Objectives

1) Demonstrate understanding of the indications for intubation
2) Perform rapid sequence intubation
3) Learn the pharmacology behind emergency airway management
4) Demonstrate the ability to manage the pediatric airway
5) Demonstrate the ability to identify the difficult and failed airway
6) Demonstrate working knowledge of the emergency airway algorithms
7) Practice the various techniques of airway management
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7) Practice the various techniques of airway management
Are children little adults?
Are the management principles different?
**NO, they are not!**

- 95% of the principles are *exactly* the same
- Hypoxia is bad!
- Indications for intubation are the same
- Universal algorithm is the same
- RSI, Crash, Difficult and Failed algorithms are the same
- Back up devices (LMA) are the same
The Differences. . .

- Anatomical and physiological variation which evolves as development proceeds from infancy to adolescence
- Age and weight related differences in drug dosing and equipment sizing
- Increased performance anxiety which accompanies the resuscitation of the critically ill child
Anatomical and Physiological Differences
Infant Small Child Older child/Adult

Key to optimal individual patient position—Line traversing external auditory canal crossing anterior to the shoulders

- Support for the occiput in the older child/adult and the shoulders in the infant
- Extension of the head in the infant and small child
- Hyperextension of the head in the older child or adult
The Pediatric Airway

The Kid

Miniature Adult

Small Adult

Adult

Adult/Adelescent

<3 mo 6 mo 8 mo 1 yr 3 yr 4 yr 5 yr 8 yr 10 yr
Normal Anatomy

- Vocal Cords
- Extra-thoracic trachea
- Pleural space
- Lung
Normal Inspiration

Vocal Cords

Extra-thoracic trachea

Pleural space

Lung

Principles...
Respiratory arrest is precipitated without “complete” obstruction.
Needle Cricothyrotomy

2 Skills required:
1) Starting an IV
2) BMV ventilation
Physiological Differences

TIME TO HEMOGLOBIN DESATURATION WITH INITIAL $F_{AO_2} = 0.87$

- SaO₂, %
- Time of $\dot{V}_E = 0$, minutes

Curves for:
- Normal 10 kg Child
- Moderately Ill 70 kg Adult
- Obese 127 kg Adult
- Normal 70 kg Adult

Mean Time to Recovery of Twitch Height From 1 mg/kg Succinylcholine i.v.
Drug Dosing and Equipment Selection
Pediatric Resuscitation associated with error and time delay and a *great deal* of discomfort!
The “Cognitive Load” of Pediatric Resuscitation

• Logistical time
  – Automatic
  – Non-automatic activities

• Critical thinking time
**Decide on a medication**

- Estimation of weight
- Recall of dose
- Calculation of dosage
- Communication of dosage (verbal orders, handwritten)
- Obtaining the correct concentration
- Calculating the correct drug volume
- Rechecking the drug volume calculation
- Administering the dose correctly,
- Administering the dose to the correct patient
- Documenting accurately

*Patient receives intended medication*
non-automatic activities
Vs. Automatic Activity

Equipment selection equally confusing:

10 different ET tube sizes
Suction catheters ET tube size specific
Various types and sizes of Laryngoscope blades
Various BVM, oral and NP airways
Sources of *non-automatic* activities, particular to children:

1) Weight estimation
2) Equipment Selection
3) Recall/referencing doses
4) Calculation of doses
5) Calculation of drug volumes
6) Calculation of fluid volumes
7) Calculation of ventilatory volumes
The Broselow Tape
## GENERIC PEDIATRIC SEQUENCE
- **Preparation**
- **Preoxygenation** 100% oxygen
- **Pretreatment** Atropine
- **Paralysis + Induction** Etomidate
- **Post intubation management** including long acting paralytic

---

## PEDIATRIC DRUGS AND EQUIPMENT

### THE BROSELOW-LUTEN SYSTEM

#### ZONE
- **PINK**
- **RED**
- **PURPLE**
- **YELLOW**
- **WHITE**
- **BLUE**
- **ORANGE**
- **GREEN**

<table>
<thead>
<tr>
<th>Length (cm)</th>
<th>Pink</th>
<th>Red</th>
<th>Purple</th>
<th>Yellow</th>
<th>White</th>
<th>Blue</th>
<th>Orange</th>
<th>Green</th>
</tr>
</thead>
<tbody>
<tr>
<td>59.5 - 66.5</td>
<td>66.5 - 74</td>
<td>74 - 84.5</td>
<td>84.5 - 97.5</td>
<td>97.5 - 110</td>
<td>110 - 122</td>
<td>122 - 137</td>
<td>137 - 150</td>
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<tr>
<td>Avg. wt (range)</td>
<td>6.5 kg (9-7)</td>
<td>8.5 kg (8-9)</td>
<td>10.0 kg (10-11)</td>
<td>13 kg (12-14)</td>
<td>16.5 kg (15-18)</td>
<td>20.75 kg (19-22)</td>
<td>27 kg (23-30)</td>
<td>36 kg (31-40)</td>
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</table>

### PRETREATMENT AGENTS
- **Lidocaine**
- **Opioid (fentanyl)**
- **Atropine**
- **Decthascillation (par), vec**

<table>
<thead>
<tr>
<th>Length (cm)</th>
<th>Pink</th>
<th>Red</th>
<th>Purple</th>
<th>Yellow</th>
<th>White</th>
<th>Blue</th>
<th>Orange</th>
<th>Green</th>
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</thead>
<tbody>
<tr>
<td>10 mg</td>
<td>14 mg</td>
<td>15 mg</td>
<td>20 mg</td>
<td>26 mg</td>
<td>30 mg</td>
<td>40 mg</td>
<td>50 mg</td>
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<tr>
<td>20 mg</td>
<td>25 mg</td>
<td>32 mg</td>
<td>40 mg</td>
<td>50 mg</td>
<td>62 mg</td>
<td>80 mg</td>
<td>100 mg</td>
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</tr>
<tr>
<td>0.13</td>
<td>0.17 mg</td>
<td>0.2 mg</td>
<td>0.26 mg</td>
<td>0.33 mg</td>
<td>0.5 mg</td>
<td>0.72 mg</td>
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<td>N/A</td>
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<td>N/A</td>
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</tr>
</tbody>
</table>

### INDUCTION AGENTS
- **Etomidate**
- **Midazolam**
- **Ketamine**

<table>
<thead>
<tr>
<th>Length (cm)</th>
<th>Pink</th>
<th>Red</th>
<th>Purple</th>
<th>Yellow</th>
<th>White</th>
<th>Blue</th>
<th>Orange</th>
<th>Green</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 mg</td>
<td>2.5 mg</td>
<td>3.2 mg</td>
<td>4 mg</td>
<td>5 mg</td>
<td>8 mg</td>
<td>8 mg</td>
<td>10 mg</td>
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<tr>
<td>2 mg</td>
<td>2.5 mg</td>
<td>3.2 mg</td>
<td>4 mg</td>
<td>5 mg</td>
<td>8 mg</td>
<td>8 mg</td>
<td>10 mg</td>
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<tr>
<td>13 mg</td>
<td>17 mg</td>
<td>21 mg</td>
<td>26 mg</td>
<td>30 mg</td>
<td>40 mg</td>
<td>50 mg</td>
<td>70 mg</td>
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</table>

### PARALYTICS
- **Succinylcholine**
- **Rocuronium**

<table>
<thead>
<tr>
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<th>Red</th>
<th>Purple</th>
<th>Yellow</th>
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<th>Blue</th>
<th>Orange</th>
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</thead>
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<tr>
<td>14 mg</td>
<td>18 mg</td>
<td>22 mg</td>
<td>26 mg</td>
<td>30 mg</td>
<td>40 mg</td>
<td>50 mg</td>
<td>70 mg</td>
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<tr>
<td>6.5 mg</td>
<td>8.5 mg</td>
<td>10 mg</td>
<td>13 mg</td>
<td>16 mg</td>
<td>20 mg</td>
<td>27 mg</td>
<td>36 mg</td>
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</table>

### MAINTENANCE
- **Paralivs**
- **Lorazepam**

<table>
<thead>
<tr>
<th>Length (cm)</th>
<th>Pink</th>
<th>Red</th>
<th>Purple</th>
<th>Yellow</th>
<th>White</th>
<th>Blue</th>
<th>Orange</th>
<th>Green</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 mg</td>
<td>0.6 mg</td>
<td>1.0 mg</td>
<td>1.2 mg</td>
<td>1.6 mg</td>
<td>2 mg</td>
<td>2.5 mg</td>
<td>3.5 mg</td>
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</tr>
<tr>
<td>0.3 mg</td>
<td>0.4 mg</td>
<td>0.5 mg</td>
<td>0.6 mg</td>
<td>0.8 mg</td>
<td>1 mg</td>
<td>1.4 mg</td>
<td>1.8 mg</td>
<td></td>
</tr>
</tbody>
</table>

### EQUIPMENT
- **E.T. Tube (mm)**
- **Lip-Tip distance**
- **Suction**
- **Laryngoscope blade**
- **Stylet**
- **Oral airway**
- **Nasopharyngeal Airway**
- **BVM**

<table>
<thead>
<tr>
<th>Length (cm)</th>
<th>Pink</th>
<th>Red</th>
<th>Purple</th>
<th>Yellow</th>
<th>White</th>
<th>Blue</th>
<th>Orange</th>
<th>Green</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5 uncf</td>
<td>3.5 uncf</td>
<td>4.0 uncf</td>
<td>4.5 uncf</td>
<td>5.0 uncf</td>
<td>5.5 uncf</td>
<td>6.0 cuffed</td>
<td>6.5 cuffed</td>
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<tr>
<td>10.5</td>
<td>10.5</td>
<td>12</td>
<td>13.5</td>
<td>15</td>
<td>16.5</td>
<td>18</td>
<td>19.5</td>
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<tr>
<td>10F</td>
<td>10F</td>
<td>10F</td>
<td>10F</td>
<td>10F</td>
<td>10F</td>
<td>12F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 straight</td>
<td>1 straight</td>
<td>1 straight</td>
<td>2 straight/curved</td>
<td>2 straight/curved</td>
<td>2 straight/curved</td>
<td>2 straight/curved</td>
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<tr>
<td>6F</td>
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<tr>
<td>50 MM</td>
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<td>60 MM</td>
<td>60 MM</td>
<td>60 MM</td>
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<td>60 MM</td>
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<tr>
<td>14F</td>
<td>14F</td>
<td>14F</td>
<td>20F</td>
<td>22F</td>
<td>24F</td>
<td>26F</td>
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</tr>
<tr>
<td>INFANT</td>
<td>INFANT</td>
<td>CHILD</td>
<td>CHILD</td>
<td>CHILD</td>
<td>CHILD</td>
<td>CHILD</td>
<td>ADULT</td>
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</tbody>
</table>

### VENTILATION
- **Total volume**
- **Frequency (bpm)**

<table>
<thead>
<tr>
<th>Length (cm)</th>
<th>Pink</th>
<th>Red</th>
<th>Purple</th>
<th>Yellow</th>
<th>White</th>
<th>Blue</th>
<th>Orange</th>
<th>Green</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-100 mL</td>
<td>75-125 mL</td>
<td>100-150 mL</td>
<td>125-200 mL</td>
<td>150-250 mL</td>
<td>200-300 mL</td>
<td>250-400 mL</td>
<td>400-600 mL</td>
<td></td>
</tr>
</tbody>
</table>

---

**ETCO2 Detector:**
- **Peds:** Pink, Red, Purple, Yellow
- **Adult:** White, Blue, Orange, Green

---

*The above 3, 4, and 5 kilograms weights are not part of the color coded zones. The following applies to these patients: Equipment - same as pink zone Drugs - 3 kg, 1/2 (50%) of pink zone doses, 4 kg, 2/3 (67%) of pink zone doses, 5 kg, 3/4 (75%) of pink zone doses

**F2O2:** 100%, PEEP: 3 - 5 cm H2O, Tidal Volume: 10 - 15 mL/kg, Inspiratory Time > 0.6 sec, PIP: 20 - 30 cm H2O
<table>
<thead>
<tr>
<th>ZONE*</th>
<th>PINK</th>
<th>RED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (cm)</td>
<td>59.5 - 66.5</td>
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<td>Avg. wt (range)</td>
<td>6.5 kg (6-7)</td>
<td>8.5 kg (8-9)</td>
</tr>
<tr>
<td>PRETREATMENT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lidocaine</td>
<td>10 mg</td>
<td>14 mg</td>
</tr>
<tr>
<td>Opioid (fentanyl)</td>
<td>20 μg</td>
<td>25 μg</td>
</tr>
<tr>
<td>Atropine</td>
<td>0.13</td>
<td>0.17 mg</td>
</tr>
<tr>
<td>Defasciculation (pan/vec)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>INDUCTION AGENTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Etomidate</td>
<td>2 mg</td>
<td>2.5 mg</td>
</tr>
<tr>
<td>Midazolam</td>
<td>2 mg</td>
<td>2.5 mg</td>
</tr>
<tr>
<td>Ketamine</td>
<td>13 mg</td>
<td>17 mg</td>
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<tr>
<td>PARALYTICS</td>
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</tr>
<tr>
<td>Succinylcholine</td>
<td>14 mg</td>
<td>18 mg</td>
</tr>
<tr>
<td>Rocuronium</td>
<td>6.5 mg</td>
<td>8.5 mg</td>
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<tr>
<td>MAINTENANCE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pan/vec</td>
<td>0.6 mg</td>
<td>0.8 mg</td>
</tr>
<tr>
<td>Lorazepam</td>
<td>0.3 mg</td>
<td>0.4 mg</td>
</tr>
<tr>
<td>EQUIPMENT</td>
<td></td>
<td></td>
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<tr>
<td>E.T. Tube (mm)</td>
<td>3.5 uncff</td>
<td>3.5 uncff</td>
</tr>
<tr>
<td>Lip-Tip distance</td>
<td>10.5</td>
<td>10.5</td>
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<tr>
<td>Suction</td>
<td>8F</td>
<td>8F</td>
</tr>
<tr>
<td>Laryngoscope blade</td>
<td>1 straight</td>
<td>1 straight</td>
</tr>
<tr>
<td>Stylet</td>
<td>6F</td>
<td>6F</td>
</tr>
<tr>
<td>Oral airway</td>
<td>50 MM</td>
<td>50 MM</td>
</tr>
<tr>
<td>Nasopharyngeal Airway</td>
<td>14F</td>
<td>14F</td>
</tr>
<tr>
<td>BVM</td>
<td>INFANT</td>
<td>INFANT</td>
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<tr>
<td>VENTILATION**</td>
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<tr>
<td>Tidal volume</td>
<td>60-100 mL</td>
<td>75-125 mL</td>
</tr>
<tr>
<td>Frequency (bpm)</td>
<td>20-25</td>
<td>20-25</td>
</tr>
</tbody>
</table>
Resuscitation Aids

Transform *non-automatic* activities, the age/size related variables particular to children, into *automatic* activities, thereby accelerating time to treatment and reducing potential for error.
Some Specifics

- ETT size = \( \frac{16 + \text{age in years}}{4} \)
  *Cannot be used if < 1 year
- Insertion Distance = ETT size \( \times 3 \)
- The smallest bag mask is 450 cc
  *Don’t use the 250cc bag
- Succinylcholine dose is 2mg/kg
RSI Sequence

- **Preparation** – use the Broselow tape
- **Preoxygenation** – be meticulous
- **Pretreatment** – none necessary
- **Paralysis with induction**
  - SCh 2 mg/kg or rocuronium 1 mg/kg
  - Etomidate 0.3 mg/kg or ketamine 1.5 mg/kg
- **Positioning** – EAM → anterior shoulder
- **Placement and Proof**
- **Postintubation Management**
Follow the nose
Postintubation Management
Pediatric Induced Anxiety
Summary

- The indications and algorithms are the same
- Use the Broselow tape to select your medication doses and equipment sizes
- Be prepared to BMV
- Intubation is different, but always in the same way
- Secure the tube and the neck
- Needle cricothyrotomy is the solution to the failed airway