“Permissive Hypoventilation” in a Swine Model of Hemorrhagic Shock


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No Disclosures
Most penetrating trauma patients in severe hemorrhagic shock receive positive pressure ventilation (PPV) upon transport to definitive care
- Intubation and manual ventilation
- Bag-valve mask (BVM) ventilation

Intubation clearly shown to have detrimental effects for penetrating trauma patients in urban locations
Background

- Whether BVM ventilation improves outcomes in severe shock-state has not been studied
  - Previous study showing detrimental effects of BVM\(^1\)
- New ACLS guidelines prioritizing uninterrupted chest compressions over advanced airway
  - Backed by animal and clinical studies
- Consideration should be given to immediate transportation without airway intervention

Goals

- Test the idea of “permissive hypoventilation” – where manual breaths are not given and 100% oxygen is administered passively via facemask
Hypothesis

In severe low-flow states, PPV would have harmful physiological effects and that “permissive hypoventilation” would result in better outcomes.
Methods

- Yorkshire swine weighing 30.0 kg
- Started on a propofol drip
- Three groups of animals
  1) Intubation and manual ventilation (n=6)
  2) BVM ventilation with ambu-bag (n=7)
  3) Permissive hypoventilation with face mask (n=6)
Methods

- Placement of Swan-Ganz catheter through central venous introducer
- Femoral arterial line placed
- 14-gauge catheter with stopcock in carotid artery for exsanguination
- Baseline arterial blood gas (ABG), laboratory values, and hemodynamic parameters
Outcomes

- Stopcock opened and animal was exsanguinated
- Hemodynamic and laboratory values measured at 10 minute intervals
- Primary outcome was time until death
- Secondary Outcomes
  - Hemodynamic Parameters – cardiac index, CVP
  - Metabolic values – pH, lactic acid, O₂
  - End-organ damage – creatinine
Mean Survival:
Intubated: 51.1 mins
Bag-Valve Mask: 48.5 mins
Facemask: 50.0 mins
p = 0.84
Thermoregulation and Hemodynamics
**Body Temperature**

- **Intubated**
- **Bag-valve**
- **Facemask**

✖ p<0.001 when compared to intubated and BVM group at all time points
Systolic Blood Pressure

![Graph showing systolic blood pressure over time for different methods: Intubated, Bag-valve, and Facemask. The graph indicates a significant difference (p<0.001) compared to the intubated group at all time points.]
Central Venous Pressure

- Intubated
- Bag-valve
- Facemask

<p><0.001 when compared to intubated group at 10 minutes</p>
Cardiac Output

- Intubated
- Bag-valve
- Facemask

※ p<0.001 when compared to intubated and BVM group at all time points
Acid-Base Status and Gas Exchange
pH

\[ \times \quad p < 0.001 \text{ when compared to intubated and BVM group at all time points} \]
Carbon Dioxide

- Intubated
- Bag-valve
- Facemask

\( \times p<0.001 \) when compared to intubated and BVM at all time points
Bicarbonate Levels

- Intubated
- Bag-valve
- Facemask

- p<0.001 when compared to intubated and BVM group at all time points
Metabolic Changes and End-Organ Damage
Lactic Acid

- **Intubated**: p<0.001 when compared to intubated at all time points
- **Bag-valve**: p<0.05 when compared to BVM at 30 and 50 minutes
Creatinine Levels

- Intubated: ➠ p<0.05 when compared to BVM at all time points
- Bag-valve: ★ p<0.05 when compared to intubated at 40 minutes
Creatinine Levels by Weight

- Intubated
- Bag-valve
- Facemask

**p<0.05 when compared to intubated and BVM at all time points**
Conclusions

- Positive pressure ventilation, whether by endotracheal tube or BVM, does not result in a survival advantage
  - Worse thermoregulation
  - Hemodynamic compromise
- Worse perfusion vital organs
  - Higher lactic acid levels
  - Worse increase in creatinine
Conclusions

- “Permissive Hypoventilation” leads to decreased CO$_2$ elimination
- More profound respiratory acidosis
  - Evidence of protective effects of hypercapnia
- Profound alkalosis with positive pressure ventilation
Conclusions

- Consideration should be given to immediate transportation without airway intervention.
- Similar to change with ACLS guidelines, prospective, randomized trials are needed to determine best mode of ventilation for penetrating trauma patients in urban locations.
Limitations

- Small sample size
- Use of propofol – hemodynamic depression
  - Ideal for large animal studies
- Examined only physiological changes
  - Inflammatory markers
Questions?