Donor Lung Management: Newer Ventilation Modes

NATCO Winter Meeting
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January 16, 2009

Background

- Need for donor lungs far exceeds supply
- Brain dead donor
  - Trauma
  - CVA/ICH
  - Anoxia
- Donors may develop suboptimal lung function

Reasons for suboptimal donor lung function

- Donor Factors
  - Smoking history
  - Aspiration
  - Infection
- Brain Death
- Pulmonary edema
  - Iatrogenic
  - "neurogenic"
- ARDS

Physiology – Brain Death

- Dysregulation of neurohumoral factors
- Proinflammatory mediator release
- Endothelial permeability
- Hypoxia
- Not ARDS, but lung compliance limited; non-cardiogenic pulmonary edema a factor

Goals of Donor Lung Management

- Optimize donor lung function in context of multiple organ recovery
- Improve oxygenation in “borderline” cases
- Increase the number of donor lungs usable for transplant

Donor Lung Management I: *Dry Lung*

- Limit fluid administration
- Possible conflict with donor kidney management
- Diuresis - CVP<10 desirable

Donor Lung Management – II: *Steroids*

- High dose steroid administration steroids improves oxygenation (Follette DM, et al. JHLTx 1998)
  - 15 mg/kg solumedrol vs. no steroids
- No steroid treatment->decrease in PaO2
- Steroid treatment->increase in PaO2 and increased lung utilization (25/80 vs. 3/38)

Donor Lung Management – II: *Steroids*

- Administration of 1 g solumedrol reduced pulmonary fluid accumulation and was associated with increased donor yield (Venkateswaran RV et al, Ann Thor Surg 2008)

Donor Lung Management – III: *Recruitment*

- Noiseux et al, Quebec, CA
- 2006-2008
- Baseline ABG FiO2 100%, PEEP 5
- 30 sec recruitment to 30 cm H2O
- 2 min normal ventilation
- 30 sec inflationto 30 cm H2O

Donor Lung Management – III: *Recruitment*

- 1 hour nl ventilation FiO2 40%, PEEP 10, PAP<30
- Challenge gas
- Recruitment protocol increased lung utilization from 20-33%
- No hemodynamic instability

Donor Lung Management – IV: *Ventilator Management*

- Standard critical care guidelines for potential organ donors
  - "cerebral protection" – NOT lung oriented !
- Typically AC or SIMV mode
- PaO2>100, PaCO2 30-35 with larger TVs (10 ccs/kg), lower PEEP

Donor Lung Management – IV: *Ventilator Management*

What's known:

- High tidal volume and high RR are independent predictors of acute lung injury in patients with severe brain injury (Mascia et al, CCM 2007)
- Limitation of TV, and CO2 control may limit lung injury

Donor Lung Management – IV: *Ventilator Management*

- **The "ideal" ventilator strategy/mode for optimal treatment of donor lungs has yet to be defined**
- **Clinical need: balance the goals of recruitment against the danger of overdistension/barotrauma ->lung injury**

Ventilator Modes

Volume Control
AC, IMV

Pressure Control

Hybrid/combination
PRVC, APRV

- **In context of donor lung management, volume cycled ventilation may not optimize recruitment and/or avoid barotrauma**

Pressure Control Ventilation (PCV)

- Larger inflation volumes may cause distension and exacerbate lung injury
- Pressure cycled ventilation limits barotrauma
- Airway flow decreases to limit mean and peak airway pressures
- Limitation: variable tidal volumes

Pressure regulated volume control (PRVC)

- "Variable" or dynamic pressure control setting
- Permits delivery of TVs within a predefined pressure range - combines pressure control and volume control

Airway pressure release ventilation (APRV)

- Form of ventilation with short expiratory time; inverse I:E ratio
- Resting higher lung volume <-> lower lung volume
- When pt breathes spontaneously, paralysis not needed
- Brain dead donor, APRV=bilevel CPAP
- APRV allows breathing with larger TVs

Pressure regulated volume control (APRV)

- Alternative mode of weaning in ARDS and treatment for hypoxia
- In ARDS, APRV reduces shunt vs. PSV in ARDS
- TVs variable depending of lung compliance
- De-recruitment possible if release/expiratory time prolonged

What mode to use?

- No one mode proven “ideal”
- Reduce atelectasis, avoid ventilator induced lung injury
  - high tidal volumes and high RR
- Local practices-diverse
  - Volume cycled ventilation
  - PCV
  - PRVC/APRV

Our recent single insitution experience (Life banc OPO/Cleveland Clinic)

- Local OPO=LifeBanc (Dr. Dan Lebovitz)
- 2008: 58 lung transplants; <5 local
  - Low OPO yield for lungs

Our single institution experience (Lifebanc OPO/Cleveland Clinic)

- **Use of initial traditional ventilator mode, usually AC or SIMV**
- **Sustained recruitment with PCV/PRVC/APRV mode with TV 6-8 ccs/kg, limited PEEP**
- **2009: 157 lung transplants; *36 local***

Local Donor Demographics (Lungs utilized)

- **N=36**
- **10 F, 26 M**
- **Age: 36+/- 16 years**
- **Mean wt: 78 kg, ht: 68 in**
- **COD: CVA 11, 6 GSW, 15 blunt trauma, 4 anoxia**
- **Mean tobacco use: 5.2+/-8.2 pack-years**
- **Days on vent: 3.5+/-1.4 days**

Initial ventilator management

- **Modes:**
  - **A/C 18**
  - **SIMV 1**
  - **PCV 13 (driving pressures 12-25)**
  - **PRVC 1**
  - **APRV 3**
- **TVs 8 ccs/kg, PEEP 6**
- **Mean PaO2 354+/-116**

Secondary ventilator management

- Modes:
  - PCV 23 (driving pressures 12-22, PEEP 5-8, I:E 2-3.5:1)
  - PRVC 1 (PEEP 8, I:E 2.5:1)
  - APRV 13 (24-38/0-8)
- TVs 8.5 ccs/kg, PEEP 5
- Mean PaO2 419+/-90

Outcomes: Local Donors

- Increased utilization of local donors
  - 36 local donors!
- Mean Age: 54+/-12 years
- Mean LAS: 42 (31-91; 1 on ECMO preop)
- Procedure
  - 6 Single, 28 double
  - 1 double lung liver, 1 heart-double lung

Overall Outcomes

- Median time on vent: 3.5 days
- Median ICU stay: 9 days
- 32/36 alive at mean f/u of 7 months (89%)
  - 2 deaths (sepsis/MOF)
  - 1 death (sepsis/H1N1; POD #21)
  - 1 withdrawal of support at POD #50 at family request (but good lung function)

Summary-I

- Proper ventilator support +/- adjunctive therapies are key to optimizing donor lung yield
- Modes other than CMV/SIMV are and will continue be increasingly used for recruitment
- Limiting baro and volutrauma should remain guiding principles in use of PCV, PRVC, APRV

Summary-II

- Our local OPO's utilization of alternative ventilator modes suggests early postoperative outcomes comparable prior results, with increased local yield

Practical Suggestions

- Communication is paramount
  - Unified philosophy between OPO/directorship and surgical/medical MDs at recipient hospital
- Dissemination of information/education about alternative ventilator modes
- During donor management, in-patient ABG comparisons with AC/SIMV modes

Conclusions

- **Further analysis of outcomes with alternative ventilator modes required; jumping to conclusions should be discouraged**