Transport Ventilation: More Than Just Rolling Down the Windows

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University of Vermont Health Network
Critical Care Transport Team
“HealthNet”
Disclosures

No actual or potential conflicts of interest in relation to this presentation.
Learning Objectives

1. Compare and contrast respiratory care in the hospital and transport environments
2. Identify considerations and techniques to prepare a patient for transport
3. Discuss benefits and limitations of various transport modalities
What is prehospital medicine?
Traditionally
Same Care... Different Challenges...
KNOW BEFORE YOU GO
Receiving Facility

Dedicated 60+ Seconds for ACTIVE LISTENING HANDOFF

Preplanned Collaborative Approach

Lead & Model by good example!

Appropriate Feedback at Appropriate Time
Clinical handovers between prehospital and hospital staff: literature review

Kate Wood,¹ Robert Crouch,² Emma Rowland,³ Catherine Pope⁴
Handoff Dynamics

- **Behavior**
  - Active Listening
  - Eye Contact
  - Body Language

- **Working Relationship**
  - Mistrust
  - Perceptions
  - Non-judgmental

- **Professionalism**
  - Scope of Practice
  - Shared Mental Model
  - Ask Questions

- **Context**
  - Acuity
  - Environment
Shared Mental Model

1. Shared knowledge about **how the task (i.e. handoff) will be accomplished** within the environment

2. Inline **perceptions** of each **team member’s role** & how the team members will collaborate to communicate information

3. **Shared** understanding of each team member’s **knowledge, skills, attitudes, strengths and limitations (good work relationship)**

Communications Key Points

1. Familiarity with providers during handoff

2. Use of common language or a “cognitive picture”

3. Allowing for dynamic conversation

4. Multiple Handoffs $\rightarrow$ Lost info

THE ABBOTT AND COSTELLO SHOW
WHO'S ON FIRST?

Common Language
"I've never heard the phrase "compensated PEEP" before... maybe it's an American term. But a Google search seems to say that you're correct.

Uncompensated = what you set is what you get. European vents (Draeger, Siemens) do this.

Compensated = you do the math. North American vents (Puritan Bennett, GE) do this. This is easy to remember because North Americans are always compensating for something."
Conclusions: There is a relationship between EMS MIST completeness and high performance of non-technical skill by trauma teams. Trauma video review (TVR) can help identify modifiable behaviors to improve EMS handoff and resuscitation efforts and therefore trauma team performance.
Review

Barriers to effective EMS to emergency department information transfer at patient handover: A systematic review

Lindsay Troyer, William Brady, MD *

Department of Emergency Medicine, University of Virginia, Charlottesville, VA 22908, United States of America
<table>
<thead>
<tr>
<th>Severity</th>
<th>EMR</th>
<th>EMT &amp; AEMT</th>
<th>Paramedic</th>
<th>Critical Care Transport</th>
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<tbody>
<tr>
<td>Critical</td>
<td>Simple</td>
<td>Fundamental</td>
<td>Complex</td>
<td>“Tuesday”</td>
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<tr>
<td>Emergent</td>
<td>Simple</td>
<td>Fundamental</td>
<td>Complex</td>
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<tr>
<td>Lower Acuity</td>
<td></td>
<td>Simple</td>
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Figure 3: Increasing Depth and Breadth of Knowledge from EMR through Paramedic
<table>
<thead>
<tr>
<th>Transport Levels</th>
<th>EMT Stable</th>
<th>AEMT Stable</th>
<th>Paramedic Potentially Unstable</th>
<th>Critical Care Paramedic Unstable</th>
</tr>
</thead>
<tbody>
<tr>
<td>- EMT therapies</td>
<td>- AEMT therapies</td>
<td>- Paramedic therapies</td>
<td>Including but not limited to:</td>
<td></td>
</tr>
<tr>
<td>- EMT medications</td>
<td>- AEMT Medications</td>
<td>- Paramedic medications</td>
<td>- Multiple vasoactive medications/pressors</td>
<td></td>
</tr>
<tr>
<td>- Vital signs</td>
<td>- Any crystalloid infusion</td>
<td>- Any medication on the EMS formlary that was</td>
<td>- Initiation of additional blood products</td>
<td></td>
</tr>
<tr>
<td>- Temperature monitoring</td>
<td>- Patient-controlled analgesic (PCA) pump that is locked</td>
<td>started as an infusion prior to departure may be continued, including antibiotics and insulin</td>
<td>- Initiation of additional antibiotics or antivirals</td>
<td></td>
</tr>
<tr>
<td>- Foley catheter</td>
<td>- Cardiac monitoring for cardiac arrest arrhythmias only (See AEMT section of this protocol)</td>
<td>- BiPAP</td>
<td>Initiation of insulin infusion</td>
<td></td>
</tr>
<tr>
<td>- Suprapubic catheter</td>
<td>- CPAP</td>
<td>- Max 1 vasopressor</td>
<td>Managing uncorrected shock</td>
<td></td>
</tr>
<tr>
<td>- Feeding tube with no need to access or adjust</td>
<td>- ETCO₂</td>
<td>- Continuation of blood or blood products</td>
<td>Continuation of invasive monitoring.</td>
<td></td>
</tr>
<tr>
<td>- Saline lock</td>
<td>- Cardiac monitoring of 4 lead ECG with anticipated need for ACLS intervention</td>
<td>- Cardiac monitoring of 4 lead ECG with anticipated need for ACLS intervention</td>
<td>Continuation of balloon pump/impella pump (requires waiver)</td>
<td></td>
</tr>
<tr>
<td>- Maintenance of stable, long term ventilated patients with any mode of ventilation so long as the patient is familiar and capable of operating the equipment OR patient is accompanied by a care provider who is capable of the same</td>
<td>- Serial 12 leads</td>
<td>- Chest tube maintenance</td>
<td>Transvenous pacing.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Invasive monitoring equipment which has been capped/locked and labeled for transport</td>
<td>- Epidural catheter if secured, capped, and labeled</td>
<td>NPPV (BiPAP) complex</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- The following require a SECOND provider in the patient compartment</td>
<td>- EMT Stable</td>
<td>- Intubated/ventilated patients</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Active transcutaneous pacing</td>
<td>- AEMT Stable</td>
<td>- Complex patients may require additional staffing resources</td>
<td></td>
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<tr>
<td></td>
<td>- Automated Transport Ventilator (stable intubated patient, may only adjust rate, tidal volume, and adult vs. child settings, if applicable)</td>
<td>- Paramedic Potentially Unstable</td>
<td>Critical Care Transport Team Options:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Cardioversion</td>
<td>- Critical Care Paramedic Unstable</td>
<td>- CCT (Air/Ground)</td>
<td></td>
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<td></td>
<td>- Deep suctioning</td>
<td></td>
<td>- CCP &amp; at least one of the following:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- RSI/DSI (requires credentialing)</td>
<td></td>
<td>- 1 CFRN/CTR or</td>
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<td>- 1 CRN/CEN or</td>
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<td>- 1 NP/IPA or</td>
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<td>- 1 FP-C/CCP-C or</td>
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<td>- 1 Respiratory Therapist or</td>
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<td>- 1 Physician</td>
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<td>- Paramedic &amp; at least one of the following:</td>
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<td>- 1 CFRN/CTR or</td>
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<td>- 1 Respiratory Therapist or</td>
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<td></td>
<td>- 1 Physician</td>
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<td></td>
<td>- Last resort</td>
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<td></td>
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<td></td>
<td>- Any other appropriate crew</td>
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INTERFACILITY TRANSPORT TEAM SCOPES OF PRACTICE

EMT

- Care and treatment of stable patients.
- Therapies within the EMT scope of practice (Appendix 4).
- Medications within EMT scope of practice (Appendix 1).
- Non-invasive monitoring (BP, HR, RR, SpO₂, temperature).
- Previously inserted Foley catheter, suprapubic tube, established feeding tube (NG, PEG, J-tube not connected to infusion or suction).
- Saline lock permitted (no infusion).
- Maintenance of stable, long term ventilated patients with any mode of ventilation so long as the patient is familiar and capable of operating the equipment OR patient is accompanied by a care provider who is capable of the same.

Maintenance of stable, long term ventilated patients with any mode of ventilation so long as the patient is familiar and capable of operating the equipment OR patient is accompanied by a care provider who is capable of the same.
ADVANCED EMT

- Care and treatment of stable patients.
- Therapies within the AEMT scope of practice (Appendix 4).
- Medications within AEMT scope of practice (Appendix 1).
  - May be administered orally (PO) per patient care transfer orders.
- Any isotonic or balanced crystalloid IV infusion (no pump).
- Cardiac monitoring for cardiac arrest arrhythmias only and correlated with physical assessment findings (no palpable pulses). If cardiac monitoring is indicated due to suspected or anticipated non-cardiac arrest arrhythmias, the patient is not appropriate for transport by an AEMT.
  - Monitor all of the following vital signs:
    - Heart rate, respirations, non-invasive blood pressure, SpO₂, ETCO₂
    - 4 lead ECG as a vital sign ONLY, non-interpretive
    - Alarm when rates are above or below limits set by the operator
      - The AEMT should be familiar with and configure visual and audible cardiac monitor alarm settings for each patient transport
  - Semiautomatic mode for defibrillation of patients in cardiac arrest
  - 12-lead analysis and transmission (computer interpretation)

CPAP.
Interfacility Transfer 7.0

PARAMEDIC

- Care and treatment of potentially unstable patients.
- Therapies within the Paramedic scope of practice (Appendix 4).
- Medications within Paramedic scope of practice (Appendix 1).
  - Any medication on the EMS formulary that was started as an infusion prior to departure may be continued.
  - Initiation of previously ordered antibiotic infusion.
  - May be administered orally (PO) per patient care transfer orders.
- Maximum 1 vasopressor infusion.
- Cardiac monitoring of 4 lead ECG with anticipated need for ACLS intervention.
- Chest tube maintenance.
- Invasive monitoring equipment if capped/locked and labeled for transport.
- Epidural catheter if secured, capped, and labeled.

The following require a SECOND provider in the patient compartment:

- Active transcatheter pacing at time of transfer.
- Anticipated cardioversion.
- Anticipated deep suctioning.
- Automated Transport Ventilator - ATV (Stable intubated patient). May only adjust rate, tidal volume, and adult vs. child settings, if applicable.
- RSI/DSI. (Agency & providers must be credentialed.)

The following require a SECOND provider in the patient compartment:

Automated Transport Ventilator - ATV (Stable intubated patient). May only adjust rate, tidal volume, and adult vs. child settings, if applicable.
CRITICAL CARE PARAMEDIC, including but not limited to:

- Care and treatment of unstable patients.
- Greater than one vasopressor infusions.
- Initiation of additional blood products.
- Managing uncorrected shock.
- Initiation of additional antibiotics or antivirals.
- Initiation of insulin infusion.
- Continuation of invasive monitoring.
- Continuation of balloon pump/impella pump. (Requires CCP waiver.)
- Transvenous pacing.
- NPPV (BiPAP) which may require complex adjustments or conversion back to PPV mode.
- Rapid sequence or delayed sequence induction. (Requires RSI credentialing.)
- Intubated/ventilated patients. (Complex vent settings may require additional team members.)

Intubated/ventilated patients. (Complex vent settings may require additional team members.)
Bilevel Positive Airway Pressure (BiPAP)  
Adult  
5.3

PARAMEDIC STANDING ORDERS

INDICATIONS

- Spontaneously breathing patient in severe respiratory distress due to Asthma/COPD, Congestive Heart Failure / Pulmonary Edema, Pneumonia or Drowning.

ABSOLUTE CONTRAINDICATIONS (Do not use)

- Cardiac/Respiratory arrest

VS

Continuous Positive Airway Pressure (CPAP)  
Adult & Pediatric  
5.4

ADVANCED EMT STANDING ORDERS – ADULT & PEDIATRIC

INDICATIONS

- Spontaneously breathing patient in moderate to severe respiratory distress due to congestive heart failure/pulmonary edema, asthma/COPD, pneumonia, drowning or undifferentiated respiratory distress, concurrent with the following signs and
ADVANCED EMT/PARAMEDIC STANDING ORDERS

INDICATIONS
- Resuscitative efforts:
  - Can only adjust rate, tidal volume, and adult vs. child setting if applicable
- Any patient requiring ventilatory assistance in conjunction with advanced airway adjuncts.
- Any patient requiring ventilatory assistance in conjunction with basic airway maintenance.
- Any patient requiring ventilatory assistance in conjunction with manual airway maintenance.

CONTRAINDICATIONS
- Airway obstruction.
- Resistance.
- Poor lung compliance.
- Pneumothorax – tension pneumothorax.
- Pulmonary over-pressurization (blunt injury, water ascent injury, etc.).
- Children less than 5 years of age or 18 kg (35 lbs). Check manufacturer’s recommendations.

PROCEDURES
1. Determine that a need for the automated transport ventilator (ATV) exists. Follow manufacturer’s instructions for the device.
2. Ensure that all tubing is free from kinks.
3. Determine the proper tidal volume setting. This is done by determining the patient’s ideal weight (approx. weight for any physically fit patient having the same sex, height, frame) and multiplying it by 6 – 8 mL/kg. Begin with the lowest tidal volume limit.

<table>
<thead>
<tr>
<th>Height in FVs</th>
<th>6 mL/kg</th>
<th>8 mL/kg</th>
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<td>300</td>
<td>400</td>
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<td>5’ 9”</td>
<td>424</td>
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FEMALE

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<td>585</td>
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<tr>
<td>6’ 1”</td>
<td>452</td>
<td>603</td>
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</table>

SPECIAL CONSIDERATIONS
- Due to COPD, chest rise may not appear full. Do not increase tidal volume (TV) past upper TV limit.
- If lung sounds are absent or on one side only: rule out airway obstruction, improper tube placement, or pneumothorax, and check tidal volume settings.
- If chest expansion is not adequate, the rescuer should slowly increase tidal volume until chest expansion is adequate, or the uppermost limit (for the patient’s ideal weight) is reached.
- If chest appears to over expand, decrease tidal volume.
PROCEDURES

1. Determine that a need for the automated transport ventilator (ATV) exists. Follow manufacturer’s instructions for the device.
2. Assure that all tubing is free from kinks.
3. Determine the proper tidal volume setting. This is done by determining the patient’s ideal weight (approx. weight for any physically fit patient having the same sex, height, frame) and multiplying it by 6 – 8 mL/kg. Begin with the lowest tidal volume limit.

ADVANCED EMT/PARAMEDIC STANDING ORDERS

PROCEDURES (continued)

4. Set Breaths per Minute (BPM) control to rate of 8 – 15 per minute.
5. Check alarm by occluding the patient valve assembly outlet. The audible pressure limit alarm should sound as the ventilator cycles through the delivery phase.
6. Assess lung compliance and chest rise with a bag valve device. Tidal volume may be adjusted lower if poor lung compliance is found.
7. Attach the patient valve assembly to the airway device or mask used on the patient.
9. Count the number of complete ventilator cycles for a full minute. The number should be the same as the setting (+/- 1).
10. Assess and manage the airway as you normally would for any patient with controlled ventilation.
11. If spontaneous breathing begins, it may be desirable to turn the BPM down as long as patient’s spontaneous rate is 10 – 12 per minute.
12. Check oxygen cylinder pressure level frequently. This device will deplete a “D” cylinder rapidly.

SPECIAL CONSIDERATIONS

- Due to COPD, chest rise may not appear full. Do not increase tidal volume (TV) past upper TV limit.
- If lung sounds are absent or on one side only, rule out airway obstruction, improper tube placement, or pneumothorax, and check tidal volume ml/bpm settings.
- If chest expansion is not adequate, the rescuer should slowly increase tidal volume until chest expansion is adequate, or the uppermost limit (for the patient’s ideal weight) is reached.
- If chest appears to over expand, decrease tidal volume.
HFNC

- Heat and humidification
  - Infection
  - Respiratory mechanics
  - Thermoregulation
  - Evaporative losses
- Oxygen consumption
- Speed vs goals of care
Rapid Sequence Airway with the Intubating Laryngeal Mask in the Emergency Department

Daniel H. Lee,* Jamie Stang,* Robert F. Reardon,* Marc L. Martel,* Brian E. Driver,* and Darren A. Braude†

†Department of Emergency Medicine, Hennepin County Medical Center, Minneapolis, Minnesota, and *(De)partments of Emergency Medicine and Anesthesiology, University of New Mexico Health Sciences Center, Albuquerque, New Mexico
Reprint Address: Daniel H. Lee, MD, Department of Emergency Medicine, Hennepin County Medical Center, 701 Park Ave, Mall Code 825, Minneapolis, MN 55415

Managing the Out-of-Hospital Extralottic Airway Device

Darren Braude, MD, EMT-P*; Michael Steuerwald, MD; Trent Wray, MD; Richard Galgon, MD
*Corresponding Author. E-mail: dbraude@salud.unm.edu, Twitter: @darrenbraude.

Rapid Sequence Airway (RSA)—A Novel Approach To Prehospital Airway Management

Darren Braude & Michael Richards

Brief Research Report: Prehospital Rapid Sequence Airway

Darren Braude, Douglas Dixon, Michael Torres, John P. Martinez, Sean O’Brien & Timothy Bajema
Pediatric HFNC

- 2-year-old male RSV on HFNC with the increasing need for respiratory support.
- Do you request...
  - Ground SCT 1.5 hours each way
  - Air SCT 20 minutes each way
  - Local paramedic (on scene)

www.PollEv.com/daniellegood726
<table>
<thead>
<tr>
<th>Service</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
<td>Ground SCT 1.5 hours each way</td>
<td>0%</td>
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<tr>
<td>Air SCT 20 minutes each way</td>
<td>0%</td>
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<tr>
<td>Local paramedic (on scene)</td>
<td>0%</td>
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</tbody>
</table>
Transport Space Continuum

- **More**
- **Less**

- **Space, Weather, & Weight Capability**

- **Time out of Hospital/ Transport Speed**
  - **Short**
  - **Moderate**
  - **Long**

- Medical transport options:
  - Helicopter
  - Small airplane
  - Ambulance
Same Medicine, Different Application

- Safety first
- Environment
- Priorities
- Access to patient
- Preemptive intubation
- Settings/sensitivity triggers
- Sedation
- Mucous
Ambulance Oxygen Supply

M tank = 3,100 liters
- HFNC 60 LPM at 100%
- 52 Minutes

LOX = 19,380 liters
- HFNC 60 LPM at 100%
- > 5 Hours
FIGURE 4-8 Gay-Lussac's law. As pressure decreases, temperature decreases, so remember to keep your patients warm.

© Jones & Bartlett Learning.
Henry’s Law

Initial FiO2 x Initial Barometric Pressure = Adjusted FiO2
Barometric Pressure at Cruise Altitude

70% x 760 mm Hg = 88.7%
600 mm Hg
Oxygen Consumption Case

• 2nd flight of the day, aircraft O2 ¾ full on ground
• Alert but disoriented 46-year-old female with extensive respiratory history post ROSC
• 1 hour 15-minute flight for cardiac intervention
• Precipitous desaturation off oxygen, maintaining SpO2 low 90’s on 15 LPM
• At altitude main tank has 70 minutes at 15 LPM
• What do you do?

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What do you do?

Nobody has responded yet.

Hang tight! Responses are coming in.
Preparing for Transport

- Height or IBW
- Optimizing settings/ titrations
  - How you got there
  - Pressures, volumes
- Blood gas
- CXR
- Suction
- Medications (& enough for transport)
- Tube securement
Nitric Case

- 70-year-old male elective cardiac surgery with complications of heart failure with increased pulmonary pressures
- Going for ECMO in Boston
- On HFNC and nitric at 40 ppm
- 2 small tanks or 1 large tank available
- What are your transport considerations?

www.PollEv.com/daniellegood726
What are your transport considerations?

Nobody has responded yet.

Hang tight! Responses are coming in.
Summary

- Everyone has an expertise to bring to the table
  - Shared mental model
- Communication!
- Knowing EMS scope of practice is valuable
- Consider how modality changes out of hospital care
- Prepare and optimize hospital-based care to ensure continuity
Questions?

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