Neonatal/Pediatric Cardiopulmonary Care

Respiratory Care Procedures

Airway Clearance

Airway Clearance

- Based on careful assessment of pulmonary status
- Not specific to neonates, but to any age group
- Especially needed in neonate because of small airway diameter

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Airway Clearance Indications

- Retained secretions
  - Atelectasis
  - RDS
  - BPD
  - Intubation
  - Ineffective cough
  - Pain
  - Paralysis
  - NM disease
  - Ciliary dysfunction

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Airway Clearance Indications

- Excessive secretions
  -
  -
  -
  -
  -

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Airway Clearance Indications

- Aspiration
  –
  –
- Prophylaxis
  –

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Airway Clearance Contraindications & Hazards

- Pulmonary hemorrhage
- Excessive agitation or hypoxemia during therapy
- Feedings within 45 min-to-1 hour
- History of reflux or IVH
- Neonates <1200 g or <32 wks
- Untreated pneumothorax
- CHF

Airway Clearance Techniques

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Positive Expiratory Pressure (PEP)

- Relatively new to USA
- Done using a flow resistor, mask or mouthpiece through which patient breathes
  - As patient exhales, positive pressure is created in airways
- Pressure monitored & adjusted
  - Low:
  - High:

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Positive Expiratory Pressure (PEP)

- Done -
- Followed by Forced Exhalation Technique (FET) & repeated until secretions expelled
- Produces
  - Dilation of airways
  - Gas passes through obstruction
  - Increases oxygenation & ventilation
  - Mobilizes secretions

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Forced Exhalation Technique (FET)

- = way to modify cough to avoid airway collapse
- Performed by having patient inhale slowly then "huff" coughing 2-3 times (glottis remains open)
- Interspersed with deep, relaxed breath
- Followed by cough to remove loosened secretions

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Autogenic Drainage

- Patient breathes at 3 different lung volumes
  - 1st phase
    - Patient inhales normal V_T & exhales midway into ERV
    - Loosens mucous lining in airways

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Autogenic Drainage

- 2nd phase
  - Patient inhales slightly above V_T & again exhales to mid-ERV
  - Allows collection of mucus from periphery to the mid-central airways
- 3rd phase
  - Patient inhales to VC then exhales to beginning of ERV

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Autogenic Drainage

- Advantage
  -
  -
- Disadvantage
  -
  -

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High Frequency Chest Compression

- Applies high frequency oscillations to chest wall
- Vibrations transmitted to airways
- Inflatable jacket worn by patient ("The Vest™" made by American Biosystems)
- Inflated & deflated rapidly by external pump

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Flutter Valve

- Device that combines PEP with vibration applied to airways
- Patient exhales into Flutter Valve
- Oscillations produced by a ball applied during expiration
- Creates -

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Intrapulmonary Percussive Ventilation (IPV)

- Delivery of high frequency, low-volume, positive-pressure breaths in the range of 100-300 cycles/min
- Creates an internal percussion effect on the lungs as they are held in the state of partial inspiration
- Administered with the Intrapulmonary Percussionator IPV-1 ventilator via mouthpiece, mask, or artificial airway
- Can do with SVN in-line

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Chest Physiotherapy (CPT)

- Auscultation
- Postural Drainage
- Percussion
- Vibration
- Secretion Removal
  - Cough, FET, Sx

Aerosolized Drug Therapy

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Aerosolized Drug Therapy

- Delivered by
  -
  -
  -
  -

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Aerosolized Drug Therapy Goal

- Deliver adequate amounts of medicine to desired sites in pulmonary tree with minimum of side-effects
- Effective therapy depends on 4 factors
  1. Size & amount of particles produced
  2. Characteristic of particles
  3. Anatomy of the airways
  4. Patient's ventilatory pattern

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Effective Therapy

1. Size & Amount of Particles Produced

- Depends on type of nebulizer
- Jets are common & easy to use (SVN, LVN)
- Particle size varies & much of the meds are lost during expiration
- Reservoir helps

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Effective Therapy

2. Particle Characteristics

- Major factor that affects deposition = ability to take on additional water =

Aerosols grow larger when added to an environment of high humidity

More likely to deposit higher in airway

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Effective Therapy

2. Particle Characteristics

- Other characteristics affecting deposition
  -
  -
  -
  -
    -

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Effective Therapy

2. Particle Characteristics

- Note:
  - Lung deposition of aerosolized drugs delivered to intubated infants = 1/10 of amount delivered to intubated adults & about 1/20 amount delivered to nonintubated adults

  - Higher dosages needed when delivering aerosolized drugs to intubated infants

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Effective Therapy

3. Anatomy of the Airways

- Narrow airways more deposition in upper airways
  +
- Bronchoconstriction
  +
- Secretions
  +
- ETT

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Effective Therapy

4. Ventilatory Pattern

- Aerosol delivery is best with laminar flow followed by a brief pause
- Big problem with infants!
- Can do on vent
  –
  –
  –

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Effective Therapy

4. Ventilatory Pattern

- Aerosol drug delivery has limited use in NICU due to
  - –
  - –
- Pedi
  - –
  - – Which way is best??

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SVN

- Advantages
  - – Require little patient cooperation
  - – Good in acute distress or in presence of reduced flows & volumes
  - – Allows modification of dosage

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SVN

- Disadvantages
  - – Relatively expensive
  - – Not easily transported
  - – Require cleaning & preparation
  - – Dose delivery is inefficient
  - – Provides medium for bacterial growth
  - – Less useful in presence of airway obstruction
  - – And … … ..

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SVN

- Disadvantages
  - If used with vent - hygroscopic growth + humidity in vent circuit results in deposition in upper airways

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LVN

- "Heart nebs"
- Used when need to deliver meds over a long period of time (continuous nebulizer therapy)

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MDI

- Advantages
  - Portable
  - Efficient drug delivery
  - Short prep & delivery time
  - Resistant to hygroscopic growth in vent circuit

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MDI

- Disadvantages
  - Difficult to coordinate breath with delivery
  - Oropharyngeal impaction
  - Fixed drug concentration
  - Limited choice of drugs
  - Reactions to propellants
    - AARC & ARCF have issued statements that due to danger of hypoxia when propellant mixes with patient's V_T, patients being ventilated at V_T <100 ml should not receive in-line MDIs

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DPI

- Advantages
  - Same as MDI
  - Limited need for hand-breath coordination
  - No propellants
  - Drug dose easily counted

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DPI

- Disadvantages
  - Limited number of drugs available
  - Possible irritation of airways from dry powder
  - Require high insp flow rates
  - Require loading before use
  - Less useful in presence of airway obstruction

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Indications for Aerosolized Drugs

- Bronchodilators
  - bronchoconstriction

↓ BS	↑ F_IO_2 req	↓ chest expansion
↑ RR	nasal flaring	↑ vent pressures
wheezes	grunting	if old enough to do PFT:
↑ $PaCO_2$	retractions	↓ VC, ↓ PEFR

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Indications for Aerosolized Drugs

- Mucolytics
  - Presence of thick secretions
  - Hard to detect difference between thick secretions & bronchospasm

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Indications for Aerosolized Drugs

- Steroids
  - Presence of inflammatory process (BPD or asthma)
  - Method of action is unknown; thought to
    - Have antivasopressin effects
    - Enhance surfactant production
    - Enhance β-adrenergic function
    - Stimulate antioxidant production
    - Improve microcirculation

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Equipment for Aerosolized Drug Delivery

- SVN with mp, mask, in-line
- MDI with spacer
- DPI (not in-line with vent)

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Equipment for Aerosolized Drug Delivery

- Intubated neonates (not pedi)
  - Use of 6-8 lpm with SVN increases V_T, PIP, PEEP
  - To fix
    - Place neb at humidifier outlet & nebulize during exhalation?????????
    - Decrease vent gas flow proportionally through SVN

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Equipment for Aerosolized Drug Delivery

- Intubated neonates (not pedi)
  - Turn off or pause humidifier to reduce rain-out prod by cooling of gas by flow from neb
    - If heater left on during Rx & temp probe is between neb & patient -- heater goes into "warm-up" mode as flow from neb cools probe -- when neb flow turned off, gas in humidifier is super-heated and may burn patient
  - Remove HMEs

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Hazards & Complications

- Infection
  - Nosocomial
  - Due to contamination
    - ▼
    - ▼
    - ▼

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Hazards & Complications

- Medication side-effects
  - Drug reactions vary with size & maturation
  - Watch for changes in CV system
    - ▼
    - ▼
    - ▼

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Hazards & Complications

- Drug reconcentration
  - As drug nebulizes, larger droplets return to neb
  - Concentration of drug increases
  - Near Rx end - more drug being nebulized increasing risk of side-effects

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Hazards & Complications

- Other
  - Drug sticks to vent exhalation valve ↑ PEEP & T_I
    - ▼
  - High noise level prod by some nebs
    - ▼

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Small Particle Aerosol Generator

- SPAG
- Unique device designed & intended for administration of ribavirin (Virazole)
- No other med can be put through SPAG & ribavirin should not be delivered by any other neb
- No one is using ribavirin anymore

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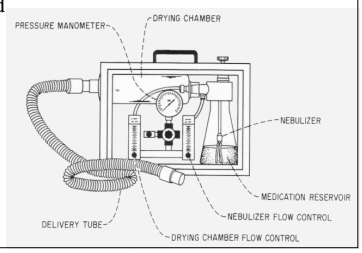
SPAG

- Ribavirin reconstituted in LVN in SPAG unit
- Compressed gas enters into pressure regulator where its reduced to 26 psi
- Gas fed to 2 separate flowmeters



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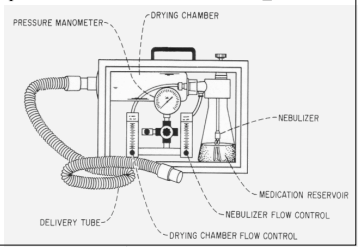
SPAG

- Flowmeter 1 goes to nebulizer with drug
- Flowmeter 2 goes to drying chamber where nebulized particles undergo evaporation to reduce size to 1.2-1.4 □
- Particles exit drying chamber to patient by mask, hood, tent, vent
- Operated at 7 lpm - total flow 15 lpm



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SPAG

- Ribavirin can collect on tubing, ETT contacts, & glom onto pregnant ladies
- 1-way valves to prevent back flow of drug to humidifier & SPAG
- Filters on expiratory vent line
- Disposable expiratory valves on vent
- Heated wire circuits to reduce rain-out
- Sx ETT q1-2 hrs
- Monitor pressures

Suctioning

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Sx - Indications

- Remove secretions
- Not done -

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Sx - Equipment

- Monitor
  - HR & SpO_2
- Stethoscope
- Ambu bag with pressure manometer
- Saline
- Sx cath kit or in-line
- H_2O soluble jelly
- Sx source
  - Neonates: -50 to -80 mmHg
  - Pedi: -80 to -100 mmHg

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Sx - Catheter Sizes

Selecting Sx Catheter Sizes

Intubated Patients:

Endotracheal Tube (mm ID)	Sx Catheter (French)
2.5	6
3.0	6-8
3.5	8-10
4.0	8-10

Intubated Patients:

Age	Sx Catheter (French)
premie	6
term	6-8
NB-6 mo.	8-10

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Sx - Procedure

- Insert cath only to tip of ETT + 4 cm - use cm marks on ETT
- Maximum Sx time =
- Maximum procedure time =
- Repeat as needed

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Sx - Hazards

- Bradycardia (vagal response, hypoxia)
- Hypoxemia
- Mucosal damage
- Atelectasis
- Airway contamination
- Accidental extubation

Oxygen Therapy

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Indication

- Presence of hypoxemia
  - Neonate
    - ▼PaO_2
    - ▼Normal
  - Pedi
    - ▼PaO_2

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Hypoxemia

- Methods of diagnosis
  -
  -
  -
- Evidenced by
  -
  -
  -
  -

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Hazards of O_2 Therapy

- ROP - Retinopathy of Prematurity
- Oxygen toxicity BPD
- Cerebral vasoconstriction
- Fire hazard

- Maintain PaO_2 -

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Equipment

- NC, masks same as adult
- Hoods
  - Use with less than
  - Flow >
  - Monitor gas temperature

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Equipment

- Incubators
  - Provide warm, humidity, filtering, oxygen
  - Red flag
    - Down:
    - Raised:
  - Problem
    - Hard to regulate O_2%
    - Better to manage with oxyhood

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Equipment

- Resuscitation Bags
  - Flow-inflating & self-inflating
  - Use pressure manometer
  - Flow 5-6 lpm