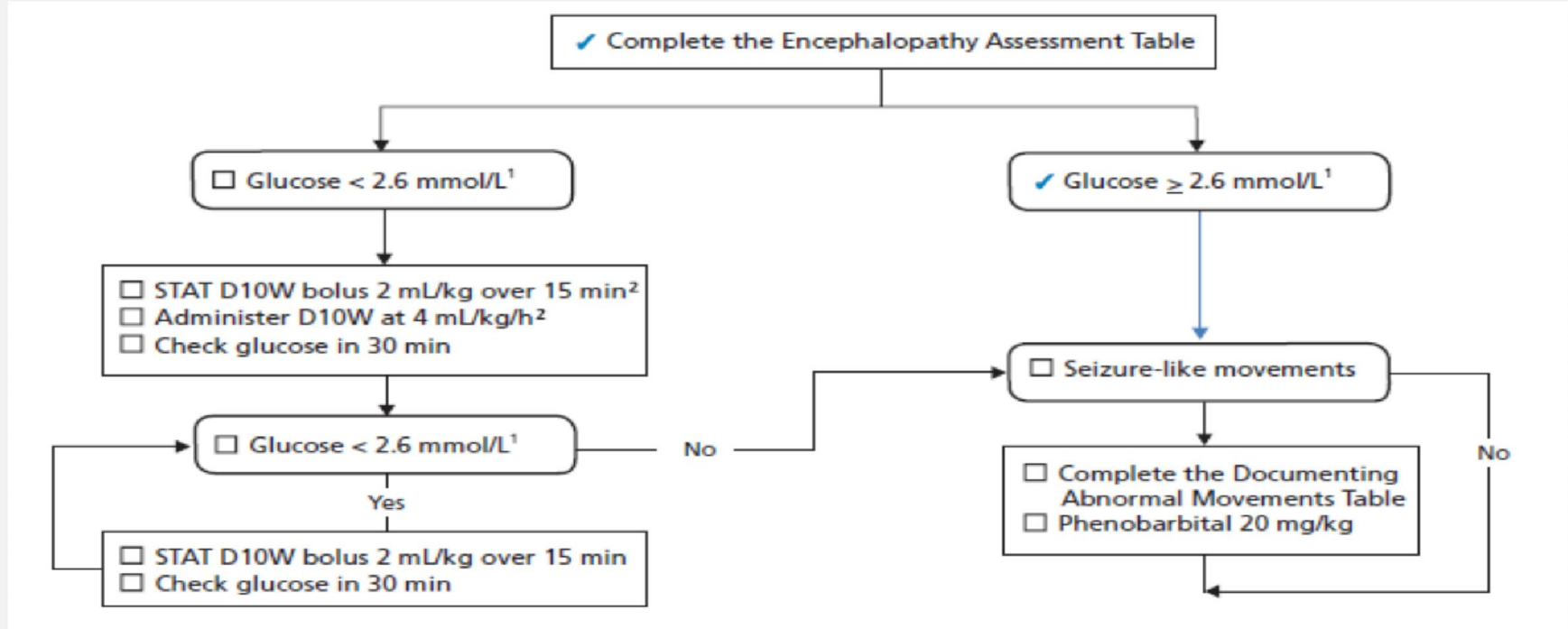
- A 20- h- old baby boy is currently rooming in with his mother. His nurse reports he has been jittery and irritable. You find, from the birth record, that he was born at 39 weeks GA to a 21- yo primigravida and weighs 3000 g.
- The mother had no documented prenatal care, and no concerns were identified during labour and birth.
- In the observation area of the nursery, the nurse is rocking the baby, trying to console him because he has been crying constantly.

- The baby is tightly flexed, sucking his fists vigorously. His legs are **tremulous**, but this movement **stops** when you hold his feet.
- **Vital signs are stable and within normal limits.**
- He has been bottle- fed 4 times since birth, and his mother has declined to breastfeed. The nurses have noticed his **suck is not well** coordinated.
- The baby has **no** Alerting Signs in the Respiratory or Cardiovascular Sequences.
- Abnormal movements are witnessed, and you are concerned that **his tone is increased.**
- The Consolidated Core Steps add the following information: point of care **glucose** is 4.5 mmol/ L and **temperature** is 37°C.

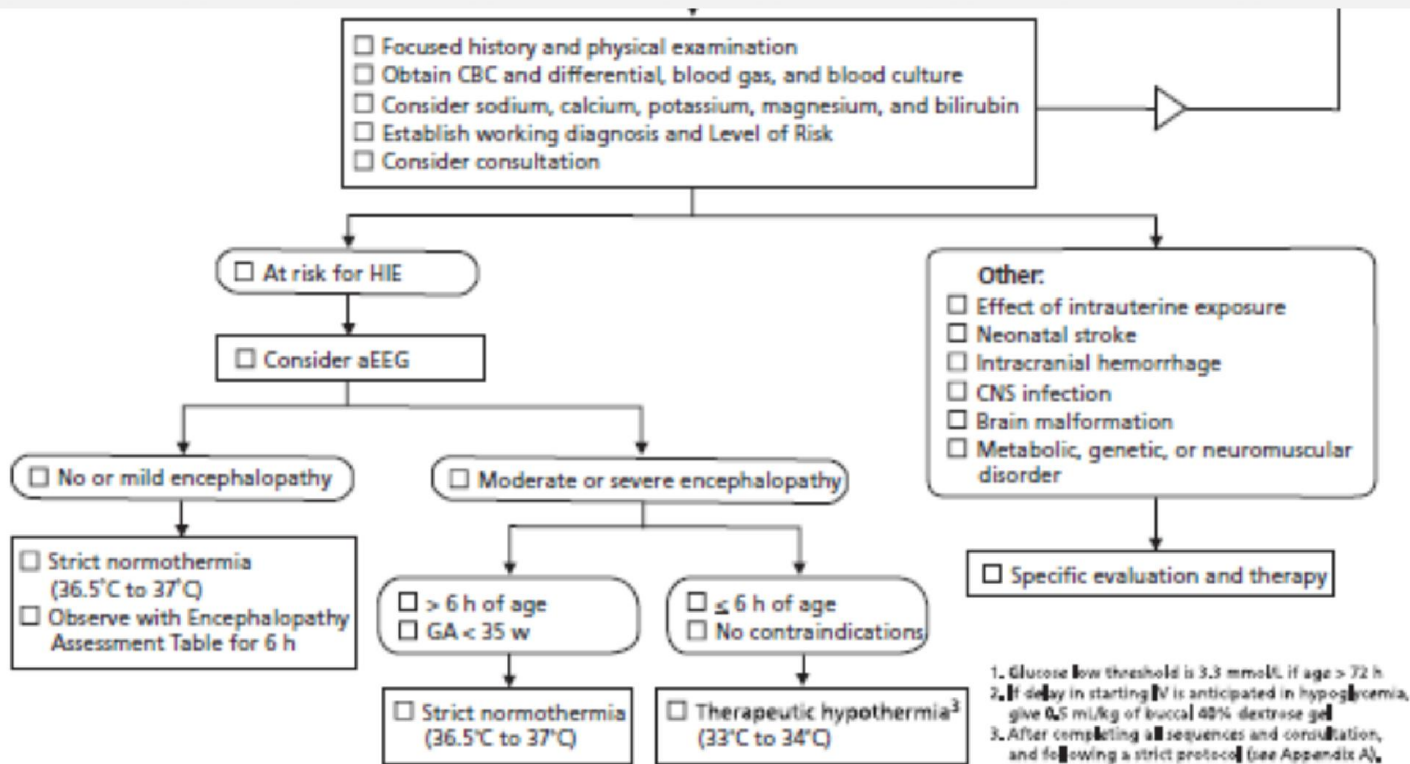
# 1. Complete the ACoRN Primary Survey and Consolidated Core Steps, and generate a Problem List with the infant in the nurse's arms.



## 2. How do you Organize Care for this infant?



## 2. How do you Organize Care for this infant?



- The mother says she used **heroin during her pregnancy**, including on the day of delivery. She has no co- existing medical conditions. She came to hospital fully dilated and delivered quickly. Membranes ruptured at the time of delivery.
- No paternal history is available. The baby was vigorous at birth. Apgar scores were 8 at 1 min and 9 at 5 min. No resuscitation was required.
- **On examination,** **the baby is irritable and yawns and sneezes frequently. He has a shrill cry and is difficult to console. He wakes crying approximately 30 min after each feed. Tone is high and he startles easily. There are no other positive physical findings.**

- **Nonpharmacological comfort measures** are initiated by the nursing staff.
  - You ensure the baby will be nursed in a **quiet setting, with lights dimmed and lower noise levels.**
  - **Nonnutritive sucking, swaddling, and kangaroo care** may help to settle this baby.
  - **Scoring** is initiated using your nursery's standard protocol.



### 3. Is this baby having seizures? Why or why not?

- No, the baby is **not having seizures** because movements stop when extremities are held. You organize care based on the normal glucose reading and absence of seizures, and proceed to Next Steps.

4. Determine the infant's NAS score by completing the following table.

Neonatal abstinence syndrome score									
System	Signs and symptoms	Score	Time					Comments	
			10:15						
Central nervous system	Excessive high-pitched cry	2	2						
	Continuous high-pitched cry	3							
	Sleeps < 1 h after feeding	3	3						
	Sleeps < 2 h after feeding	2							
	Sleeps < 3 h after feeding	1							
	Hyperactive Moro reflex	2	2						
	Markedly hyperactive Moro reflex	3							
	Tremors disturbed	2	3						
	Mild tremors undisturbed	3							
	Moderate-to-severe tremors undisturbed	4							
	Increased muscle tone	2							
	Excoriation (specify area)	1							
	Myoclonic jerks	3							
Generalized convulsions	5								
Metabolic Vasomotor Respiratory	Sweating	1							
	Fever 37.5°C to 38.3°C	1							
	Fever > 38.4°C	2							
	Frequent yawning > 4 sec/interval	1	1						
	Mottling	1							
	Nasal stuffiness	1	1						
	Frequent sneezing > 4 × /interval	1	1						
	Nasal flaring	2							
	Respiratory rate > 60/min	1							
	Respiratory rate > 60/min + retractions	2							
	GI	Excessive sucking	1						
Poor feeding		1	1						
Regurgitation		2							
Projectile vomiting		3							
Loose stools		2							
Watery stools		3							
<b>Total Score</b>			14						
<b>Scorer's initials</b>			AS						

- The baby's scores are elevated, and the history and physical exam are consistent with NAS.
- Nonpharmacologic measures are initiated but **are not successful** in controlling the baby's symptoms.

# 5. What are your next steps?

- You counsel the mother about how to assess her baby's level of comfort and what additional calming measures she can use.
  - The initial score, at around 2 h of age, reflects baseline behaviour. Subsequent scores are performed at 4- h intervals.
  - If a score is 8 or greater, scoring is completed every 2 h, until 24 h from the last score of 8.
  - A higher score implies greater severity.
  - If scores consistently remain under 8 until an infant is 48 h of age, continue observation every 8 h for 5 to 7 days to help detect late withdrawal.
- You administer morphine in accordance with your regional protocol to treat the ongoing symptoms.
- Scoring is continued to help titrate the morphine dose. You counsel the mother about how to assess her baby's level of comfort and what additional calming measures she can use.

**Thank  
You**

