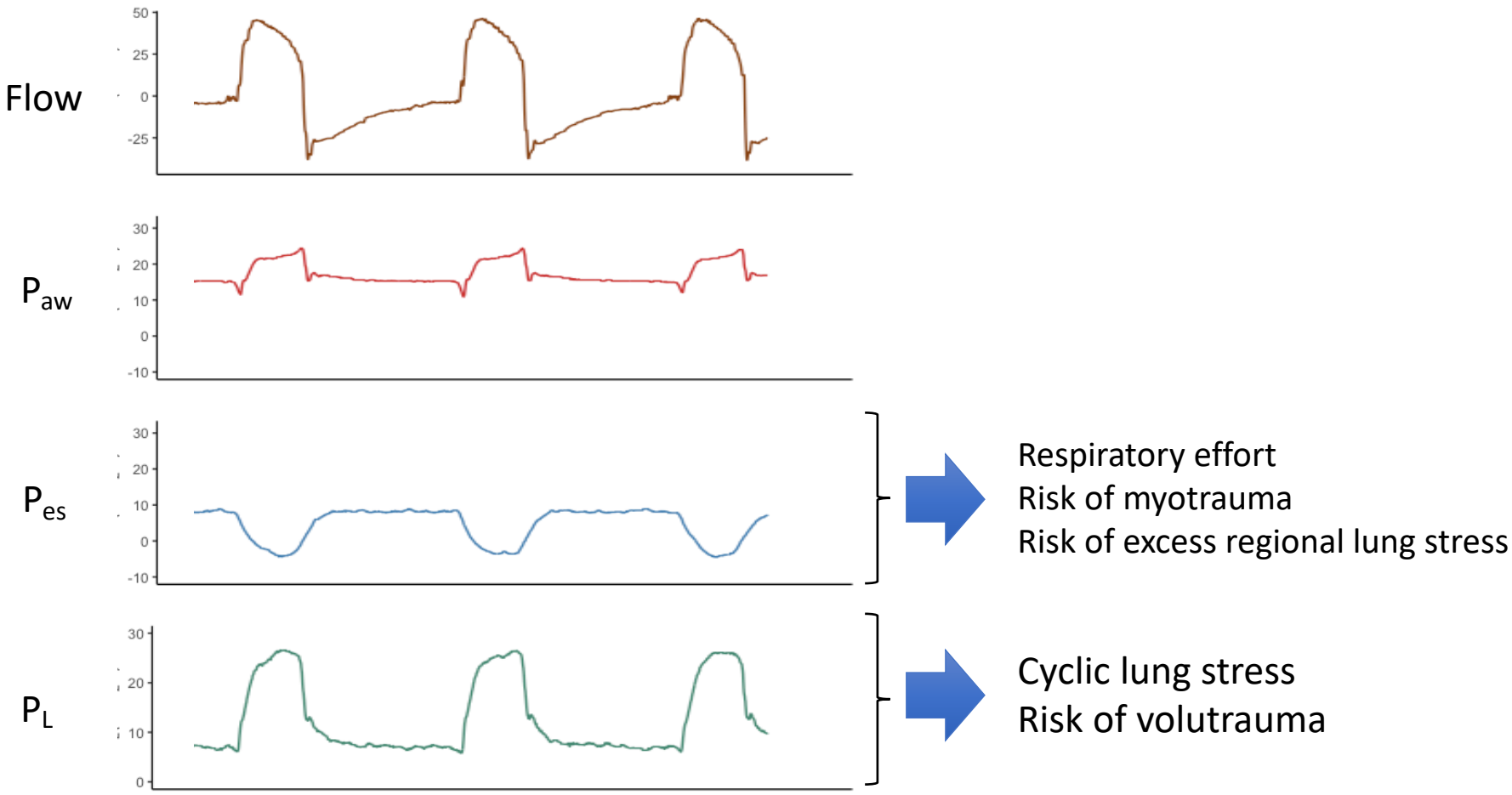
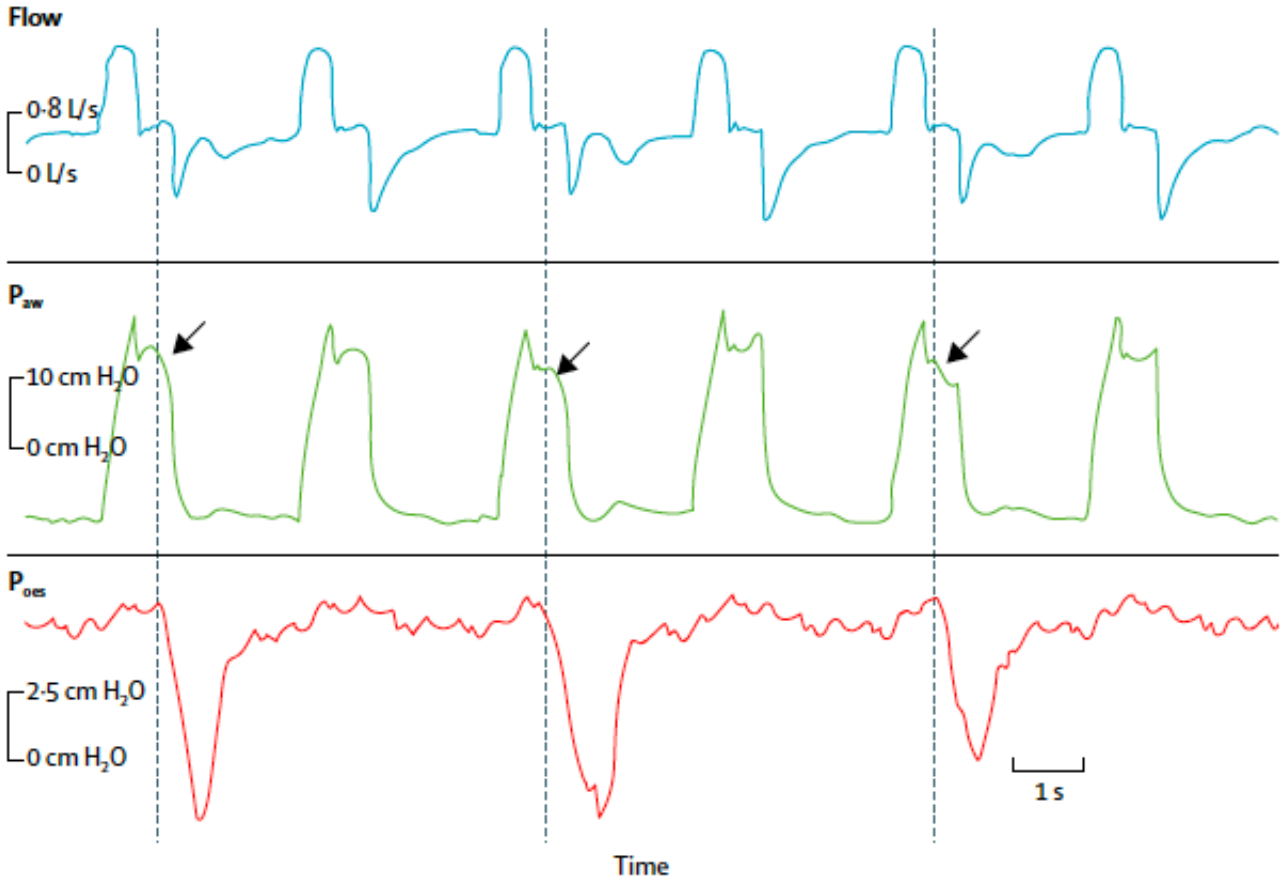
Case

- 50M
- P/F 140
- Bilateral airspace opacities, no evidence of HF
- 24 hours of NMBA completed
- How to assess risk of diaphragm and lung injury?

Monitoring for LDPV Strategy



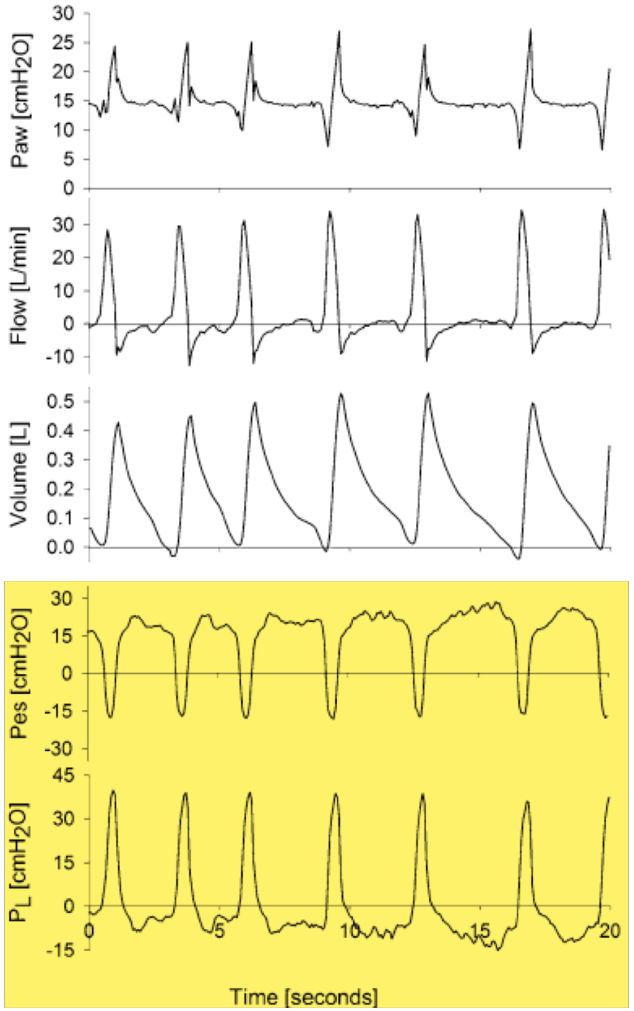
What is the potential mechanism of lung or diaphragm injury?



Case

- Sedation is lightened to alleviate reverse triggering
- Patient is now synchronous and each ventilator breath is triggered by the patient

What is the potential mechanism of lung or diaphragm injury?



Bertoni *et al. Critical Care* (2019) 23:346
https://doi.org/10.1186/s13054-019-2617-0

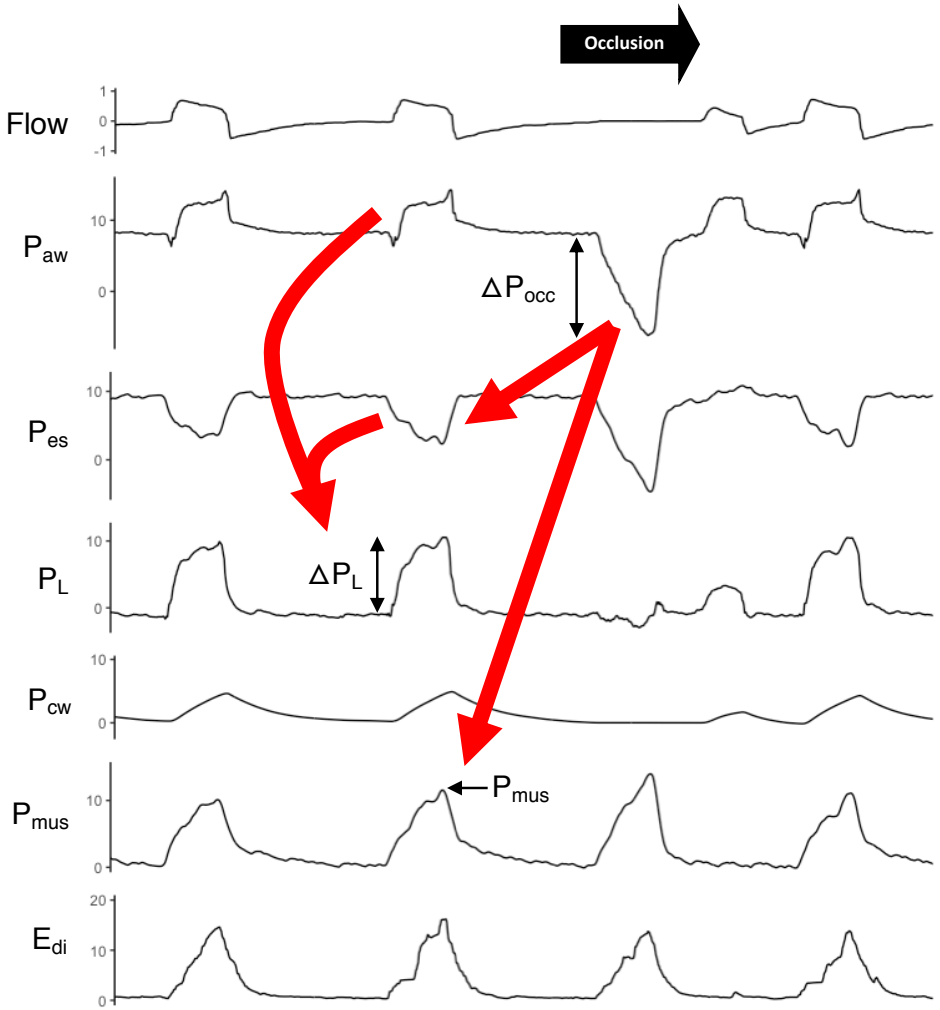
Critical Care

RESEARCH Open Access

A novel non-invasive method to detect excessively high respiratory effort and dynamic transpulmonary driving pressure during mechanical ventilation

Michele Bertoni[1,2], Irene Telias[3,4], Martin Urner[3,5], Michael Long[6], Lorenzo Del Sorbo[3,5], Eddy Fan[3,5,7], Christer Sinderby[3,4], Jennifer Beck[3,4], Ling Liu[8], Haibo Qiu[8], Jenna Wong[5], Arthur S. Slutsky[3,4], Niall D. Ferguson[3,5,7,9,10], Laurent J. Brochard[3,4] and Ewan C. Goligher[3,5,10,11*]

Non-Invasive Monitoring for LDPV Strategy



1. Estimate P_{mus}

2. Estimate ΔP_{es}

3. Estimate ΔP_L

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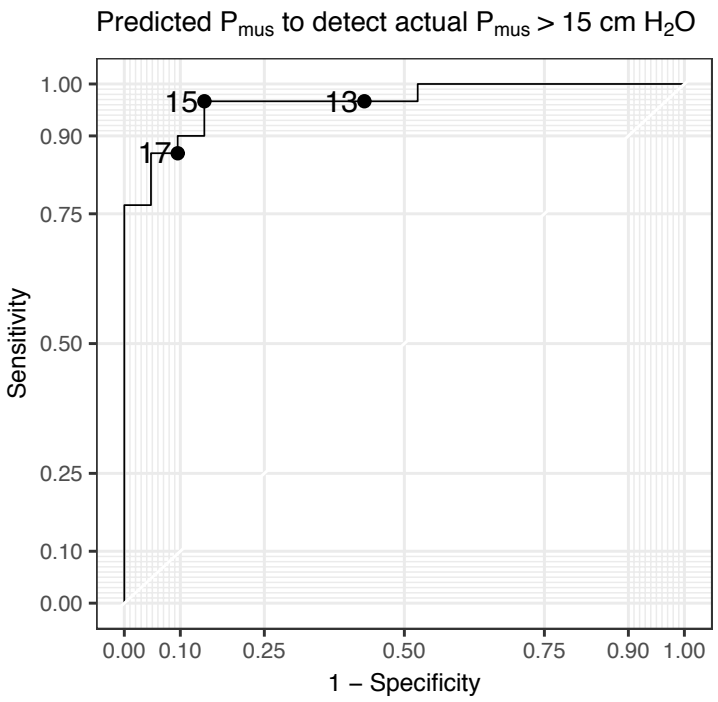
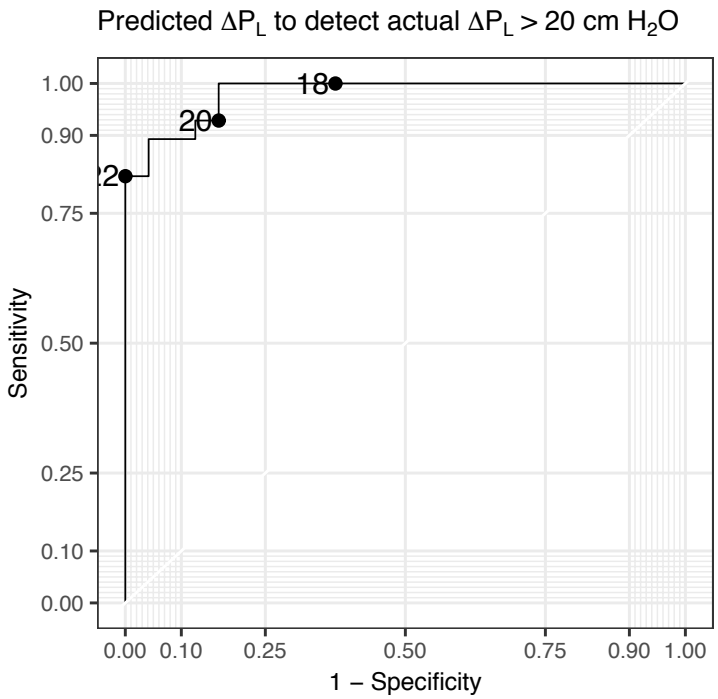
Non-Invasive Monitoring for LDPV Strategy

Predicted Pmus = -3/4 x ΔP_{occ}

Predicted ΔP_L = (PIP - PEEP) - 2/3 x ΔP_{occ}





www.pocc.coemv.ca

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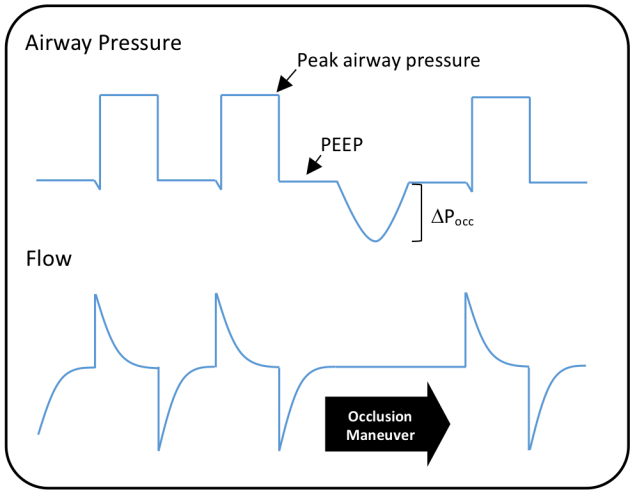
Monitoring algorithm

Ventilator Waveforms



Computations

Predicted Pmus = $-3/4 \times \Delta P_{occ}$

Predicted ΔP_L = (Peak airway pressure - PEEP) - $2/3 \times \Delta P_{occ}$

Note: ΔP_{occ} is always ≤ 0 cm H_2O (the magnitude of decrease in airway pressure from inspiratory effort during the occlusion)

Measure ΔP_{occ} every 4-8 hours (3 single-breath end-expiratory occlusions)

↓

Estimate P_{mus}
If ΔP_{occ} < 0 cm H_2O, estimate ΔP_L

↓

Predicted P_{mus} > 13-15 cm H_2O
OR
Predicted ΔP_L ≥ 16-17 cm H_2O

Yes →

Consider P_{es} monitoring to guide clinical management

OR

Consider modifying sedation and ventilation to achieve predicted Pmus and ΔP_L within acceptable limits

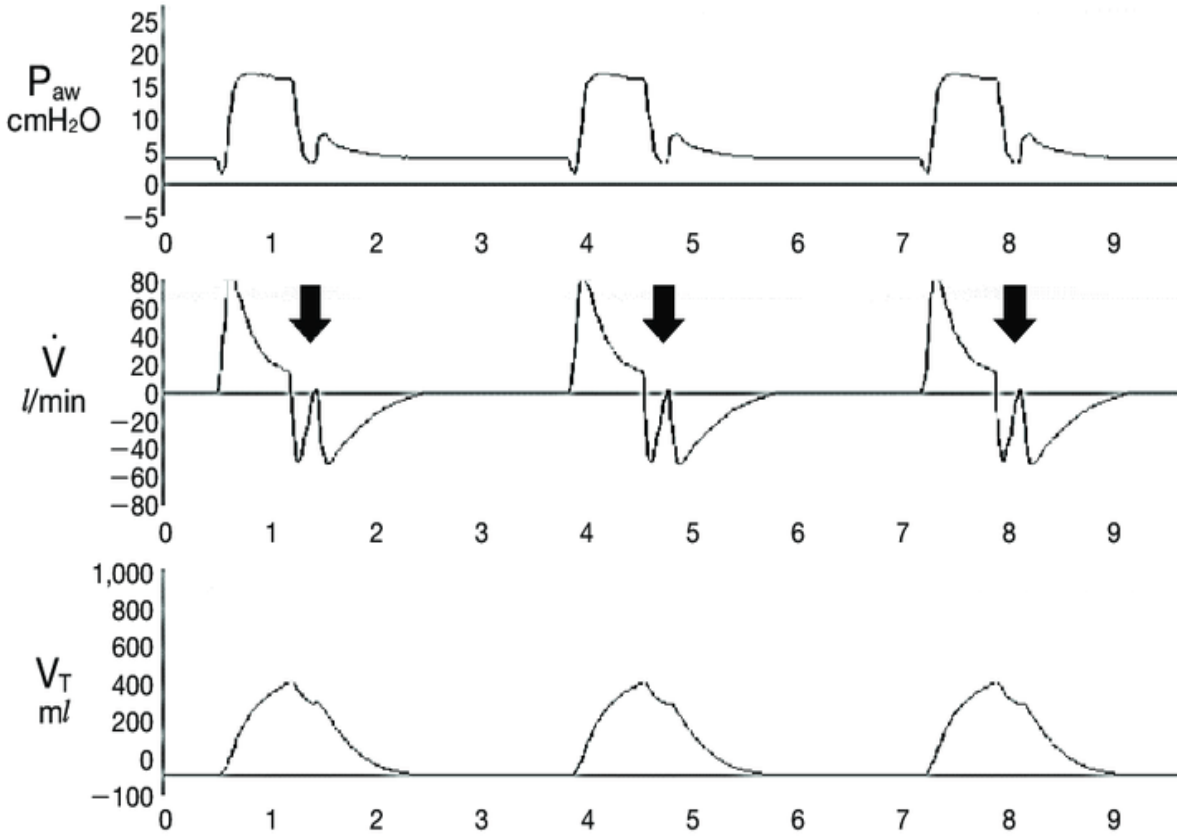
↓ No

Target achieved

Case

- P/F 180 on PEEP 5, FiO2 0.4
- Failed SBT
- After SBT, PS 10/5, FiO2 0.4, ΔP=10, Pocc = -25
- What is the likely primary mechanism of weaning failure?

What is the potential mechanism of lung or diaphragm injury?



Case

- Someone suggests PAV+ for assisted ventilation
- How do you assess risk of lung and diaphragm injury in PAV+?

Estimating Pmus in PAV+

Pvent = Ppeak - PEEP

Pvent + Pmus = Ptot

Pvent + Pmus = Pvent/Gain 5 + ? = 5/0.5

Pmus = Pvent/Gain - Pvent ? = 5/0.5 - 5

Pmus = Pvent*(1 – Gain)/Gain ? = 5*(1-0.5)/0.5

Estimating Pmus in PAV+

Gain (percentage of assistance)	Delta P_{aw} (cm H_20) = $P_{aw,Peak}$ – PEEP																					
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**12**	**15**	**17**	**20**	**22**	**25**	**27**	**30**	**32**	**35**	**37**	**40**
20	4	8	12	16	20	24	28	32	36	40	48	60	68	80	88	100	108	120	128	140	148	160
25	3	6	9	12	15	18	21	24	27	30	36	45	51	60	66	75	81	90	96	105	111	120
30	2	5	7	9	12	14	16	19	21	23	28	35	40	47	51	58	63	70	75	82	86	93
35	2	4	6	7	9	11	13	15	17	19	22	28	32	37	41	46	50	56	59	65	69	74
40	2	3	5	6	8	9	11	12	14	15	18	23	26	30	33	38	41	45	48	53	56	60
45	1	2	4	5	6	7	9	10	11	12	15	18	21	24	27	31	33	37	39	43	45	49
50	1	2	3	4	5	6	7	8	9	10	12	15	17	20	22	25	27	30	32	35	37	40
55	1	2	2	3	4	5	6	7	7	8	10	12	14	16	18	20	22	25	26	29	30	33
60	1	1	2	3	3	4	5	5	6	7	8	10	11	13	15	17	18	20	21	23	25	27
65	1	1	2	2	3	3	4	4	5	5	6	8	9	11	12	13	15	16	17	19	20	22
70	0	1	1	2	2	3	3	3	4	4	5	6	7	9	9	11	12	13	14	15	16	17
75	0	1	1	1	2	2	2	3	3	3	4	5	6	7	7	8	9	10	11	12	12	13
80	0	1	1	1	1	2	2	2	2	3	3	4	4	5	6	6	7	8	8	9	9	10
85	0	0	1	1	1	1	1	1	2	2	2	3	3	4	4	4	5	5	6	6	7	7
90	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	3	3	3	4	4	4	4

$$P_{mus,Peak} = \left(P_{aw,Peak} - PEEP\right) \times \frac{100 - Gain}{Gain}$$

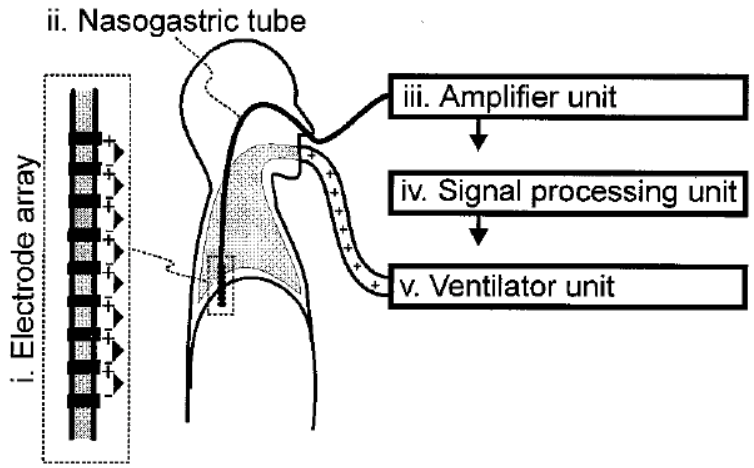
Estimating driving pressure in PAV+

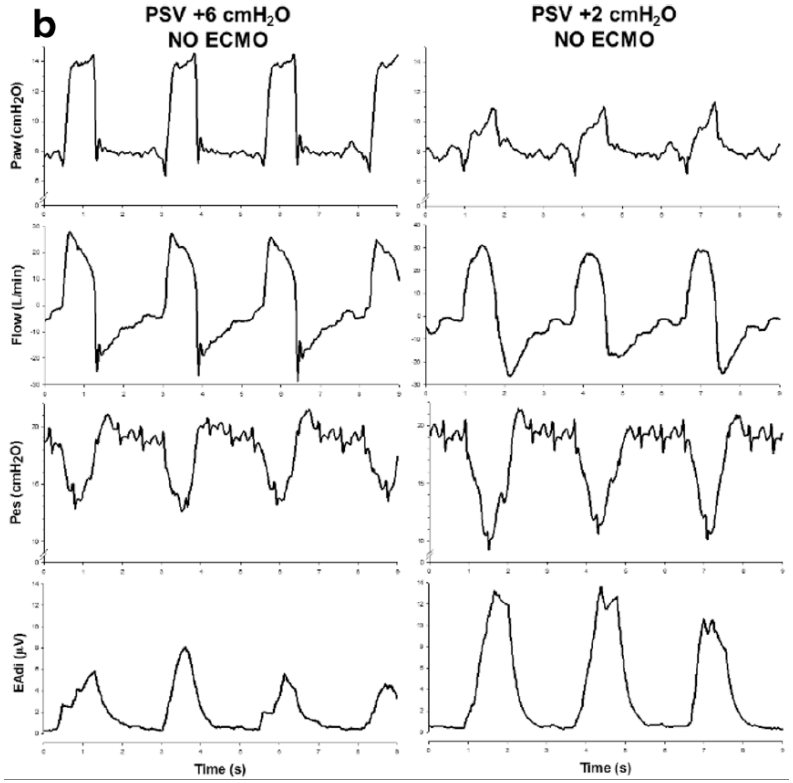
$$\Delta P = Vt / Crs$$

Case

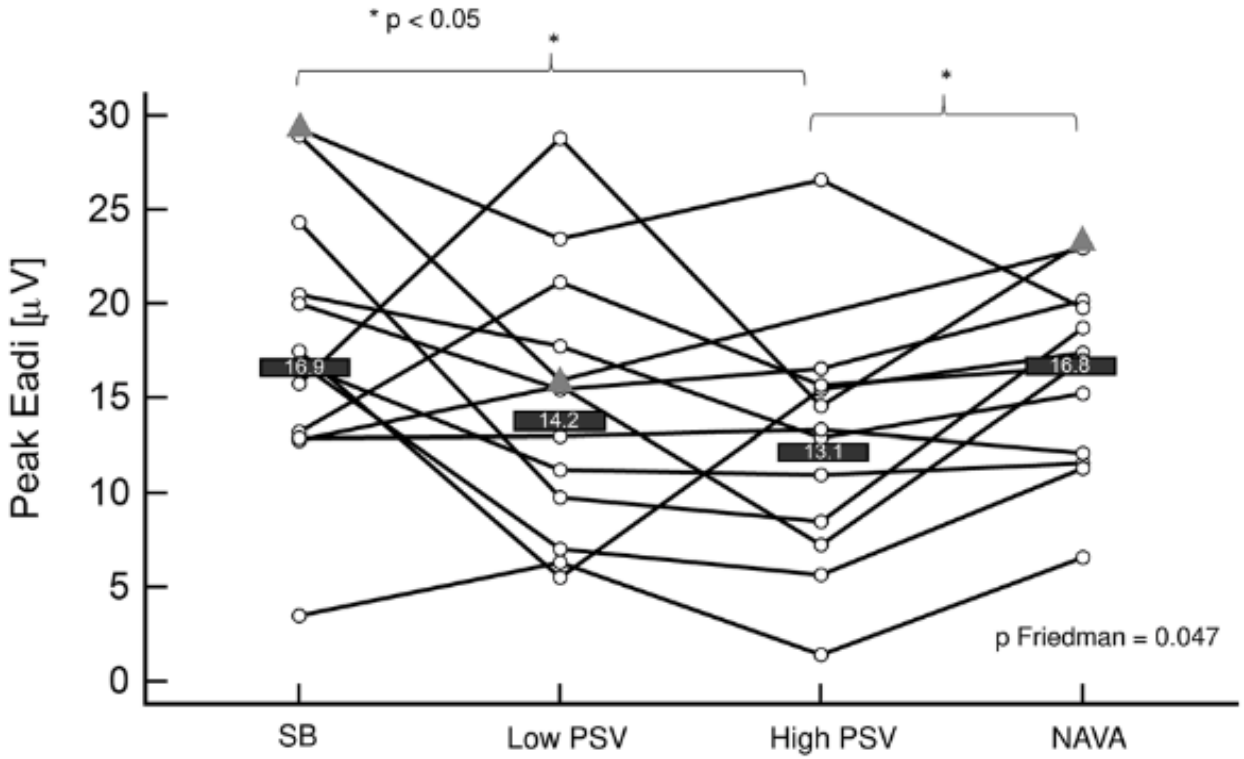
- Someone suggests NAVA for assisted ventilation
- How do you assess risk of lung and diaphragm injury in NAVA?

Diaphragm Electrical Activity



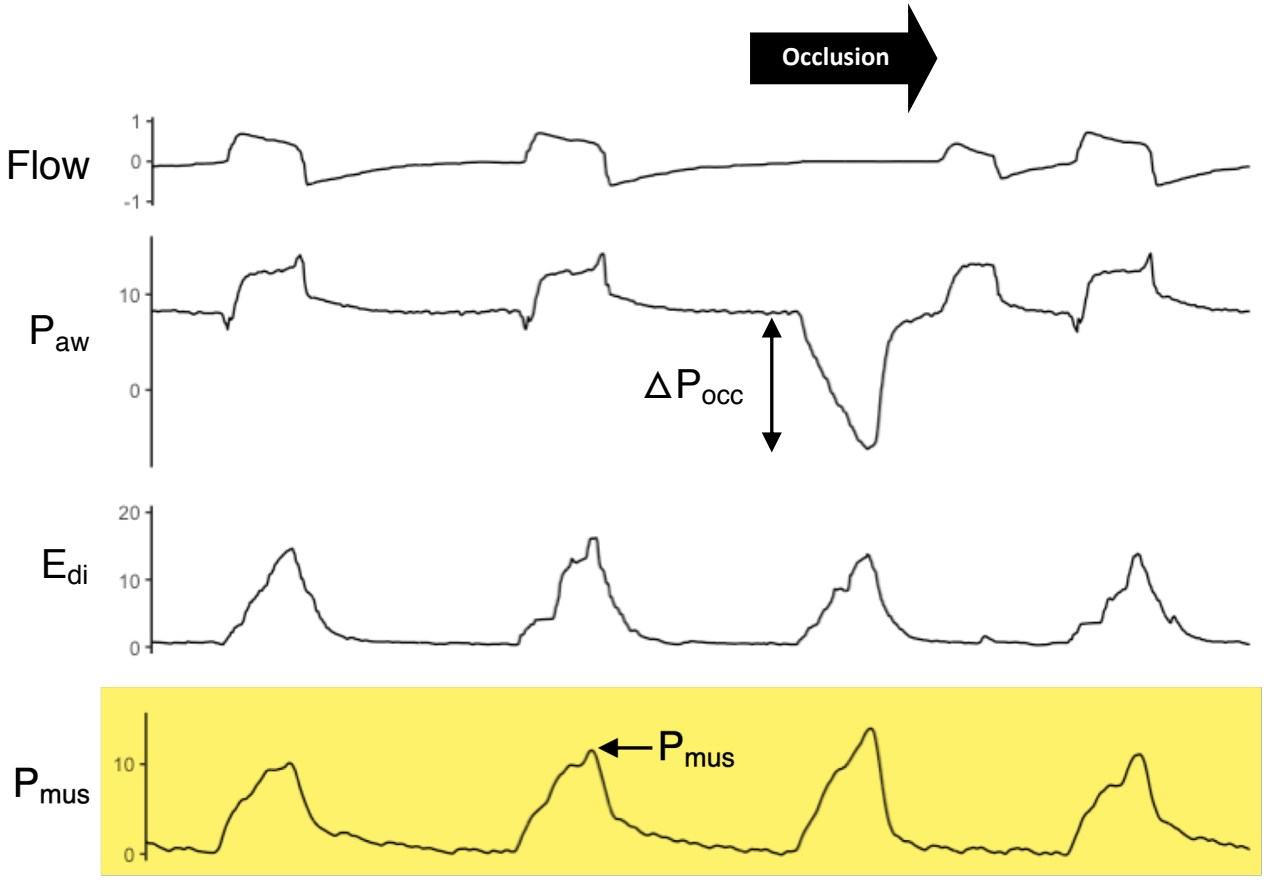


Diaphragm Electrical Activity



Piquilloud et al *Ann Intensive Care* 2019

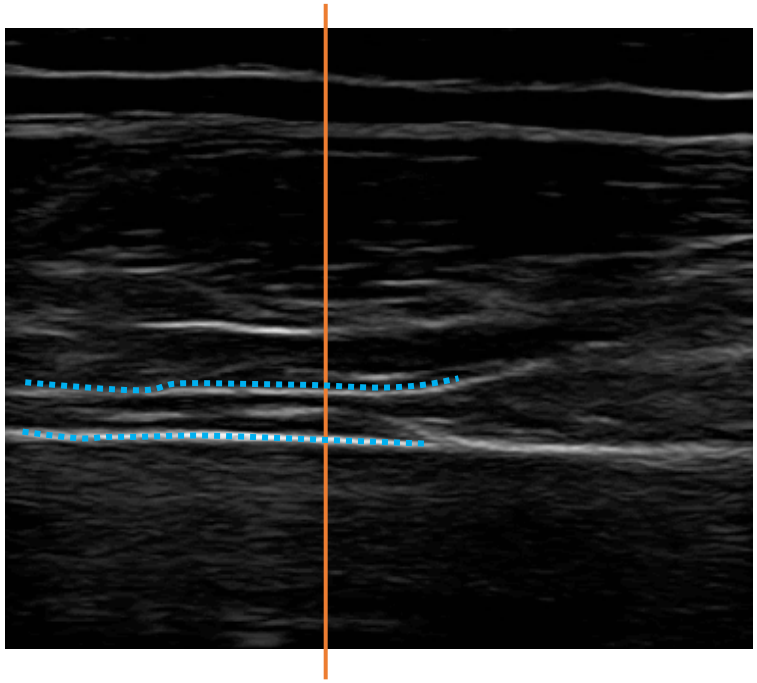
Estimating Effort from EAdi

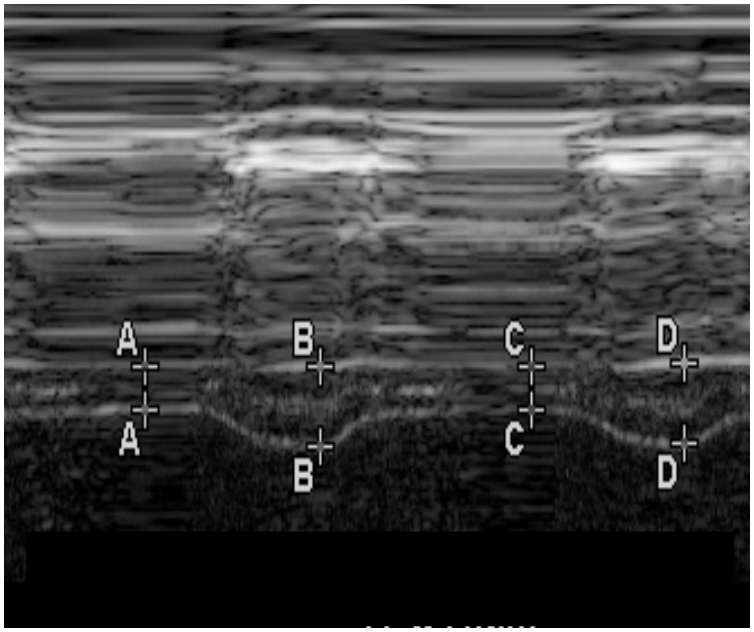


Case

- You are a POCUS enthuasiast

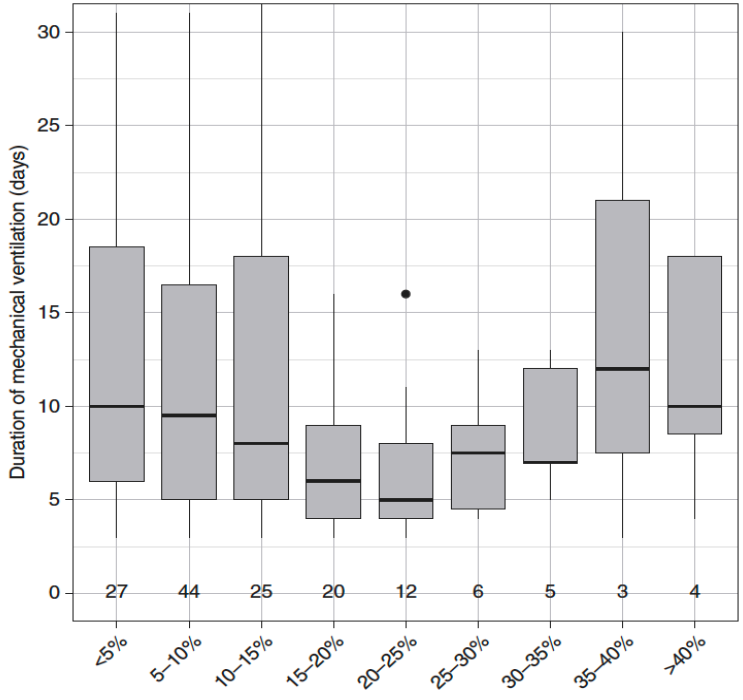
Assessing Myotrauma Risk: Diaphragm Ultrasound





Goligher et al. *Intensive Care Med* 2015

Diaphragm Ultrasound



Target window

Goligher et al *AJRCCM* 2018

Diaphragm Ultrasound