Assessment of Infants with Neonatal Abstinence Syndrome
by
Karen D’Apolito, Ph.D., APRN, NNP-BC, FAAN
Professor & Program Director, NNP Specialty
Vanderbilt University School of Nursing

Faculty Disclosure
• I am the developer of the inter-observer reliability program for the Finnegan Scoring Tool.

Objectives
1) Describe the drugs that may cause NAS.
2) Identify screening methods used to diagnose neonatal drug exposure.
3) Describe the signs of NAS.
4) Describe the Finnegan Scoring Tool and how it is used in the management of NAS.

Case Study
• Baby boy A is a 36 week infant admitted to the NICU at 12 hours of age for tachypnea, tremors, vomiting, high pitched cry and hypertonicity. The mother had no prenatal care. What is going on with this baby?

Differential Diagnosis
• Hypoglycemia – glucose is 96
• Hypocalcemia – calcium is 9
• Hypomagnesemia – magnesium is 1.58
• Hyponatremia – Na is 140
• CNS insult – Apgars 8 & 9
• All must be considered and evaluated

Hamdan, et., al, 2012

Case Study
• Check further in the history and you find:
  – Mother’s urine toxicology is positive for opiates, marijuana and cocaine.
  – Check with the labor & delivery room nurse and find the mother was in a methadone treatment program during the latter part of her pregnancy.
  – Mother has had her three other children taken away from her due to her drug use.
Final Diagnosis

- Neonatal Abstinence Syndrome
- Generalized disorder
- Licit & illicit drugs
- Poly drug use

What is Addiction?

- A chronic, relapsing, disease involving drug-seeking and abuse by long-lasting chemical changes in the brain
- Uncontrollable craving, seeking, and use of a substance such as a drug or alcohol

ARE INFANTS BORN ADDICTED TO DRUGS?

YES?? ??? NO?? YES??

YES?? YES?? NO?? YES??

NO?? ARE INFANTS BORN ADDICTED TO DRUGS? YES??

???

YES?? NO?? NO??

???

YES?? ??? YES??

Drugs Associated with NAS

**Opioids:**
- Heroin
- Methadone
- Buprenorphine

**Illicit**
- Opioids:
  - Oxycodone
  - Percocet
  - Oxycontin
  - Hydrocodone
  - Dilaudid
  - Vicodin
  - Lortab
- Non-opioid CNS Depressants
  - Benzoiazepines
  - Valium
  - Librium
  - Xanax
- SSRI’s
  - Celexa
  - Paxil
  - Zoloft
- Barbiturates
  - Nembutal
  - Tuinal
- Anticonvulsants
- Antipsychotics
- Alcohol

**Hallucinogens**
- PCP
- Marijuana

**Stimulants**
- Cocaine
- Methamphetamine
- Ecstasy
Properties of Opioids

- Opiates are constituents or derivatives of constituents found in opium, which is processed from the latex sap of the opium poppy plant
- Semi-synthetic opioids such as heroin, oxycodone, and hydrocodone are derived from these substances

Action of Opioids

- Binds opioid receptors found principally in the CNS and the GI system
- Cough suppressant
- Analgesic effect by decreasing perception of pain, reaction to pain and increases the tolerance to pain

Types of Opioids

- Natural
  - Morphine & Codeine
- Semi-Synthetic
  - Hydrocodone. Oxycodone, Heroin, Buprenorphine
- Fully Synthetic
  - Methadone, Fentanyl, Tramadol

Properties

- Heroin
  - 20-25 times stronger than morphine
  - Very addictive
  - Fetal tissue within 1 hour
- Methadone
  - Substitute for heroin
  - Detected in fetal brain: 1-2 hrs
  - Metabolite present in urine up to 5 days

Buprenorphine

- Buprenorphine
  - Similar to methadone
  - Better outcomes/less relapse
  - Easily tapered for detox
  - Less withdrawal
  - Approved for use with non-pregnant women
  - Preliminary studies

Types of Buprenorphine

- Subutex
  - Buprenorphine
  - Sublingual tablet
- Suboxone
  - Buprenorphine + Naloxone
  - Naloxone
    - Keep people from abusing buprenorphine
    - Severe withdrawal if injected (IV, IM, Snorting)
Findings

- 131 babies (58 buprenorphine; 73 methadone)
- % of neonates needing treatment was not significantly different (p=0.26)
- No difference in peak NAS scores (p=0.04)

Signs of Withdrawal in Neonate

<table>
<thead>
<tr>
<th>Physiologic</th>
<th>Heroin</th>
<th>Methadone</th>
<th>Buprenorphine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sneezing</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Stuffy nose</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Spitting/Drooling</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Diarrhea</td>
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<td>Vomiting</td>
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<td>Poor feeding</td>
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<td>Sweating</td>
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<tr>
<td>Tachypnea</td>
<td>X</td>
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<tr>
<td>Tachycardia</td>
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</tbody>
</table>

Barbiturates/Alcohol

Commonalities
- a) depressants
- b) cross placenta readily
- c) addictive
- d) produce withdrawal
Alcohol Use During Pregnancy

<table>
<thead>
<tr>
<th>Status</th>
<th>Age (15-44)</th>
<th>Current</th>
<th>Binge</th>
<th>Heavy</th>
<th>Year</th>
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<tbody>
<tr>
<td>Pregnant</td>
<td></td>
<td>9.4%</td>
<td>2.3%</td>
<td>0.4%</td>
<td>2012 &amp;</td>
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<tr>
<td></td>
<td>Non-Pregnant</td>
<td>52.2%</td>
<td>22.9%</td>
<td>3.3%</td>
<td>2013</td>
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</table>

Note: These data were averaged over 2 years.

SAMSA (Substance Abuse and Mental Health Services Administration), 2013

Fetal Alcohol Spectrum Disorder

- Spectrum of deformities
- Criteria are ranked from 1 (normal) to 4 (significant of FAS)
- Elimination of the FAE term
- Includes dysmorphology scoring system
- More objective diagnosis

FASD

<table>
<thead>
<tr>
<th>Definition of FASD</th>
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</table>
| Fetal alcohol syndrome (FAS) | - Abnormal facial features (smooth philtrum, thick upper lip, short palpebral fissures)  
|                               | - Growth problems  
|                               | - CNS problems  
|                               | - Learning, memory, attention span, communication, speech or hearing  
| Alcohol-related neurodevelopmental disorder (ARND) | - Intellectual disabilities  
| Alcohol-related birth defects (ARBD) | - Problems with heart, kidneys, bones or hearing  

Fetal Alcohol Spectrum Disorders Center for Excellence, 2013

FASD

- Microcephaly
- Short palpebral fissures
- Low nasal bridge
- Minor ear anomalies
- Flat midsagittal
- Distinct philtrum
- Thin upper lip
- Micromandible
- Small jaw

Figure 1. Continuum of Pregnancy:
Outcome of Women Who Drink Alcohol

- FAE
- FAS
- Nonviable Fetus
- No Effects
Marijuana

1) Cannabis plant
2) Delta 9 Tetrahydrocannabinol (THC)
3) Crosses placenta
4) Detected in infant’s urine 1st day & stool for up to 3 days

Nicotine

- Tobacco is the only source of nicotine
- Active ingredient in tobacco
- Stimulant & relaxant
- Causes relaxation, calmness, alertness, decreases appetite and increases metabolism through release of chemicals

Nicotine

- Release of:
  - Acetylcholine - ↑ concentration, memory
  - Norepinephrine - ↑ arousal
  - Acetylcholine & Beta-Endorphin - ↓ pain
  - Beta-Endorphin - ↓ anxiety
  - Dopamine - ↑ arousal and reward

Signs of Withdrawal in Neonates

<table>
<thead>
<tr>
<th>Physiologic</th>
<th>Alcohol</th>
<th>Marijuana</th>
<th>Barbiturates</th>
<th>Nicotine</th>
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<tr>
<td>Sneezing</td>
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<td>Stuffy nose</td>
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<td>Drooling</td>
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<td>Diarrhea</td>
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<td>Vomiting</td>
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<th>Nicotine</th>
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<tr>
<td>Fist Tucking</td>
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<td>Irritability</td>
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<td>Restlessness</td>
<td>X</td>
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<td>Tremors</td>
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<td>High-Pitched Cry</td>
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<td>Seizures</td>
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<td>Yaowling</td>
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<tr>
<td>Disturbed sleep</td>
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<td>Increased crying</td>
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<td>Hyper tonicity</td>
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Phencyclidine (PCP)

- Psychoactive Drug
- Used as anesthetic before 1965
- Low doses: numbness in extremities & intoxication (staggering, slurred speech)
- Mod doses: analgesia & anesthesia
- High doses: convulsions

http://en.wikipedia.org/wiki/Nicotine

http://en.wikipedia.org/wiki/Phencyclidine
**Phencyclidine (PCP)**

- Psychological effects – out of body experiences, paranoia, hallucinations, euphoria, suicidal impulses
- Infant: metabolites found in urine for 1-7 days after mother stopped using 3 months before delivery

http://en.wikipedia.org/wiki/Phencyclidine

**Crack/Cocaine**

- Powerful CNS stimulant
- Crosses placenta
- Metabolite present in urine & stool (urine 1-2 days; meconium > 7 days)
- t½ ~ 60 +/- 30 min in adult; 6-8 hr in infant
- Powerful vasoconstrictor

Askin & Diehl-Jones, 2001

**Methamphetamine**

1) Highly addictive form of amphetamine
2) Stimulant like cocaine
3) man-made where cocaine is plant-derived
4) Damages neurons that produce serotonin & dopamine

NIDA Notes, September 2000; April 2002

**Selective Serotonin Reuptake Inhibitors (SSRIs)**

- Increases the availability of serotonin
- Weak affinity for acetylcholine and dopamine
- Uses:
  - Depression
  - General anxiety disorder
  - Obsessive compulsive disorder
  - Eating disorders


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<th>Buprenorphine</th>
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<tr>
<td>Flat Sucking</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Irritability</td>
<td>X</td>
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<td>Seizures</td>
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<td>Yawning</td>
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<td>Disturbed Sleep</td>
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<td>Increased crying</td>
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<td>Hyperactivity</td>
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<td>Drowsiness</td>
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<td>Increased deep</td>
<td>X</td>
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Onset of Signs

- Depends upon:
  - Type of drug
  - Additional Substances
  - Timing of maternal dose
  - Infant metabolism
  - Gestational age and birth weight
  - Genetics

Onset of Signs

- Alcohol – 3-12 hours
- Barbiturates - 1-14 days
- Caffeine – At birth
- SSRI – Hours to days
- Heroin (opioids with short t1/2) – 12-24/peak 72 hrs
- Methadone – 48 hours to as long as 7-14 days

Premature Infant

- Lower risk of having signs of NAS
  - < 35 weeks More immature CNS
  - Less fat stores
  - Differences in total drug exposure

Frequency of NAS

- 50-80% of heroin exposed infants develop NAS
- 60-90% of methadone and buprenorphine exposed infants develop NAS
- 60-80% of infants with NAS will require pharmacologic management

Onset of Signs

- Cocaine/Methamphetamine
  - After the first week of life
  - First week: signs are drug effect
    - Irritability
    - Hyperactivity
    - Tremors
    - Increased crying
    - Increased suckling

Premature Infant

- Lower risk of having signs of NAS
  - < 35 weeks More immature CNS
  - Less fat stores
  - Differences in total drug exposure
Genetics

• Genes in adults (SNPs)
  – Mu-opioid receptor (OPRM1)
  – Multidrug resistance (ABCB1)
  – Catechol-0-methyltransferase (COMT)
• Study in Infants
  – 5 hospitals in Mass & Maine
  – DNA samples were genotyped for SNPs, and then NAS outcomes were correlated with genotype.

Wachman, et al, 2013

Detection and Screening

Testing for drug exposure:
  – Urine
    • Obtain as soon as possible after birth
    • High false-negative (up to 60%) rate because only reports recent drug exposure
  – Meconium
    • Better than urine
    • Drug exposure from 16 weeks GA

Ostrea, 2001

Screening

• Umbilical Cord
  – 10 cm section of cord at delivery
  – Rise with sterile saline
  – Place in sterile container
  – ELISA based test
  – Information: www.usdtl.com

Montgomery, et al, 2006

Compared to Meconium

<table>
<thead>
<tr>
<th>Drug</th>
<th>UC</th>
<th>Agreement</th>
<th>Specificity</th>
<th>Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amphetamine</td>
<td>UC</td>
<td>Agreement – 96.6%</td>
<td>Specificity – 97%</td>
<td>Sensitivity – 95%</td>
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<tr>
<td>Opiates</td>
<td>UC</td>
<td>Agreement – 95%</td>
<td>Specificity – 96%</td>
<td>Sensitivity - 78%</td>
</tr>
</tbody>
</table>

Montgomery, et al, 2005

Compared to Meconium

<table>
<thead>
<tr>
<th>Drug</th>
<th>UC</th>
<th>Agreement</th>
<th>Specificity</th>
<th>Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cocaine</td>
<td>UC</td>
<td>Agreement – 99%</td>
<td>Specificity – 100%</td>
<td>Sensitivity – 75%</td>
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<tr>
<td>Cannabinoids</td>
<td>UC</td>
<td>Agreement – 91%</td>
<td>Specificity – 91%</td>
<td>Sensitivity – 89%</td>
</tr>
</tbody>
</table>

Montgomery, et al, 2005
Detection and Screening

- Hair Analysis:
  - Radio immunoassay
  - Grows 1 cm/month
  - Metabolite present for life of hair
  - Tells you drug use for months
  - Gets into microfibrils
  - Can use neonatal hair

Ostrea, 2001

Neonatal Abstinence Scoring Tools

- Lipsit
- Neonatal Withdrawal Inventory
- Neonatal Narcotic Withdrawal Index
- Finnegan Neonatal Abstinence Scoring Tool

Lipsit, 1975; Green & Suffet, 1991; Zahorsky, 1990; Finnegan, 1975

Multiple Drug Use

Accurate in Assessing Infants for Signs of NAS

Assessment tool recommended to examine infants for signs of NAS is the Finnegan Scoring Tool

Finnegan Neonatal Abstinence Scoring Tool

<table>
<thead>
<tr>
<th>Metabolic, Vasomotor And Respiratory Disturbance</th>
<th>Time</th>
<th>AM</th>
<th>PM</th>
<th>AM</th>
<th>PM</th>
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<tbody>
<tr>
<td>Myoclonic Jerk</td>
<td>3</td>
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<tr>
<td>Generalized Convulsions</td>
<td>5</td>
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<tr>
<td>Sweating</td>
<td>1</td>
<td></td>
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<tr>
<td>Fever &lt; 101 (37.2-38.3°C)</td>
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<tr>
<td>Frequent Yawning (&gt;3)</td>
<td>1</td>
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<tr>
<td>Mottling</td>
<td>1</td>
<td></td>
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<td>Nasal Stuffiness</td>
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<td>Sneezeing (&gt;3)</td>
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<td>Nasal Flaring</td>
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<tr>
<td>Respiratory Rate (&gt;60/Min)</td>
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<tr>
<td>Respiratory Rate (&gt;60/Min With Retractions)</td>
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<td>Intestinal Disturbances</td>
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<td>Excessive Sucking</td>
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<td>Poor Feeding</td>
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<td>Regurgitation</td>
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</tbody>
</table>
Important Points

- Scoring is dynamic and not static
- Signs present within the 3-4 hr scoring interval need to be scored when it is time for the scoring
- Decide whether you will score Q 3hrs or Q 4 hours and stick with it

Problems Using Scoring Tool

- Inconsistency regarding scoring intervals and feeding schedule.
  - Example: Babies awakened after a feeding to be scored.
- Inconsistence between staff with scoring.

Problems Using Scoring Tool

- Inconsistency with defining the signs & symptoms of withdrawal.
  - Example: How do you differentiate between mild, moderate and severe tremors?
  - Example: How do you differentiate between a hyperactive and a markedly hyperactive Moro reflex?
Remedy

- Developed item definitions
- Inter-Observable reliability program

Scoring Frequency

- Initially after transition (2-4 hours after birth)
- Then, Q 3-4 hours
- Treatment begins when score is 8 or greater

Scoring Frequency

- If no treatment required by 72 hrs scoring can be discontinued & discharged after 24 hrs

Important Points

- Scoring is dynamic and not static
- Signs of withdrawal present within the 3-4 hour scoring interval need to be scored

Techniques

- Check tone:
  - Upright Suspension method

Techniques

- Check tone:
  - Pull-to-Sit method
Techniques
Check tone:
• Flexion/Extension method

Techniques
Moro Reflex

Crying
• Score 2 if excessive high pitched and unable to self console in 15 sec or continuous up to 5 minutes despite intervention.
• Score 3 if unable to self console in 15 sec or continuous >5 min despite intervention.

Sleep
• Based on longest period of sleep light or deep after feeding.
  • Score 3 if <1 hour
  • Score 2 if <2 hours
  • Score 1 if <3 hours

Moro Reflex
• Hyperactive: elicit from quiet infant.
• Score 2 for hyperactive-jitteriness that is rhythmic, symmetrical, and involuntary.
• Markedly Hyperactive:
  • Score 3 for jitteriness as above with clonus of hands/arms. May test at hands or feet if unclear (more than 8 to 10 beats).
Tremors Disturbed

- **Tremors** are involuntary, rhythmical muscle contraction and release involving to and from movements
  - Disturbed:
  - Score 1 for mild/disturbed- of hands or feet while being handled.
  - Score 2 for moderate/severe disturbed - of arms or legs while being handled.

D’Apolito & Finnegan, 2010

Tremors Undisturbed

- NOT touching baby after the infant has been handled (wait 15-30 seconds)
- Score 3 for mild undisturbed - Tremors of hands or feet when not handled.
- Score 4 for moderate/severe undisturbed - Tremors of arms and/or legs or both when not handled.

D’Apolito & Finnegan, 2010

Increased Muscle Tone

- **To test:** perform pull to sit maneuver.
- Score 2- no head lag with total body rigidity. Do not test while asleep or crying. Other maneuvers may be used.

D’Apolito & Finnegan, 2010

Excoriation

- Score 1 if present at nose, chin, cheeks, elbows, knees, or toes.
- Do not score for diaper area. This is related to loose or watery frequent stools.

D’Apolito & Finnegan, 2010

Myoclonic Jerks

- Involuntary twitching of muscle.
- Score 3 for twitching at face/ extremities or jerking at extremities (more pronounced than jitteriness of tremors).

D’Apolito & Finnegan, 2010

Generalized Seizures

- Score 5 for tonic seizures with extension or flexion of limb(s). Does not stop with containment. May include few clonic beats and/or apnea
Sweating

- Score 1 for wetness at forehead, upper lip, or back of neck
- Do not score related to the environment (be consistent with linen)

Fever/Frequent Yawning/Mottling

- Fever
- Score 1 if 37.2-38.3°C (101°F or <)
- Score 2 if 38.4°C (≥101°F)
- Frequent Yawning
- Score 1 if >3 within interval.
- Mottling (marbled appearance (pink & white))
- Score 1 if present at chest, trunk, arms, or legs.

Nasal Stuffiness/Sneezing

- Nasal Stuffiness - nares partially blocked from drainage with noisy respiration.
- Score 1 if present with/without runny nose
- Sneezing - individual or serial
- Score 1 for >3 during scoring interval

Nasal Flaring

- Nasal Flaring - nostrils flared out during respirations.
- Score 2 if present

Respiratory Rate

- Respiratory Rate - tachypnea >60 with/without retractions.
- Score 1 for rate >60 without retractions
- Score 2 for rate >60 with retractions
- Count for one full minute

Excessive Sucking

- Rooting with attempts to suck fist, hand, or pacifier before or after feeding.
- Score 1 for >3 attempts noted.
Poor Feeding

- Excessive sucking - (as described previously) but infrequent or uncoordinated with feeding. Gulping with frequent rest periods to breath.
- Score 2 if present

Regurgitation/Projectile Vomiting

- Regurgitation - effortless (not associated with burp).
- Score 2 for 2 or more episodes
- Projectile Vomiting - forceful during or after feed.
- Score 2 for 1 or > episodes

Loose/Watery Stools

- Loose stool - Loose, curdy, seedy, or liquid without water ring
- Score 2 if present
- Watery stool - Soft, liquid or hard with water ring
- Score 3 if present

Optimal Scoring

- Important to know the item definitions
- Important to establish an inter-observer reliability strategy to assure accurate scoring
- Scoring is dynamic and not static

Inter-observer Reliability

- The two nurses compare their scores
- Determine their percent agreement
- Goal: Achieve 90% agreement or greater

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<th>Total Number of Items of Disagreement</th>
<th>Percentage Score</th>
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Reliability Testing

- Initial
- Each new staff member caring for the baby
- Two staff score at same time
- Determine a protocol – reliability assessment every 9, 10 or 11th score
Demonstration Video

References 1


Reference 2


References 3