Welcome

DISCLOSURE

- I am a Senior Clinical Consultant for MV and NIV
- Bias: I have a favorite RT

Kathleen Richards

My Favorite RT

MAP vs NAP

The Impact of Ventilation on Hemodynamics

Agenda

- Define MAP and NAP
- Methods of increasing MAP
- MAP and pulmonary blood flow
- Address consequences of MAP
- Best way to recruit and stabilize lungs
- Learning pulmonary mechanics from the produce section of the grocery store

"The 60/90 Rule"

T.H.M

60 Minutes

90% Forgotten

The 10% You Need to Remember

MAP vs. NAP

Updated Definitions

MEAN Airway Pressure

Any potentially counterproductive pressure applied to the airways (i.e., not very nice)

NICE Airway Pressure

The lowest amount of pressure possible for a patient's particular pathophysiology (i.e., nicer)

What is the most dangerous component of mechanical ventilation?

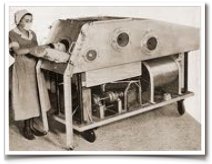
Areas of Potential Physiological Interaction with POSITIVE Pressure Ventilation

- Intrathoracic pressures
- Distribution of gas into the alveoli
- Stretch injury
- Pulmonary capillary blood flow
- Surfactant functions
- Lymphatic system
- Cardiac output
- Organ system function

Take Home Message

Ventilation is powerful and it can hurt.

Least Invasive Method of Ventilating



Why?

Normal Breathing is a result of NEGATIVE pressure, not Positive Pressure.

Iron Lungs use NEGATIVE Pressure

Normal Breathing is a result of NEGATIVE pressure, not Positive Pressure.

Spontaneous vs. Mechanical Breathing

In normal breathing, the negative pressure phase of inspiration:

- ☆ assists venous return
- ☆ alleviates pressure on the pulmonary capillaries
- ☆ encourages good blood flow

In PPV, the intrathoracic pressure increases during inspiration causing:

- ☹ decreased venous return
- ☹ decreased right ventricular output
- ☹ restricted pulmonary blood flow

Ventilation and Hemodynamics

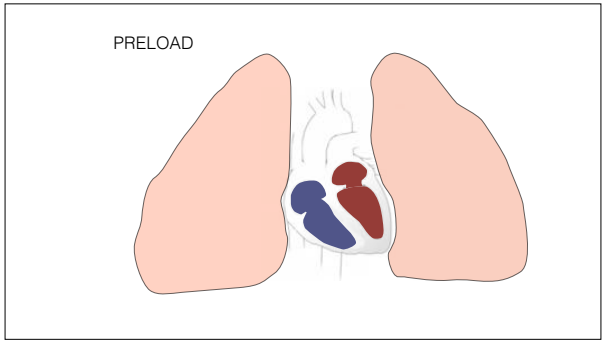
Hemodynamics

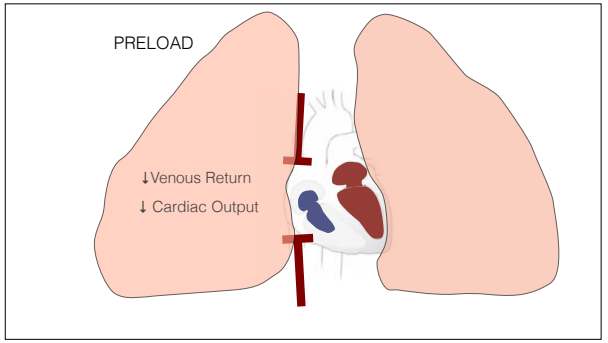
- The study of the properties blood flow
- Key factors are Venous Return & Cardiac Output
- **PRELOAD**
- **AFTERLOAD**

Impact of Ventilation on Hemodynamics

PRELOAD

- The amount of blood in the heart just before it contracts
- Depends on how much is coming back (Venous Return)
- Decreased by pressure on heart from MAP
- Reduced preload will tend to decrease cardiac output
- **Increased** preload is **good**

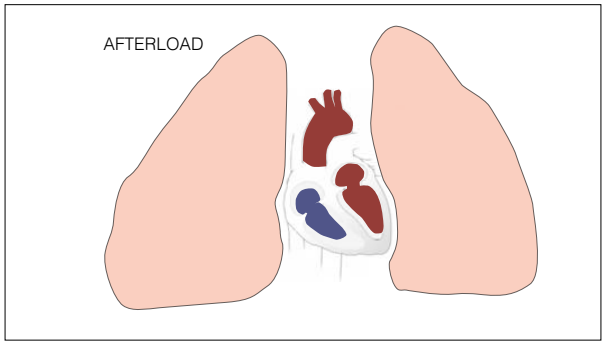


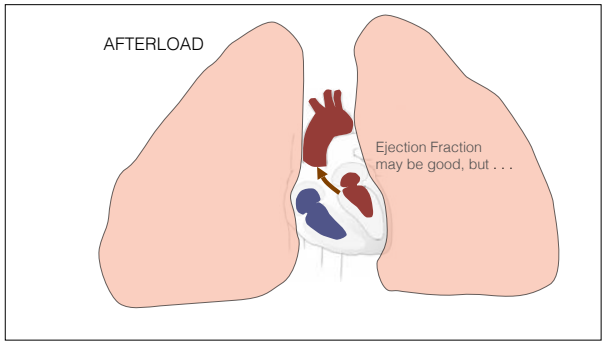


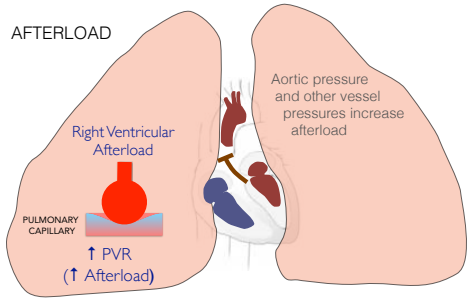
Impact of Ventilation on Hemodynamics

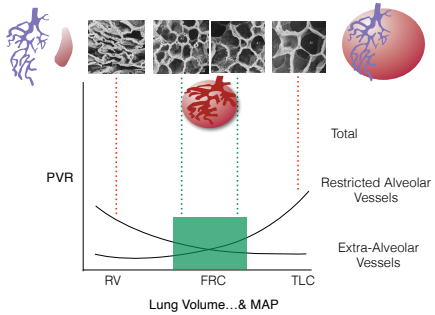
AFTERLOAD

- The pressure the heart must overcome to eject blood to rest of body
- Increases when blood vessels are compressed or restricted (e.g., excessive MAP)
- Reducing afterload will tend to improve cardiac output
- **Increased** afterload is **bad**







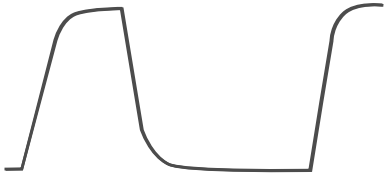


Take Home Message

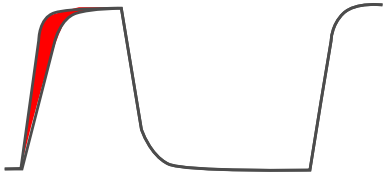
Pulmonary blood flow can be inhibited by too much or too little MAP…so find the sweet spot.

How is MAP Increased?

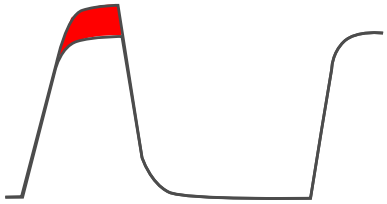
5 Ways to Raise MAP



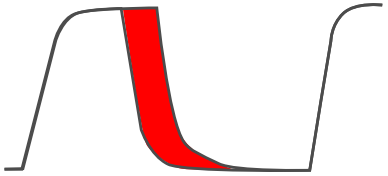
Shorten Rise Time



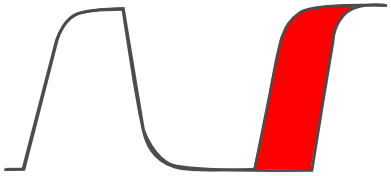
Raise PIP or Volume



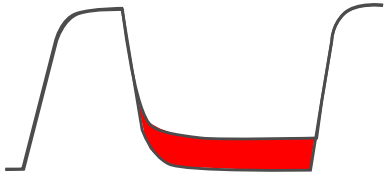
Increase I-Time

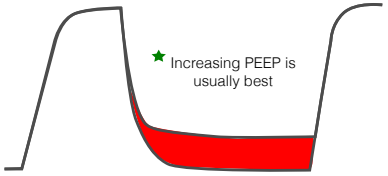


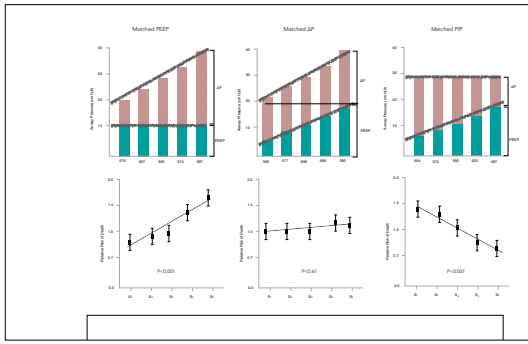
Increase Rate



Raise PEEP







Take Home Message

PEEP is the most stable, static, and—most of the time—the safest pressure we apply

Impact of **MAP** on Cerebral Circulation

Big Breaths Hurt!

"One of the central tenets in critical care medicine is to proactively identify patients at risk of inadequate oxygen delivery and to improve their hemodynamic profile and oxygen delivery before permanent end-organ hypoxic/ischemic injury can occur."

- Beth A. Johnson, MD

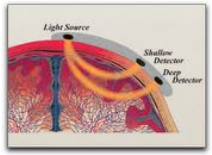
hypoxic/ischemic injury

Lack of oxygen in the delivered blood

Shortage of blood supply to an organ

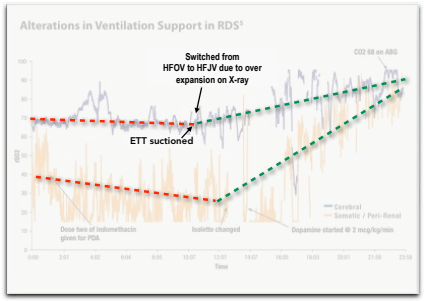
NIRS

(Near Infra-Red Spectroscopy)



Continuous and Noninvasive Tissue Oxygenation Monitoring

Monitor Trends for Cerebral and Renal Tissue Oxygenation



Take Home Message

MAP can impact Cerebral Circulation, and…
be careful when blowing up a raft

Consequences of Too Much **MAP**

Addressing the Problem

Marked Reduction in MAP and OI Using HFJV in Neonates with Severe Refractory Hypoxemic Respiratory Failure

P Friedlich M.D., N Subramanian M.D., M Garg M.D.
Children's Hospital Los Angeles, Division of Neonatology.
Keck School of Medicine
University of Southern California , Los Angeles , CA.

Objective

To describe the use of HFJV in 10 infants with hypoxemic respiratory failure unresponsive to conventional ventilation and HFOV, not eligible for ECMO.

Goals

- reduce over-inflation by minimizing gas trapping
  (HFOV = **1:2** I:E Ratio HFJV = *starts* at **1:6** I:E ratio)
- lower MAP
- minimize barotrauma and oxygen exposure

"**MAP**otrauma"

Subjects

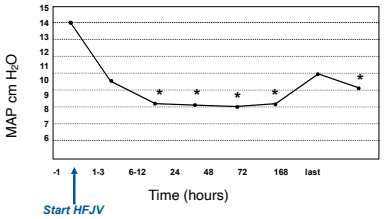
First 10 patients placed on HFJV (from HFOV)

Patients	GA (weeks)	Diagnosis	Days on HFOV
1	28	CLD/sepsis	41
2	28	CLD/pneumonia	29
3	23	CLD/pneumonia	33
4	26	CLD/pneumonia	115
5	28	CLD/pneumonia	29
6	24	CLD/pneumonia	31
7	23	CLD/pneumonia	28
8	28	CLD/pneumonia	41
9	27	CLD/pneumonia	65
10	25	CLD/pneumonia	87

$\bar{x}$ = 49.9 days

Mean Airway Pressure

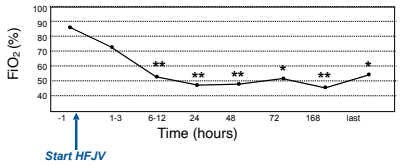
* p < 0.01



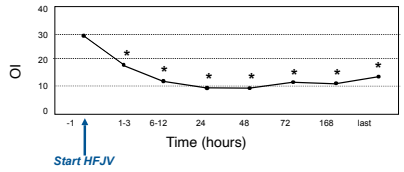
FiO_2

* p < 0.05

** p < 0.05



Oxygenation Index



Results

Patients	GA (weeks)	Diagnosis	Outcome
1	28	CLD/sepsis	Died
2	28	CLD/pneumonia	Home/O_2
3	23	CLD/pneumonia	Home/O_2
4	26	CLD/pneumonia	Home/O_2
5	28	CLD/pneumonia	Home/O_2
6	24	CLD/pneumonia	Home/O_2
7	23	CLD/pneumonia	Home/O_2
8	28	CLD/pneumonia	Home/O_2
9	27	CLD/pneumonia	Home/O_2
10	25	CLD/pneumonia	Home/O_2

Days on HFJV

Patients	GA (weeks)	Diagnosis	Days on HFJV
1	28	CLD/sepsis	
2	28	CLD/pneumonia	
3	23	CLD/pneumonia	
4	26	CLD/pneumonia	$\bar{X}$ of
5	28	CLD/pneumonia	7
6	24	CLD/pneumonia	
7	23	CLD/pneumonia	
8	28	CLD/pneumonia	days
9	27	CLD/pneumonia	
10	25	CLD/pneumonia	

Conclusions

- Lower MAP, OI, and FiO_2 in these 10 neonates with severe lung injury
- No complications associated with HFJV
- Resolved over-inflation, as noted by CXR
- (Patients went home!)
- ("Maybe we should avoid over expansion in the first place.")

Take Home Message

Reducing gas trapping is therapeutic and important…
doing so can lower MAP.

MAP During NIV

Non-Invasive Ventilation

NIPPV vs NCPAP

Haresh Kirpalani
N Engl J Med 2013 Aug

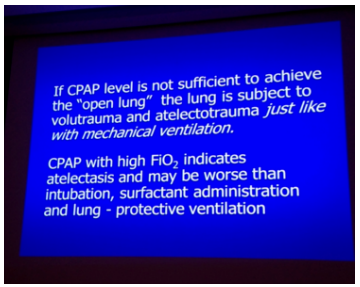
"…the rate of…BPD did not differ significantly after noninvasive respiratory support with NIPPV (38.4%) as compared to NCPAP (36.7%)."

37.5%

Dr. Marty Keszler

"Are we mislead by terms?"

- Continuous Positive Airway **Pressure**
- High **Flow** Nasal Cannula
- Non-invasive **Ventilation**



Dr. Marty Keszler

Nasal CPAP/HFNC

Challenge is getting a therapeutic, effective distribution of MAP

Take Home Message

Non-Invasive Ventilation

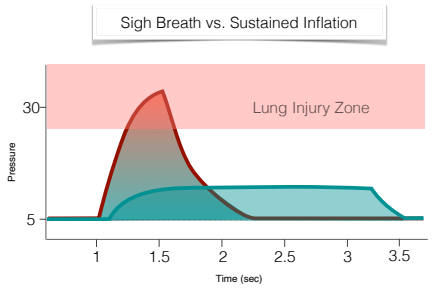
Misnomer

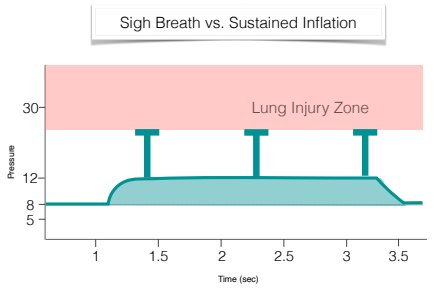
"Nomer"

Recruitment Maneuvers and Optimal MAP

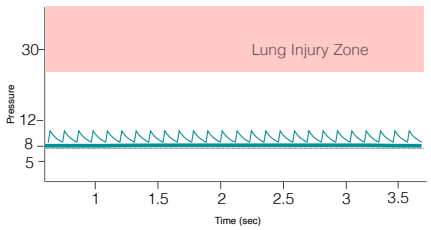
Molly Seshia, MD

PAS Conference - Washington, DC





Sigh Breath vs. Sustained Inflation



Jane Pillow on "Breath Hold"

Art Slutsky, M.D.
Toronto, ON, CAN

Take Home Message

Get the lungs open and keep them open…

as gently as possible

MAP vs NAP in the Produce Section

- Distribution of Tidal Volume
- "Surface Area" Recruitment
- Optimal MAP

MAP vs NAP in the Produce Section

Take Home Message

“Never take your husband grocery shopping.”

— Kathleen Richards

fini