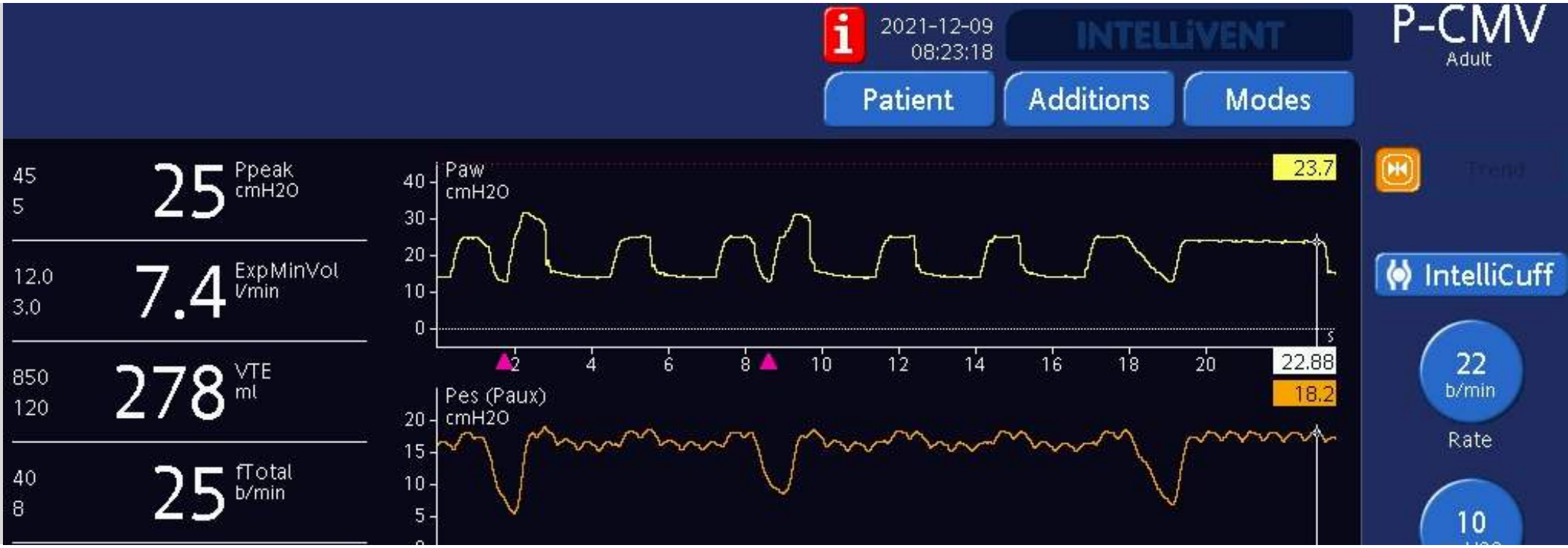

Triggered: A look into reverse triggering

J. Beno Thompson MSrt, RRT-NPS

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Conflicts of Interest

- Current Clinical Applications Specialist for Hamilton Medical Inc.

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Interactive Poll

- Text
  - benothompson557 to 22333
  - Choose your answer and text A, B, C, D, or E to this thread.

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#1

What Asynchrony is Present?

A. Flow Starvation

B. Reverse Trigger

C. Delayed Cycle

D. Double Trigger

E. I have no idea!

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#2

What Asynchrony is present?

- low Starvation
- Reverse Trigger
- . Delayed Cycle
- Double Trigger
- ll have no idea!

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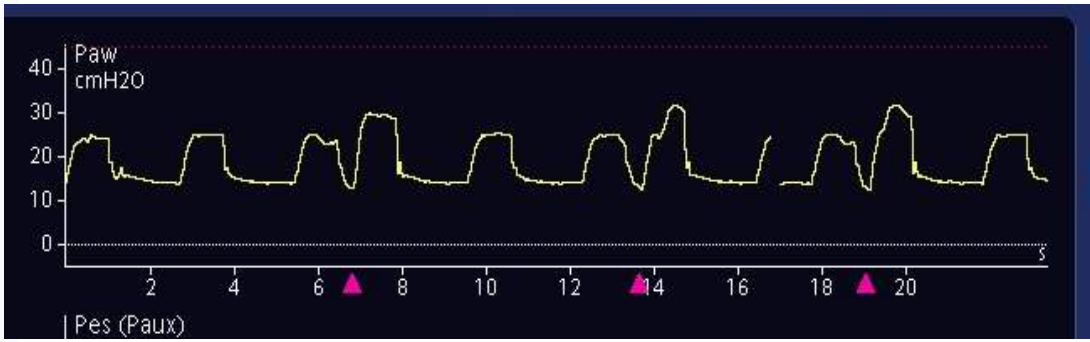

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Double Trigger

Double Triggering (Multiple Triggering)

- Two or more patient triggered breaths separated by minimal expiratory flow
- Mismatch of “machine” and “neural I-time”

Vignaux. ICM. 2006

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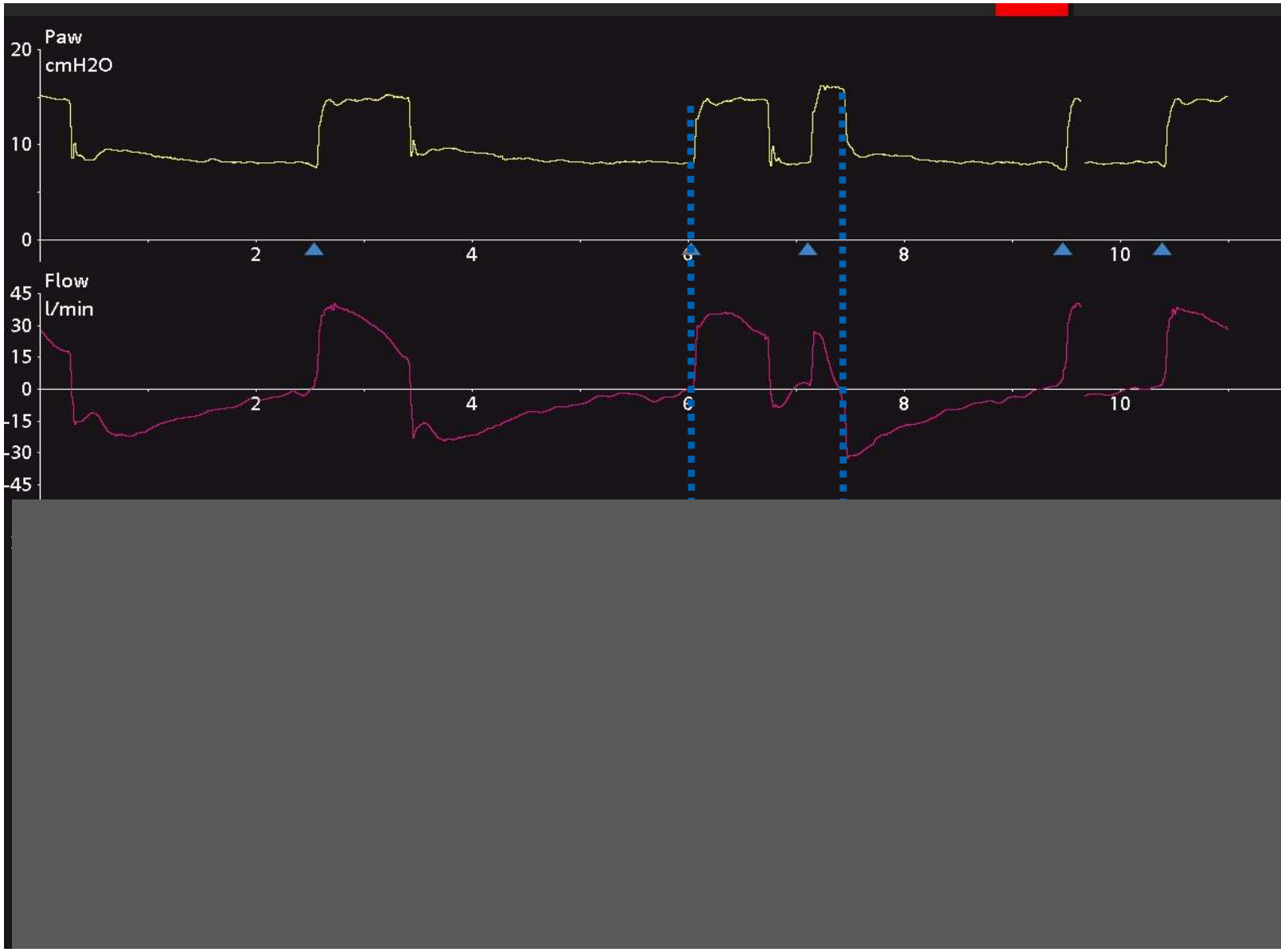
Double Triggering

Double Triggering



Double Triggering Possible Causes

- Cycling criteria (ETS, Esens%, FlowTerm%, Flowcycle) set too high (PS)
- I-time too short (VC & PC)
- Insufficient support

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Double Triggering Resolution

- Adjust ETS, Esens%, FlowTerm%, Flowcycle
- Lengthen I-time
- Increase inspiratory support

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Reverse Trigger

Definition

- Reverse trigger is an inspiratory effort occurring after a ventilator-initiated breath begins.

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Reverse triggering

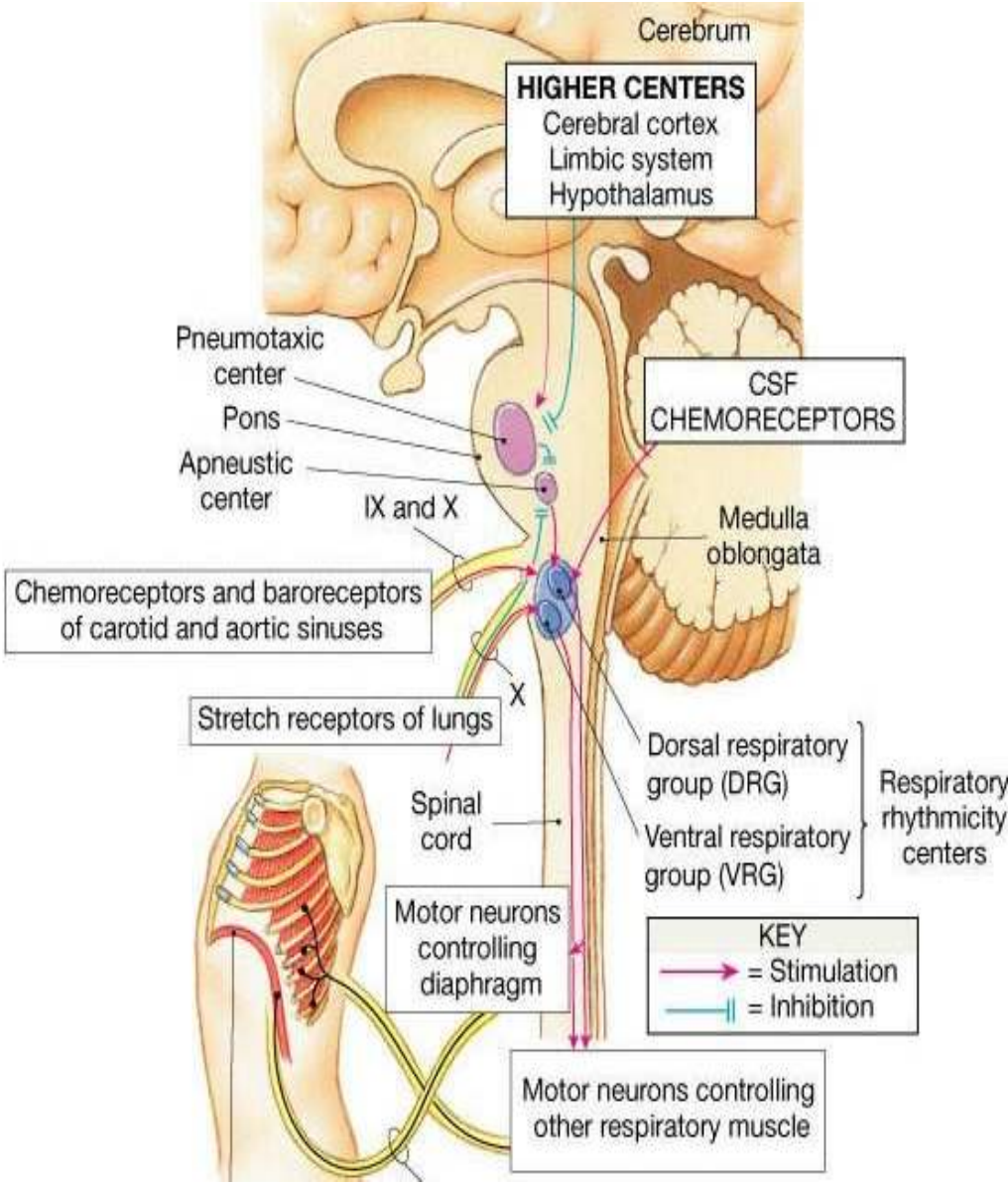
- A type of respiratory entrainment
  - Fixed repetitive temporal relationship
  - Discordant relationship between two oscillatory systems

Akoumianaki, Lyazidi, Rey, et al.: Mechanical Ventilation-Induced Reverse-Triggered Breaths

HAMILTON MEDICAL

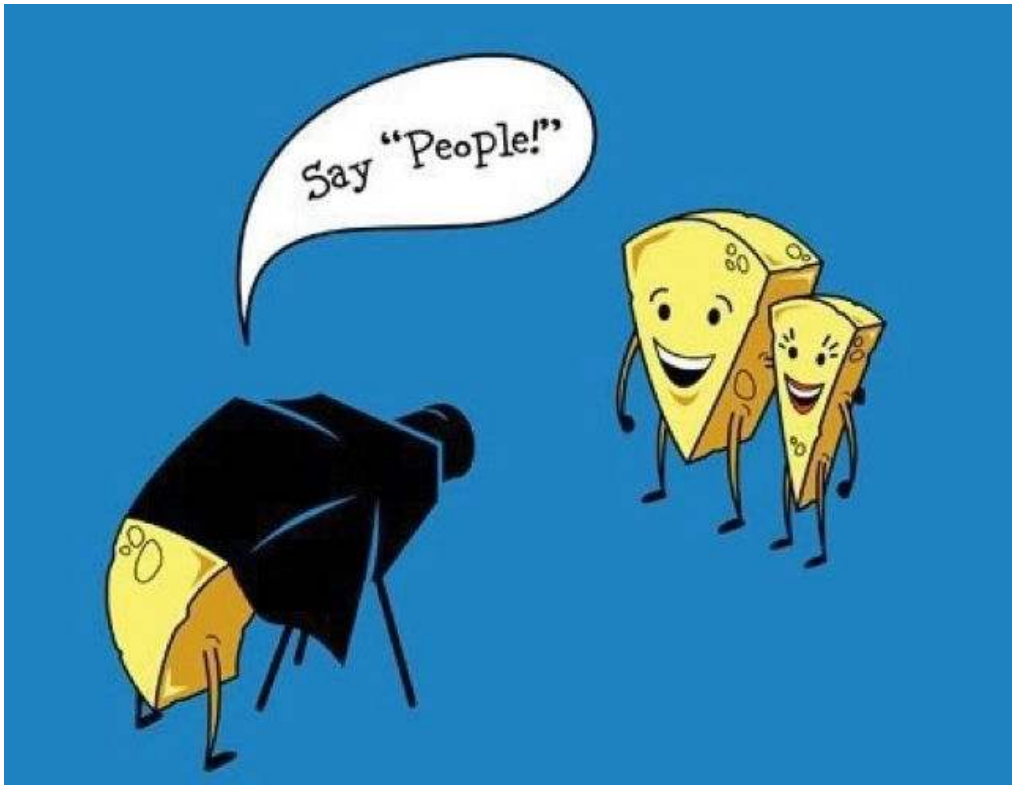
Hering-Breuer reflex

- Reflex triggered by stretch receptors in the lungs to prevent over-inflation
- Responsible for terminating inspiration and activating exhalation



Vadhan J, Tadi P. Physiology, Hering Breuer Reflex

Is it Opposite Day?



- Stretch receptors in the lungs adapt functionality during deep sedation
- Hering-Breuer reflex reverses functionality

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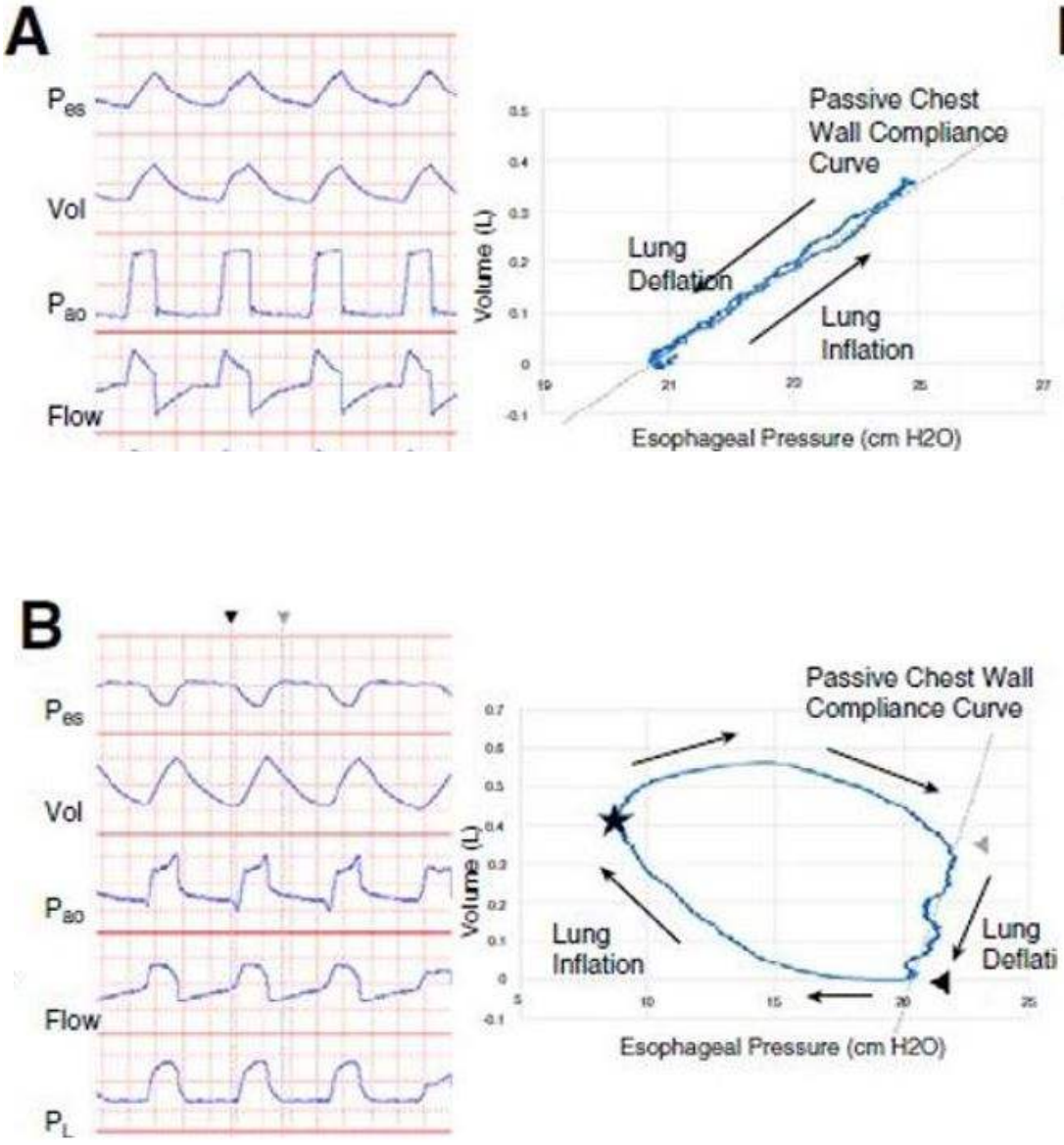
Four phenotypes

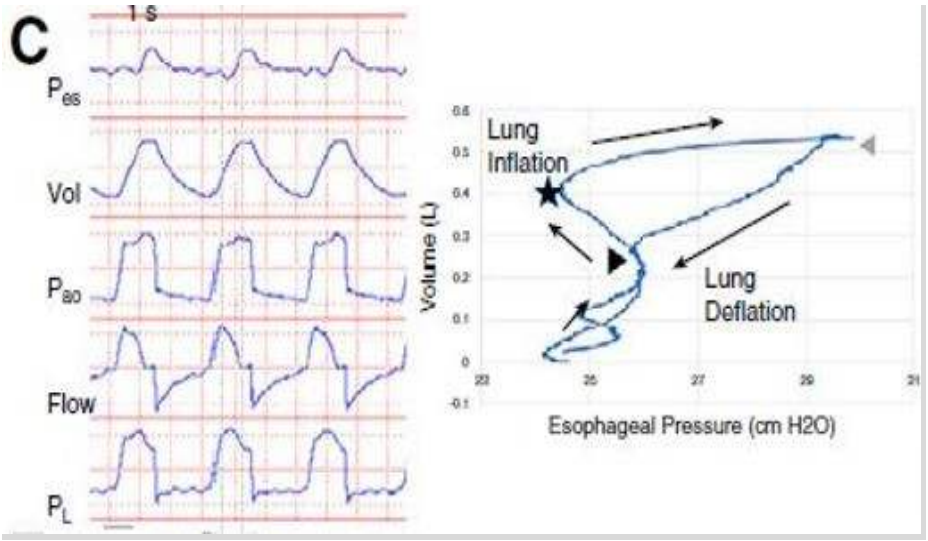
- Early reverse trigger with early expiratory relaxation
- Early reverse trigger with delayed relaxation
- Mid-cycle reverse trigger
- Late reverse trigger



Baedorf Kassis, Su, Graham, et al.: Reverse Trigger Phenotypes in ARDS

Early reverse trigger with early relaxation

- Maximum diaphragmatic contraction and relaxation occurs completely during inflation with relaxation and patient termination either during inflation or very early in deflation (< 50% of total deflation)
- Vt increases of 64–113 ml and Ptranspulm pressures of 2–3 cmH2O



Baedorf Kassis, Su, Graham, et al.: Reverse Trigger Phenotypes in ARDS

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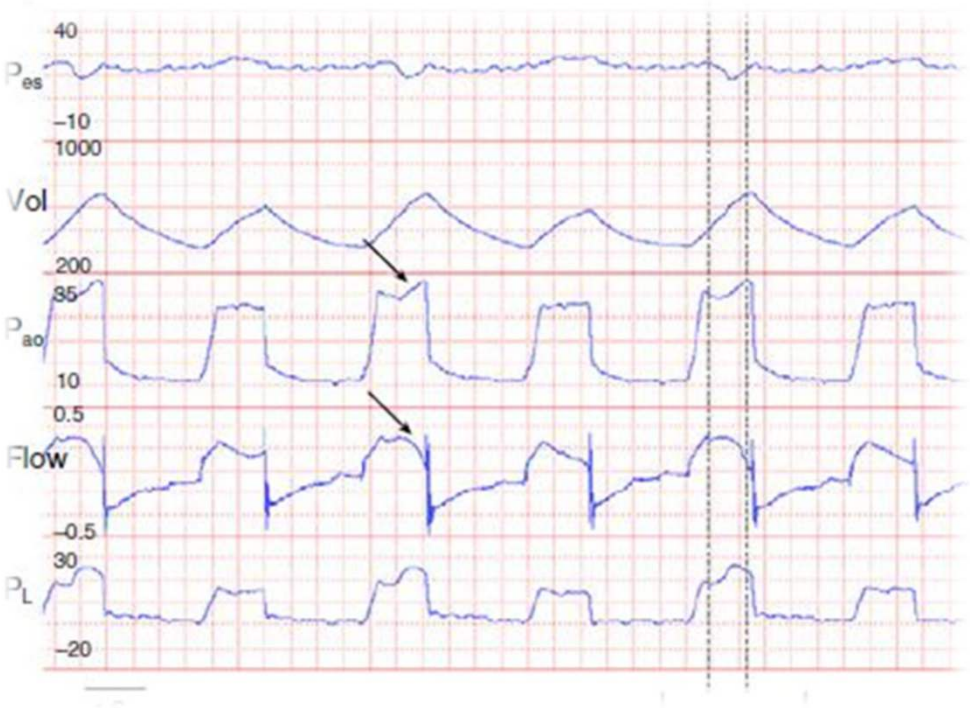
Early reverse trigger with early relaxation



- Increase PEEP
- Increase inspiratory support (Vt, Pcontrol, TI)
- Increase frequency

Baedorf Kassis, Su, Graham, et al.: Reverse Trigger Phenotypes in ARDS

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Why increase PEEP?

Volume-controlled Ventilation Does Not Prevent Injurious Inflation during Spontaneous Effort

Takeshi Yoshida[1,2], Susumu Nakahashi[1,3], Maria Aparecida Miyuki Nakamura[4], Yukiko Koyama[1], Rollin Roldan[4,5], Vinicius Torsani[4], Roberta R. De Santis[4], Susimeire Gomes[4], Akinori Uchiyama[1], Marcelo B. P. Amato[4], Brian P. Kavanagh[2], and Yuji Fujino[1]

[1]Intensive Care Unit, Osaka University Hospital, Suita, Japan; [2]Translational Medicine, Department of Critical Care Medicine and Department of Anesthesia, Hospital for Sick Children, University of Toronto, Toronto, Ontario, Canada; [3]Emergency and Critical Care Center, Mie University Hospital, Tsu, Japan; [4]Laboratório de Pneumologia LIM-09, Disciplina de Pneumologia, Instituto do Coração (Incor), Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo, São Paulo, Brazil; and [5]Unidad de Cuidados Intensivos, Hospital Rebagliati, Lima, Peru

Why increase PEEP?

Journal of
Clinical Medicine

MDPI

Review

Patient-Self Inflicted Lung Injury: A Practical Review

Guillaume Carteaux [1,2,3,*], Mélodie Parfait [1,2,†], Margot Combet [1,2,†], Anne-Fleur Haudebourg [1,2], Samuel Tuffet [1,2,3] and Armand Mekontso Dessap [1,2]

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Why increase PEEP?

Medizinische Klinik
Intensivmedizin und Notfallmedizin

Pflege

Med Klin Intensivmed Notfmed 2021 · 116: 614–623
https://doi.org/10.1007/s00063-021-00823-2
Eingegangen: 22. Februar 2021
Überarbeitet: 19. März 2021
Angenommen: 23. März 2021
Online publiziert: 7. Mai 2021

Benjamin Neetz[1] · Thomas Flohr[2] · Felix J. F. Herth[1] · Michael M. Müller[1]

[1]Thoraxklinik am Universitätsklinikum Heidelberg, Pneumologie und Beatmungsmedizin, Translational Lung Research Center Heidelberg (TLRC), Heidelberg, Deutschland
[2]Medizinische Klinik und Poliklinik I, Universitätsklinikum Würzburg, Würzburg, Deutschland

„Patient self-inflicted lung injury" (P-SILI)

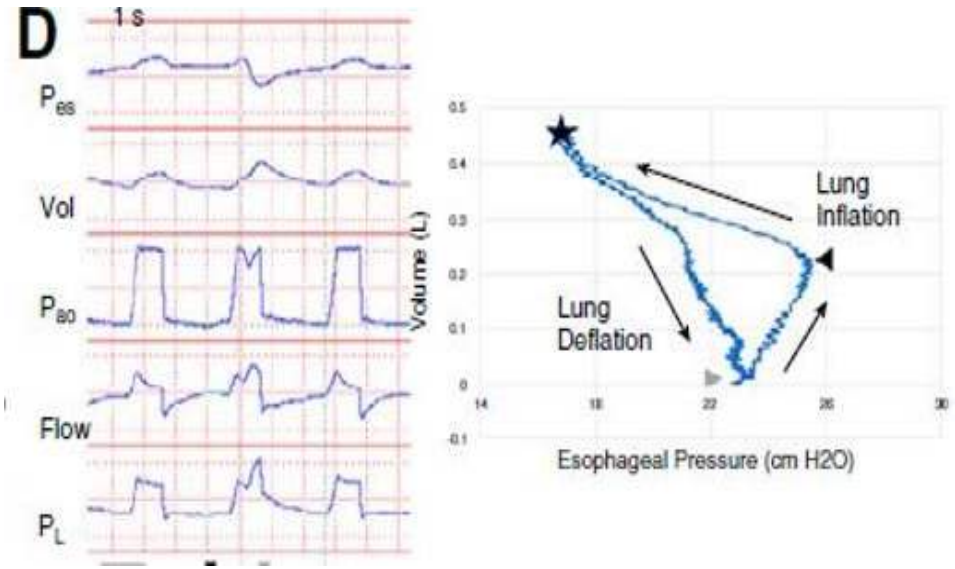
Von der Pathophysiologie zur klinischen Evaluation mit differenziertem Management

Benjamin Neetz, Flohr, Herth, et al: Patient self-inflicted lung injury (P-Sili)

HAMILTON MEDICAL

Early reverse trigger with delayed relaxation

- Maximum diaphragmatic contraction occurs completely during inflation with relaxation and patient termination happening after 50% of deflation
- Vt increases of 86–170 ml and Ptranspulm of 4–9 cmH2O



Baedorf Kassis, Su, Graham, et al.: Reverse Trigger Phenotypes in ARDS

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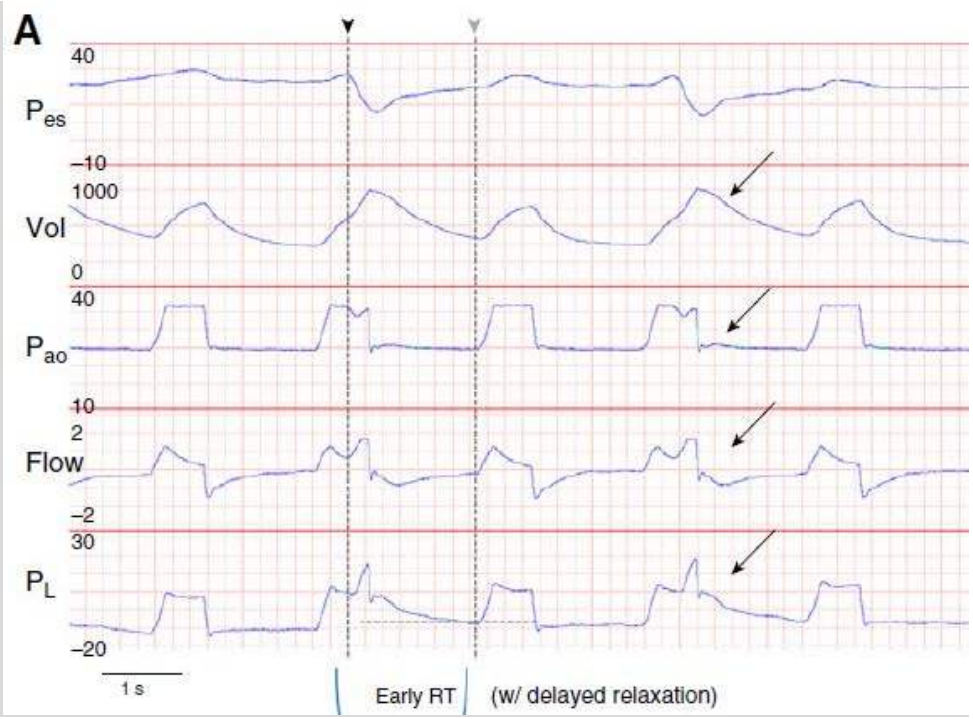
Early reverse trigger with delayed relaxation



- Increase PEEP
- Increase inspiratory support (Vt, Pcontrol, TI)
- Frequency increases should be done with close attention to potential breath stacking

Baedorf Kassis, Su, Graham, et al.: Reverse Trigger Phenotypes in ARDS

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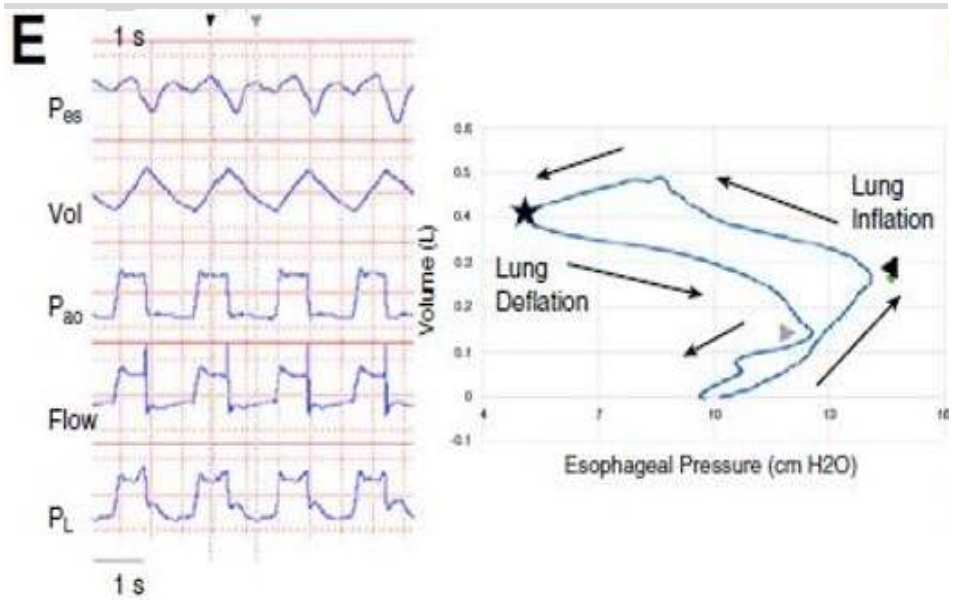
Mid-cycle reverse trigger

- Inspiratory effort begins during inflation, but maximal inspiratory muscle pressure occurs during deflation
- Vt increases of 38–64 ml
- Results in incomplete exhalation and breath stacking



Baedorf Kassis, Su, Graham, et al.: Reverse Trigger Phenotypes in ARDS

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Mid-cycle reverse trigger

- Increase PEEP
- Increase inspiratory support (Vt, Pcontrol, TI)
- Frequency increases could exacerbate breath stacking

Baedorf Kassis, Su, Graham, et al.: Reverse Trigger Phenotypes in ARDS

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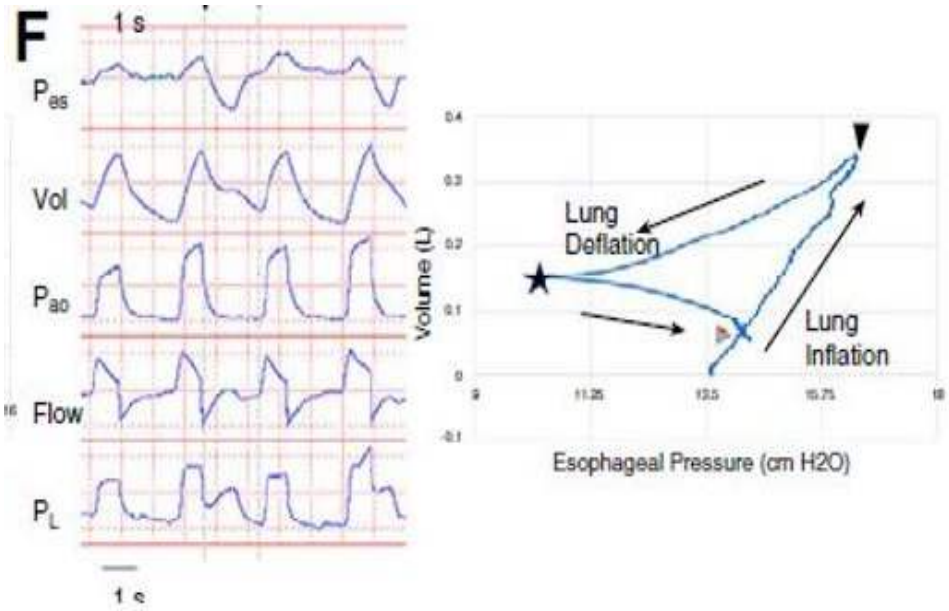
Late reverse trigger

- Both initiation and maximum effort occurs completely during the deflation phase
- Vt increases 155–197 ml
- Breath stacking results in large delivered Vt with incomplete exhalation



Baedorf Kassis, Su, Graham, et al.: Reverse Trigger Phenotypes in ARDS

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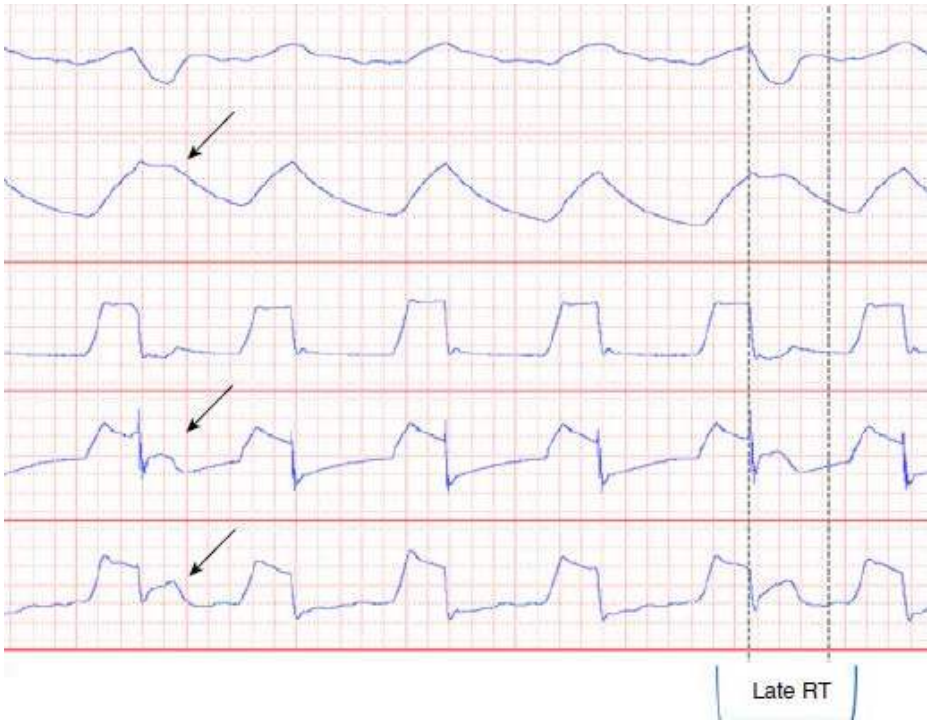
Late reverse trigger



- Increase PEEP
- Increase inspiratory support (Vt, Pcontrol, TI)
- Frequency should not be increased due to inherent breath stacking

Baedorf Kassis, Su, Graham, et al.: Reverse Trigger Phenotypes in ARDS

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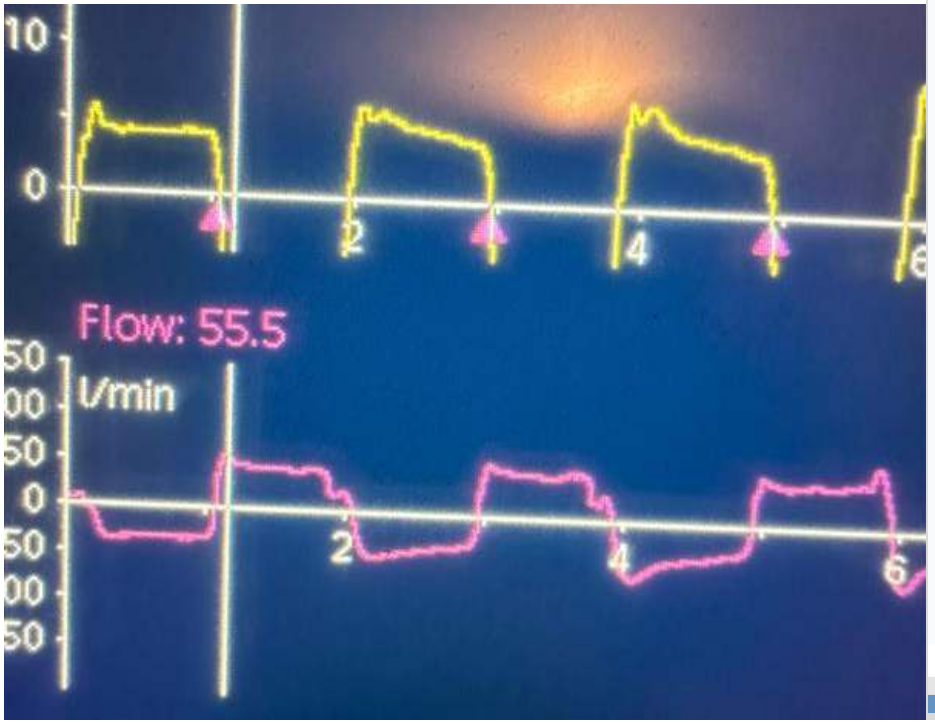
Pop quiz!!



Text **BENOTHOMPSON557** to **22333** once to join

My waveforms are ugly, what's going on here?

A Mid-Cycle Reverse Trigger

B Late Reverse Trigger with Late Relaxation

C Late Reverse Trigger

D Sometimes waveforms are just ugly. Deal with it.

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Pop quiz!!

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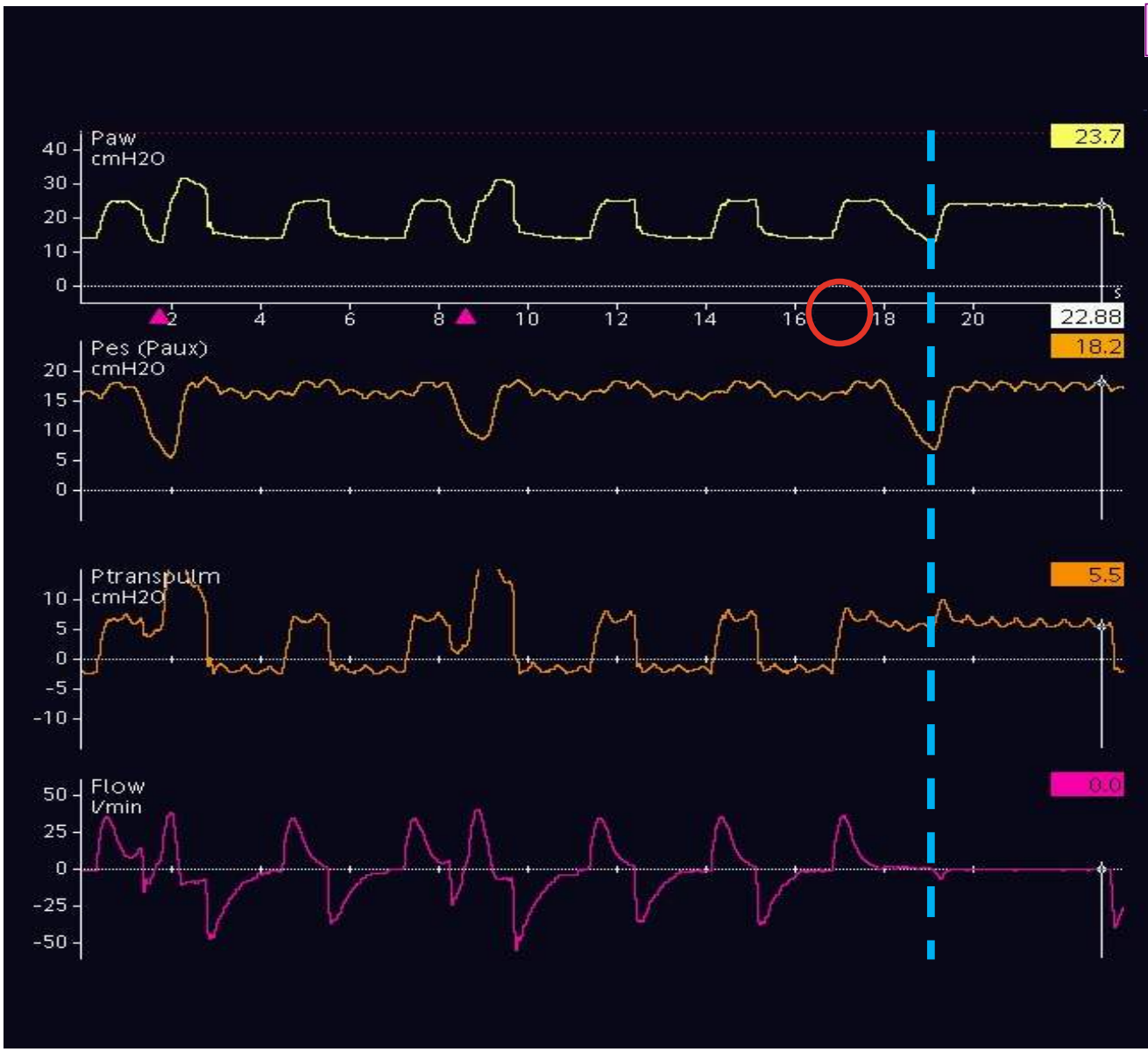
45
5
32 Ppeak cmH2O
12.0
3.0
7.6 ExpMinVol l/min
850
120
512 VTE ml
40
8
25 fTotal b/min
19 Pmean cmH2O
32 Ppeak cmH2O
31 Pplateau cmH2O
19 Pmean cmH2O
14 PEEP/CPAP cmH2O
2 / 9
Paw cmH2O
40
30
20
10
0
2
4
6
8
10
12
14
16
18
20
s
Pes (Paux) cmH2O
20
15
10
5
0
Ptranspulm cmH2O
10
5
0
-5
-10
Flow l/min
50
25
0
-25
Trend
IntelliCuff
22 b/min
Rate
10 cmH2O
Pcontrol
14 cmH2O
PEEP/CPAP
40 %
Oxygen
Controls

CB6

Reverse triggering identification



Slide 32

CB6 I would probably say
Identifying reverse triggering
Caroline, 4/20/2022

CB8 I have added this black background to make the image go from top to bottom so the slide matches our presentation template slides.
Caroline, 4/21/2022

Solutions

- Neuromuscular blockade
- Increase PEEP
- Increase support (Vt, Pcontrol, TI)
- Frequency increases should be made with serious considerations for breath stacking
- Late reverse trigger benefits from a decrease in frequency with concurrent increase in inspiratory support

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Summary

- Reverse triggering is an under-recognized phenomena occurring in deep sedation
- Reversal of Herring-Breuer reflex
- Four phenotypes
- Can lead to excessive Vt and air trapping if left unattended

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References

- Akoumianaki E, Lyazidi A, Rey N, Matamis D, Perez-Martinez N, Giraud R, et al. Mechanical ventilation-induced reverse-triggered breaths: a frequently unrecognized form of neuromechanical coupling. Chest 2013;143:927–938.
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- Baedorf Kassis E, Su H, Graham A, Novack V, Loring S, Talmor D, et al. Reverse Trigger Phenotypes in Acute Respiratory Distress Syndrome. American Journal Respiratory Critical Care Medicine 2021;203:1;67-77.

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Thank you for your attention.

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Clinical Applications Specialist

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Questions?

What I think I look like talking about Mechanical Ventilation vs what I actually look like