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sense and simplicity

New Tools of the Trade for Implementing a Successful NIV Program

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Course Objectives

- Review indications and complications of NIV
- Define NIV Goals and Success
- Review Auto-Trak Sensitivity
- Define Hospital-Acquired Pressure Ulcers (HAPU), risk factors, etiology, prevention, treatment, and implications
- Discuss new NIV modes and features: AVAPs, PPV, Auto-Trak +, and C-Flex

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Patient selection considerations

- **Strong evidence**
  - CHF
  - COPD exacerbation
  - Facilitating weaning of COPD
  - Immunocompromised patients
- **Moderately strong evidence**
  - Asthma
  - Cystic fibrosis
  - Postoperative RF
  - Avoidance of extubation failure
  - DNI patients
- **Weaker evidence**
  - Partial UAW
  - ARDS
  - Trauma

Strong = multiple controlled trials

Moderately strong = single controlled trial or multiple case series

Weaker = a few case series or case reports

Acute Applications of Noninvasive Positive Pressure Ventilation; T. Liesching, H. Kwok, N. Hill; *Chest 2003;124:699-713*

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NIV Success

- Success of NIV is usually defined as avoidance of intubation
- Many factors may influence the success rate
- What is an acceptable or desirable success rate?

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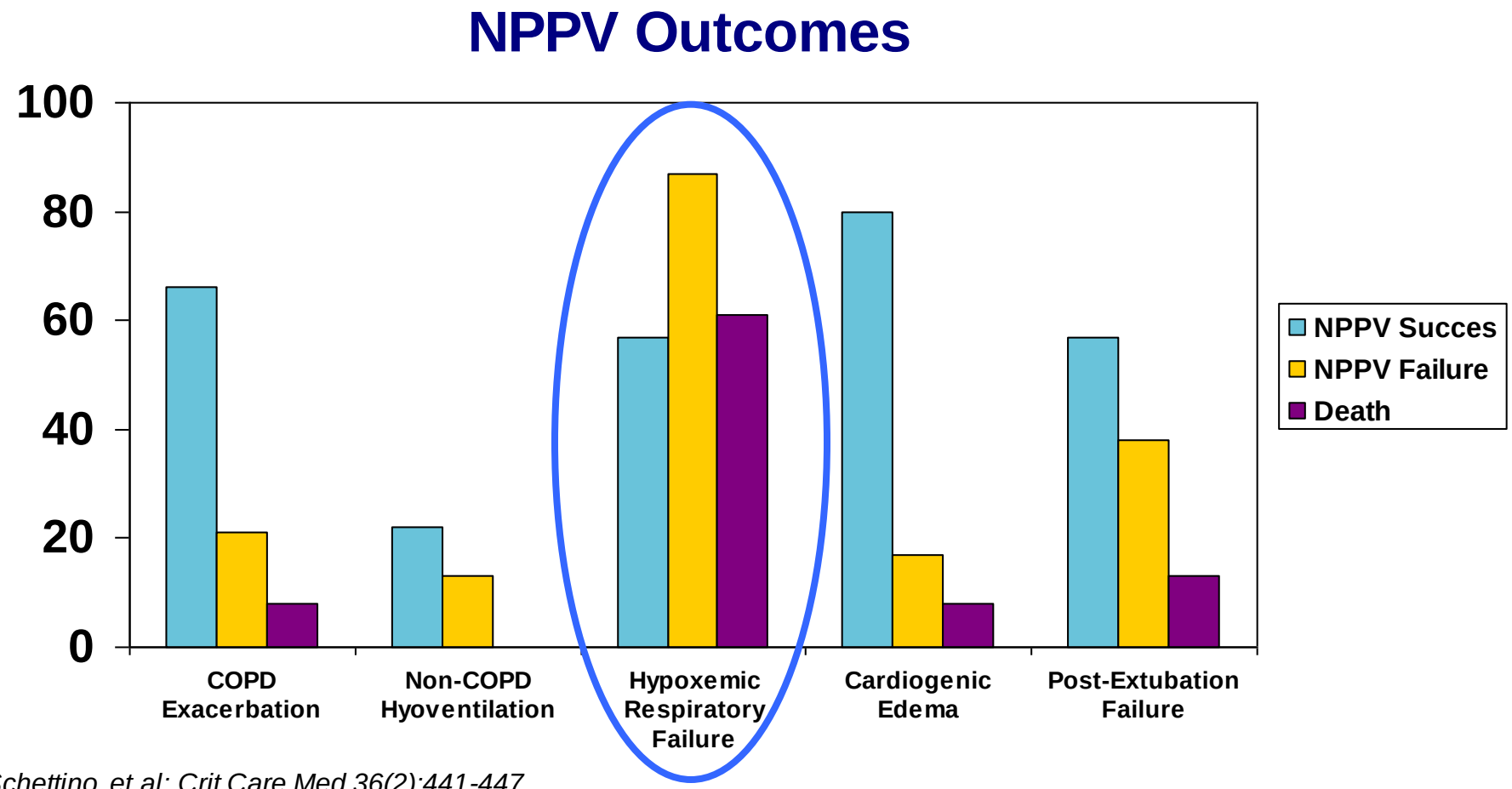
MGH, acute respiratory failure



Schettino, et al; Crit Care Med,36(2):441-447

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Goals of NIV

- Alleviate respiratory distress by
  - Improving gas exchange[1,2]
  - Reducing work of breathing[1,2]
    - Decrease rapid shallow breathing
  - Augmenting alveolar ventilation
- Achieve patient-to-ventilator synchrony[3]
- Minimize risks and avoid complications associated with endotracheal intubation[1,2]

[1]Hill, N. Non-invasive ventilation for chronic obstructive pulmonary edema., *Res[or Care* 2004 ;49(1):72-87.

[2]Nava, S., Hill, N. Non-invasive ventilation in acute respiratory failure, *The Lancet*, July 2009, Vol 374:250-258.

[3]Sniuff, T. Clinical Practice Guideline for the Use of Noninvasive Positive Pressure Ventilation in COPD Patients With Acute Respiratory Failure. Journal of Critical Care, Vol 19, No 2 (June), 2004: pp 82-91

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NIV Utilization and Success

- “There is arguably more evidence to support the use of NIV than any other practice related to the care of patients with acute respiratory failure. Despite this strong evidence base, NIV seems to be under-utilized”

- Hess, DR. Respir Care 2011;56(2):153:165

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NIV Utilization

- It is estimated that 25-30% of all mechanical ventilation in North America is delivered via Non-Invasive techniques
  - The utilization in Europe is closer to 50%
- Why the disparity???

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Utilization of Non Invasive Ventilation in Acute Care Hospitals: A Regional Survey

Vinay Maheshwari, MD; Daniela Paioli, MD; Robert Rothaar, MD; and Nicholas S. Hill, MD, FCCP†

CHEST 2006; 129:1226–1233

- ***Conclusions:*** **The utilization rates for NPPV vary enormously among different acute care hospitals within the same region. The perceived reasons for lower utilization rates include lack of physician knowledge, insufficient respiratory therapist training, and inadequate equipment. Educational programs directed at individual institutions may be useful to enhance utilization rates.**

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RT Directors Reasons for Low NIV Utilization

Maheshwari et al, Chest 2006

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Clinical keys to success

- Early intervention
  - Consider NIV as the first mode of ventilator support
  - The earlier the initiation, the higher the success rate
  - Availability of equipment and staff
- Trained staff
- Appropriate interface
- High performance equipment
- Cardiopulmonary monitoring

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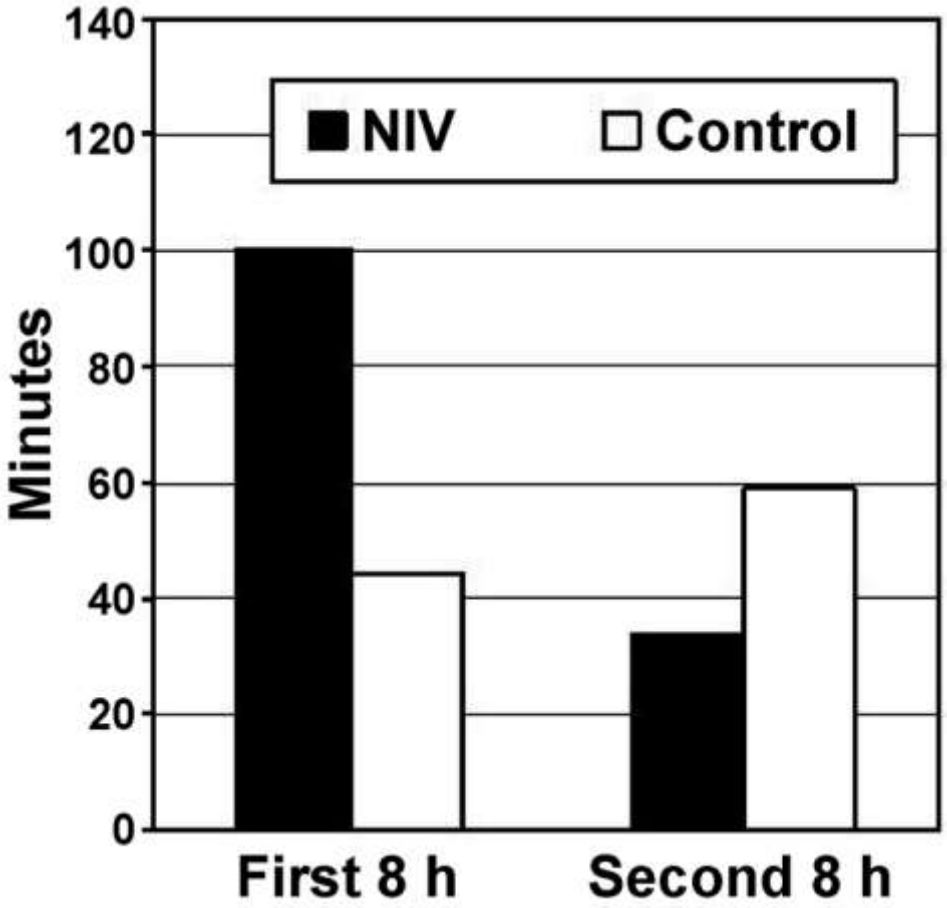
RT Time to Initiate and Provide NIV



Kramer et al, Am J Respir Crit Care Med 1995

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Ventilator selection

- Type
  - Critical care
  - Noninvasive (bilevel)
  - CPAP
- Leak Compensation
- Oxygen delivery capability
  - 21-100%
- Integrated alarms

Respir Care 2004; 48(10):919-921

Why use a BiPAP Ventilator for NIV?

- Performance capabilities
  - Automated Leak compensation
  - Optimal triggering and cycling
  - Flow and Pressure specs
  - Rise time adjustment
- Comprehensive monitoring
  - Waveforms
  - Patient data

Respiratory Care; 48(10):919-921

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Digital Auto-Trak™ Sensitivity

- Leak tolerance and compensation
- Optimal triggering and cycling
- Continuously automated adjustment and response to changes in patient demand

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Enhanced Leak Compensation

- Digital Auto-Trak™ Sensitivity provides up to 60 L/min of Leak compensation
- Provides breath-to-breath, automated adjustment to insure stable pressure delivery
- Eliminates the need for an air-tight mask seal
- Insures accurate monitoring of Tidal Volume

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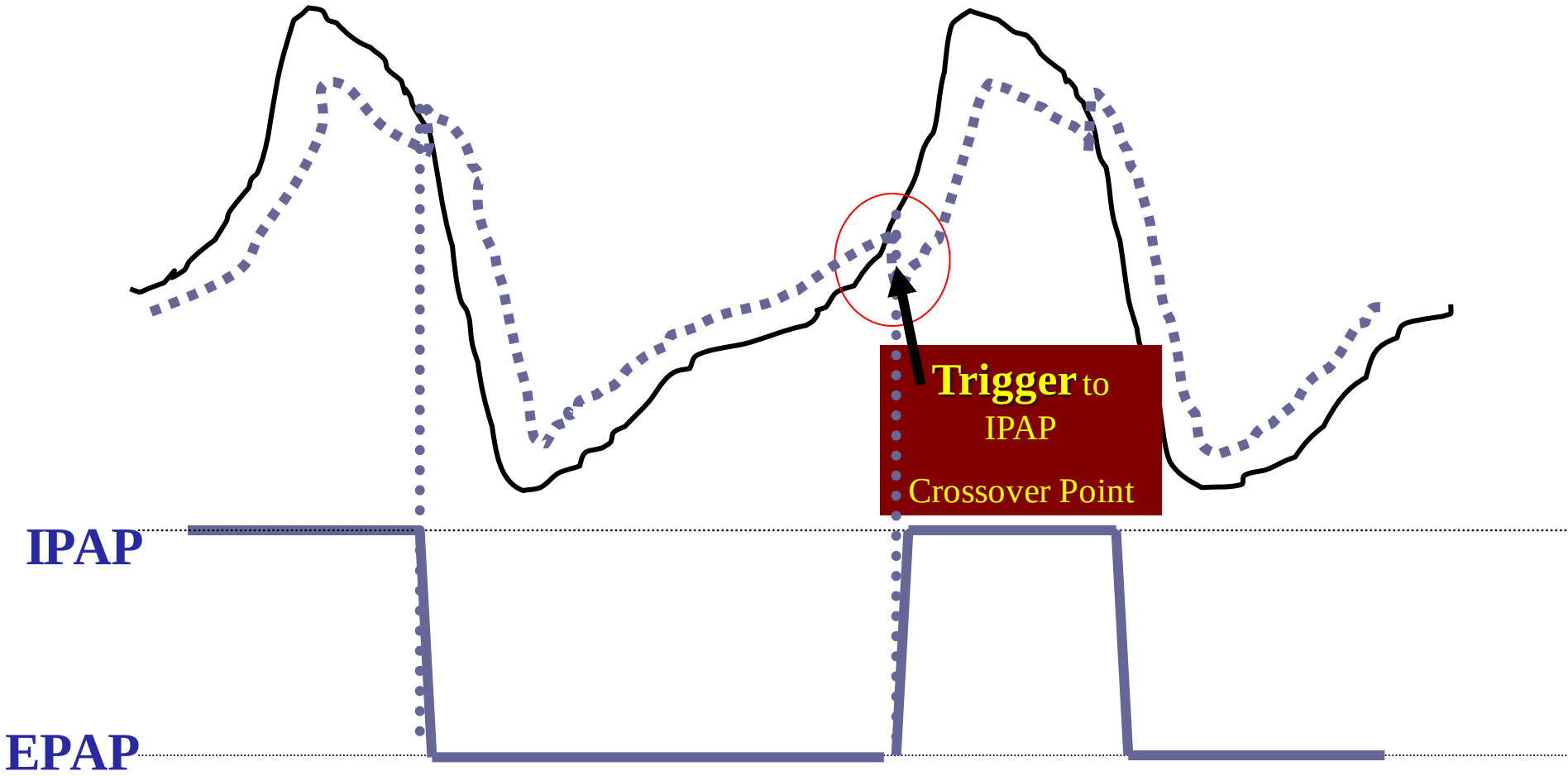
Shape Signal concept



Benefit： Detects rapid change in patient flow

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Auto-Trak Sensitivity™ - Breath cycling

- Provides automatic and continuous adjustment of breath termination threshold
  - Optimal patient-ventilator synchrony
  - Improved patient comfort
  - Eliminates the need for “active exhalation”

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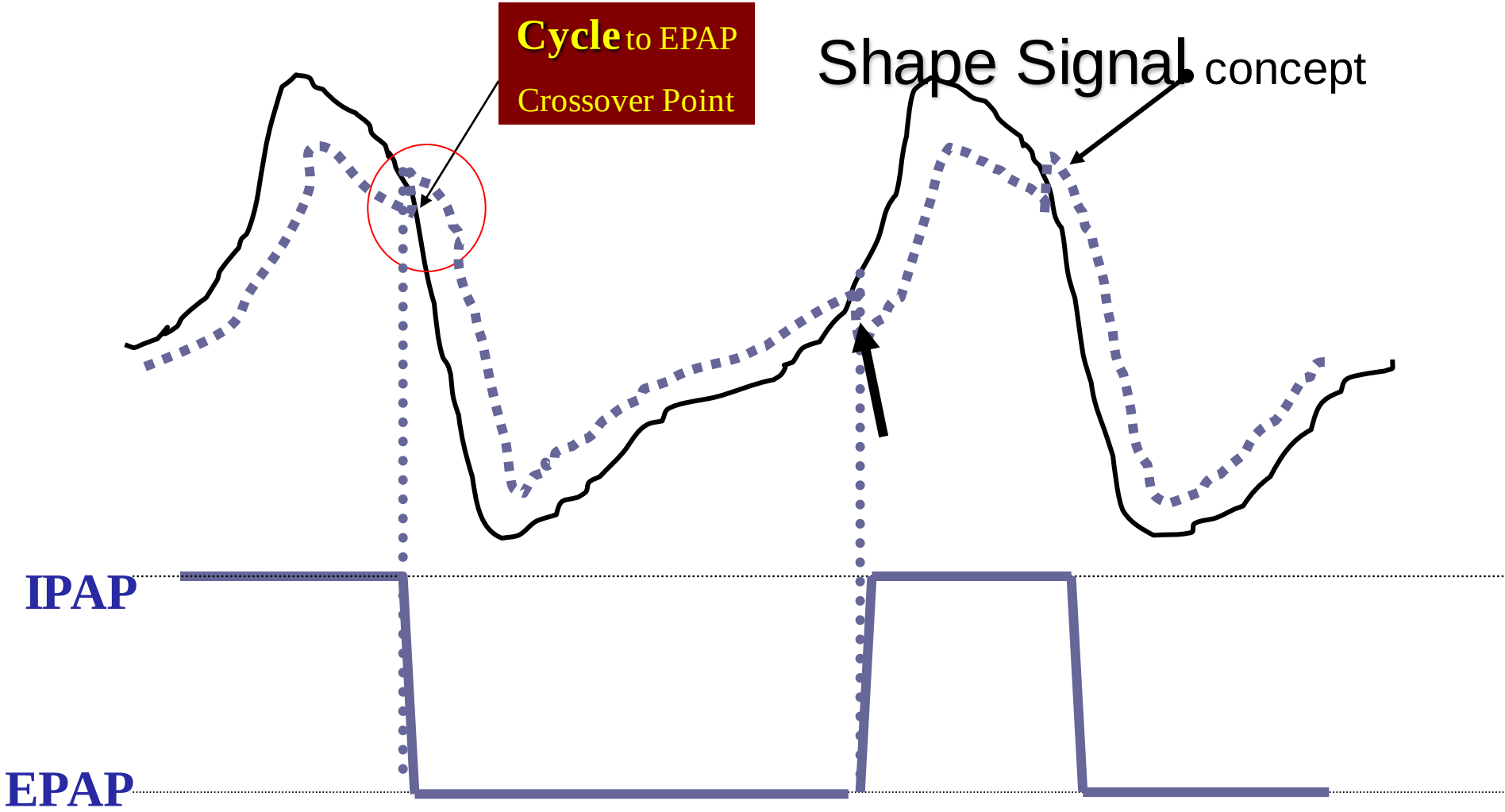

Benefit： Detects rapid change in patient flow

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Interface selection

- Estimate length of use
- Compatibility with device
- Safety features
- Facial features
  - Skin condition
  - Facial abnormalities
- Up to 50% of NIV failures are related to the interface

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Interface Considerations

- Interface types
  - Total face mask
  - Full face mask
  - Nasal mask
- Headgear selection

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Interface Design Features

- Ease of application
- Stability and adjustable headstrap for custom fit
- Soft, self-sealing, comfortable cushion
- Adequate seal with minimal pressure applied to face and nose
- Safety features
- Ability to maintain a “prescription” leak

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Clinicians remove interfaces an average of **18-20 times** per DAY!

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Interface related complications of NIV

Adverse Effect	Remedy
Discomfort	Check fit, adjust straps, change interface
Excessive air leaks	Realign interface, check strap tension, change to full face mask
Nasal bridge redness or ulceration	Use artificial skin, minimize strap tension, use spacer, alternate interface or use a PerforMax or Total face mask
Skin irritation or rashes	Use skin barrier lotion and/or topical corticosteroids, change to mask made from a different material, properly clean mask
Claustrophobic reactions	Try nasal interface or PerforMax or Total face mask, sedate judiciously

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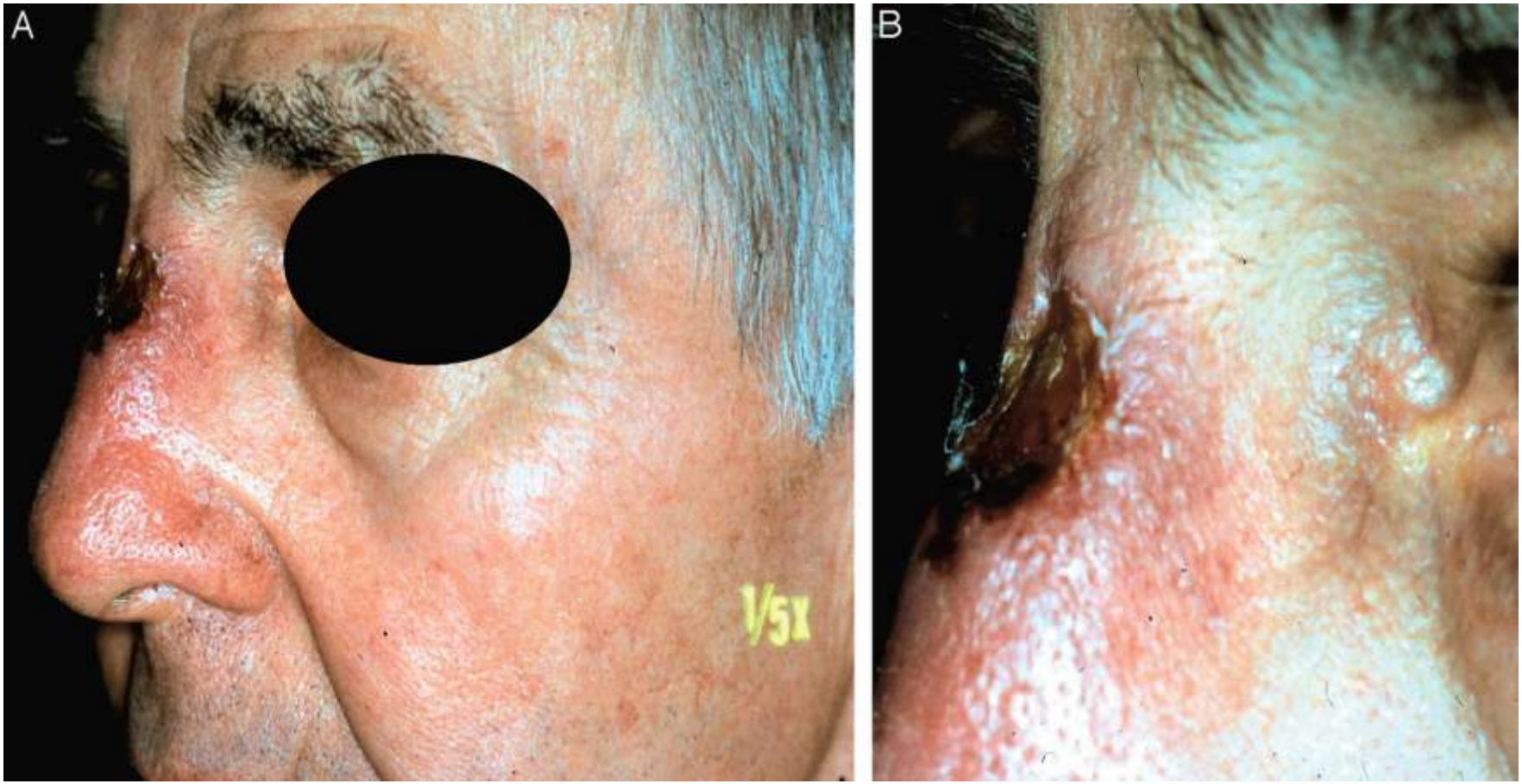
The Problem



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Skin Integrity during NIV

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Saving Face

- As part of the Healthcare Affordability Act, CMS will not reimburse for treatment of Hospital Acquired Pressure Ulcers (HAPU)
- This was a focal topic at the 2011 National Pressure Ulcer Advisory Panel (NPUAP) Meeting
- Key areas are assessment, prevention, monitoring quality indicators, and treatment

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Initial Assessment

- All patients should be assessed for skin integrity on admission
- Assessment of risk factors for HAPU should also be determined on admission and prior to NIV initiation
  - Braden scale
- Relative risk should determine monitoring frequency and prevention strategy

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Risk Factors for Pressure Ulcer Formation

- Old age
- Dehydration
- Hypotension
- Hypoxemia
- Anemia
- Diabetes
- Atherosclerosis
- Malnutrition
- Vitamin C Deficiency
- Corticosteroid use

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Etiology of Pressure Ulcers

- Pressure, Pressure, Pressure
  - Compressive Force
  - Shearing Forces
- Tissue Tolerance
  - Pressure Tolerance
  - Oxygen Tolerance

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Pressure Tolerance

- Compressive pressure should be < diastolic BP
  - Secondary goal is < capillary BP (32-45 mmHg)
  - Duration of pressure exposure is extremely important
  - Pressure increases markedly over bony prominences
- Shearing force cause stretching, kinking, and tearing of the perforating vessels in the subcutaneous tissues leading to deeper tissue necrosis
- Presence of shear may reduce pressure tolerance by 50%

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Incidence

- Skin Breakdown and pressure ulcer/necrosis is reported to occur in 7-45% of NIV cases that require > 48 hrs of continuous therapy
- Treatment of pressure ulcers ranges from $7,000-40,000 per case

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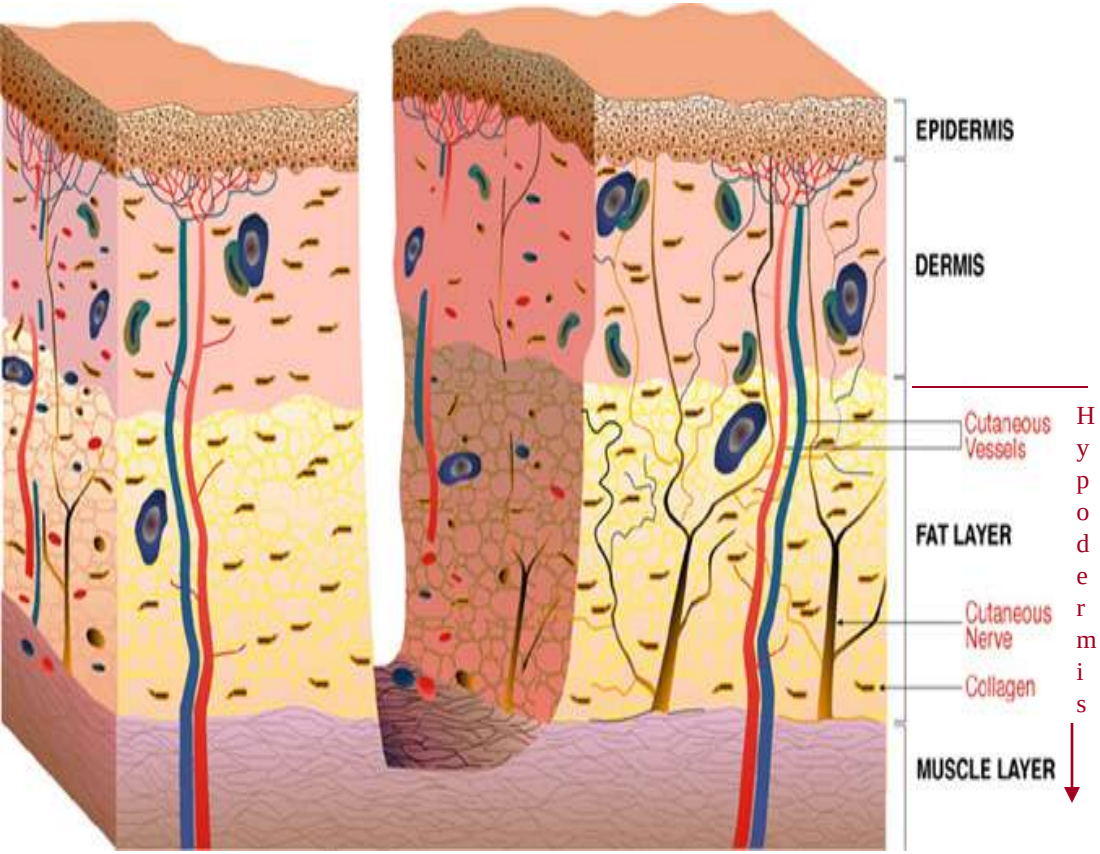
Brief Anatomy and Physiology



- Epidermis
  - the outer layer of skin
  - shedding every 21 days
- Dermis
  - contains nerve endings, blood vessels, oil glands, and sweat glands. It also contains collagen and elastin.
- Hypodermis
  - The subcutaneous tissue is a layer of fat and connective tissue that houses larger blood vessels and nerves.

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Pressure Ulcer

- Pressure ulcers are localized areas of tissue necrosis that develop when soft tissue is compressed between a boney prominence surface for an extended period of time

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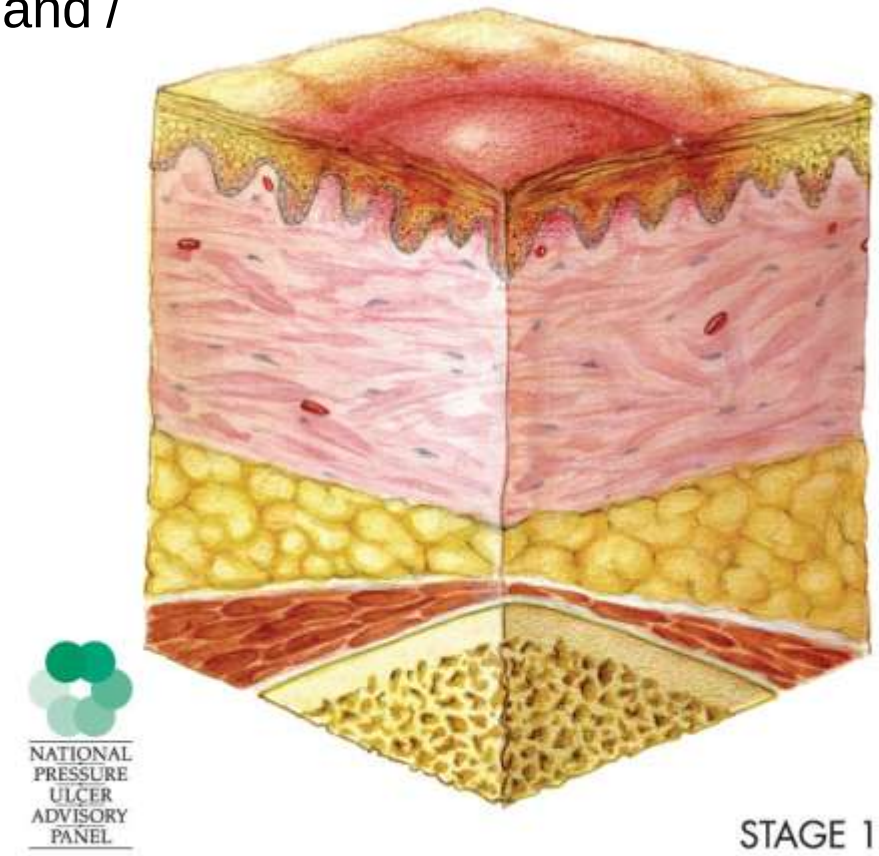
Stage 1 Pressure Ulcer

Stage 1: Intact skin with non blanchable redness. A change in the skin temp (warm or coolness), tissue consistency (firm or boggy feel) and / or sensation (pain or itching)



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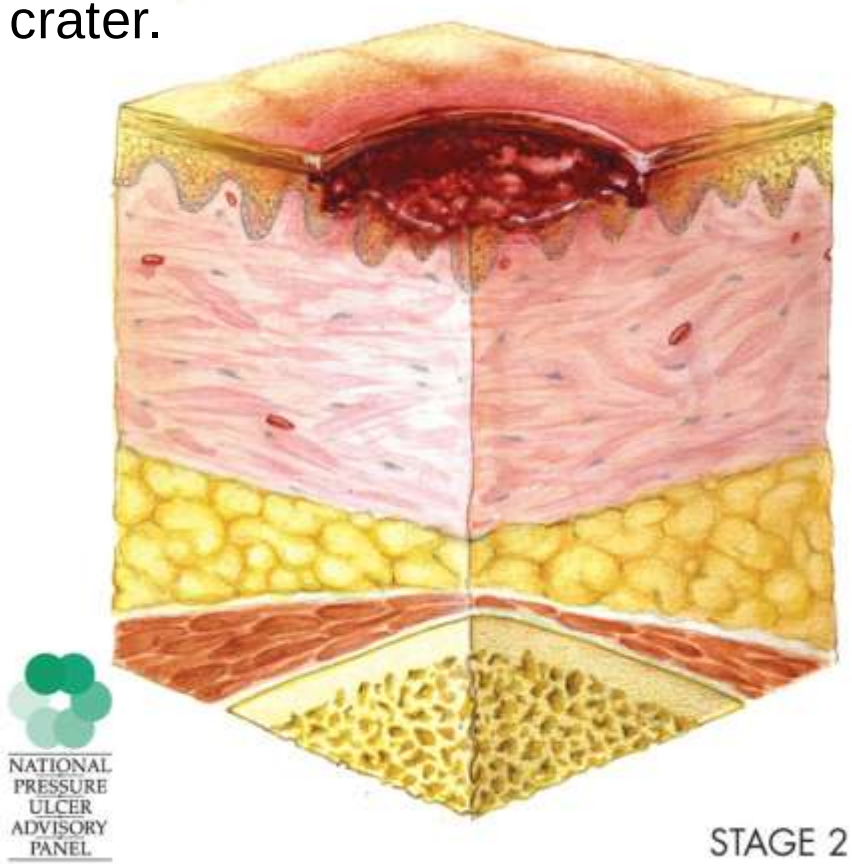
Stage 2 Pressure Ulcer

Stage 2: partial thickness loss of skin involving epidermis and/or dermis. Presents as a intact or open serum filled blister or shallow crater.



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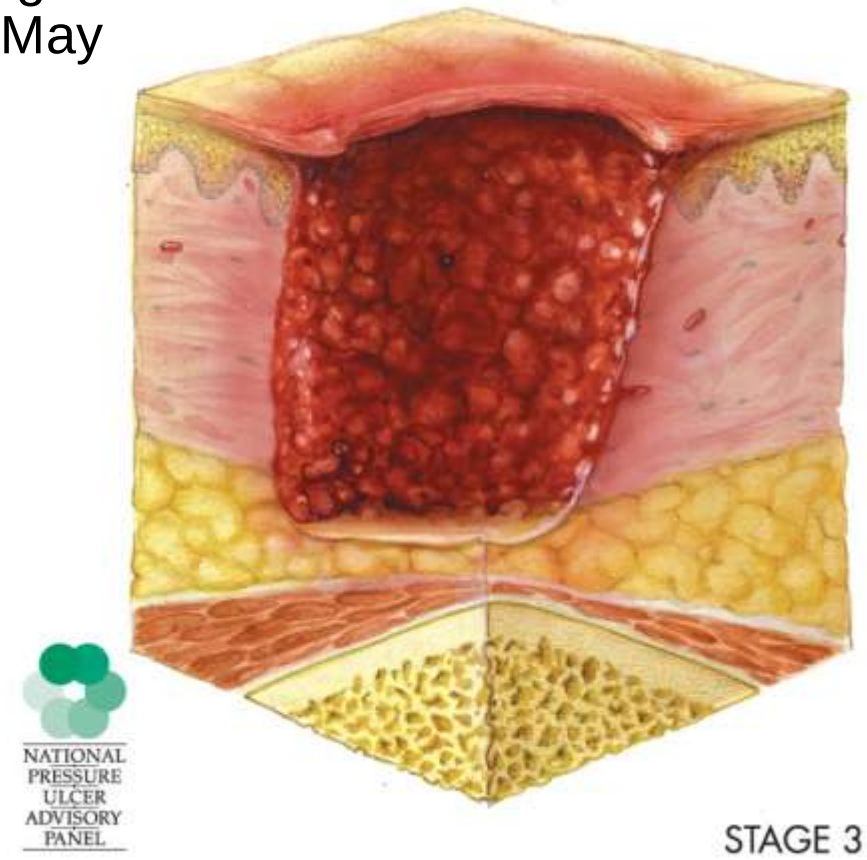
Stage 3 Pressure Ulcer

Stage 3:Full thickness tissue loss involving damage to or necrosis of subcutaneous tissue that may extend down to, but not through, underlying fascia. Presents as a deep crater May include undermining or tunneling



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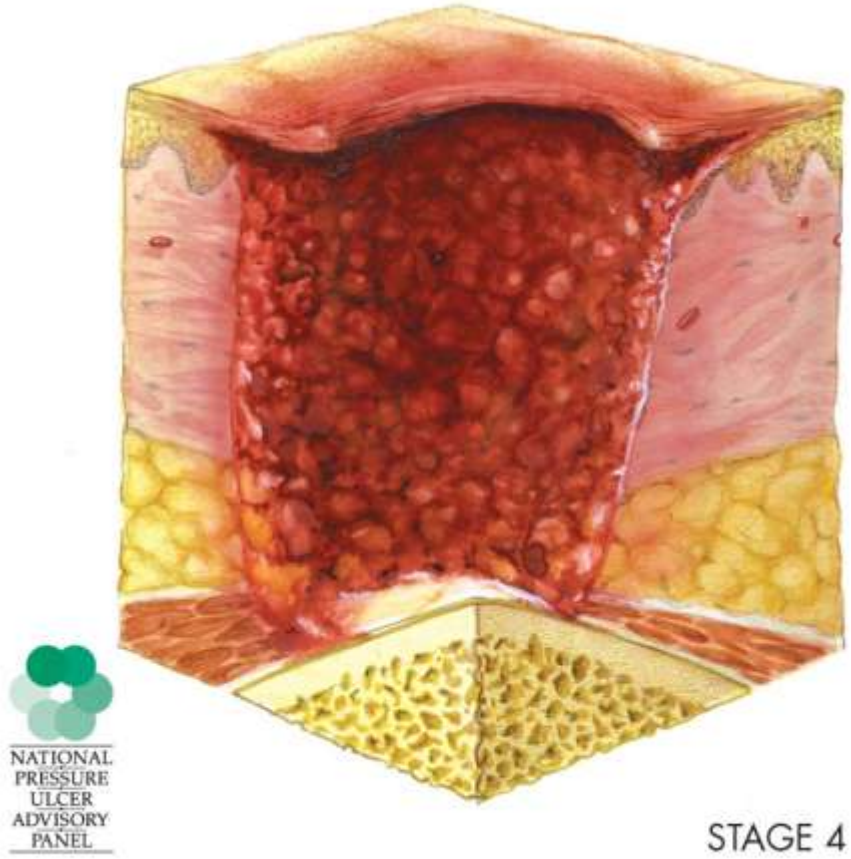
Stage 4 Pressure Ulcer

Stage 4: Full Thickness tissue loss with extensive destruction. Exposed bone, muscle or tendon Some slough or eschar may be present



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Unstageable Pressure Ulcer

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Preventing Pressure Ulcers

- Identify persons at risk
- PREVENTION!!!!
- Consider alternative mask styles
  - PerforMax, Total Face, Gel Mask
- MASK LEAKS ARE A GOOD THING! Keep mask leak no less than 7 lpm
- Skin care and early interventions/barriers
- Assessment…Assessment…Assessment
- Staff, Patient, and Family Education

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Prevention Strategies

- Adopt a mask rotation schedule in high risk patients
  - Q2-Q4 rotation between FFM and PerforMax (Total)
  - Allows pressure redistribution and offloading
- Encourage PerforMax use
  - Many clinicians are initially skeptical about P-Max
  - Many believe P-Max is only for short-term use
  - P-Max fairs well in patient preference testing
- Use a FFM with a “cut-out” @ nasal bridge
- Encourage/Educate on use of adjustable bridge
- Encourage “prescription” leak with loose fitting mask

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Education/Training

- Proper mask selection, sizing, and application
- Leaks may be essential to NIV success
- Mask pressure against the face should be between 3-6 cmH_2O higher than airway pressure
- Use of high acuity BiPAP devices with increased leak compensation and trigger/cycle function
- Mask Fitting Workshop
- Nursing Education
- Physician Education Program

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Average volume-assured pressure support

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AVAPS

- What is AVAPS
  - Average volume-assured pressure support
  - Vent automatically modifies pressure to maintain an average target user-defined VT
    - 1 cmH_2O to possibly 2.5 cmH_20 per minute change in pressure
  - During AVAPS setup, there may be a period of time before the target tidal volume is achieved
  - AVAPS **should not** be used when rapid IPAP adjustments are needed to achieve the desired VT

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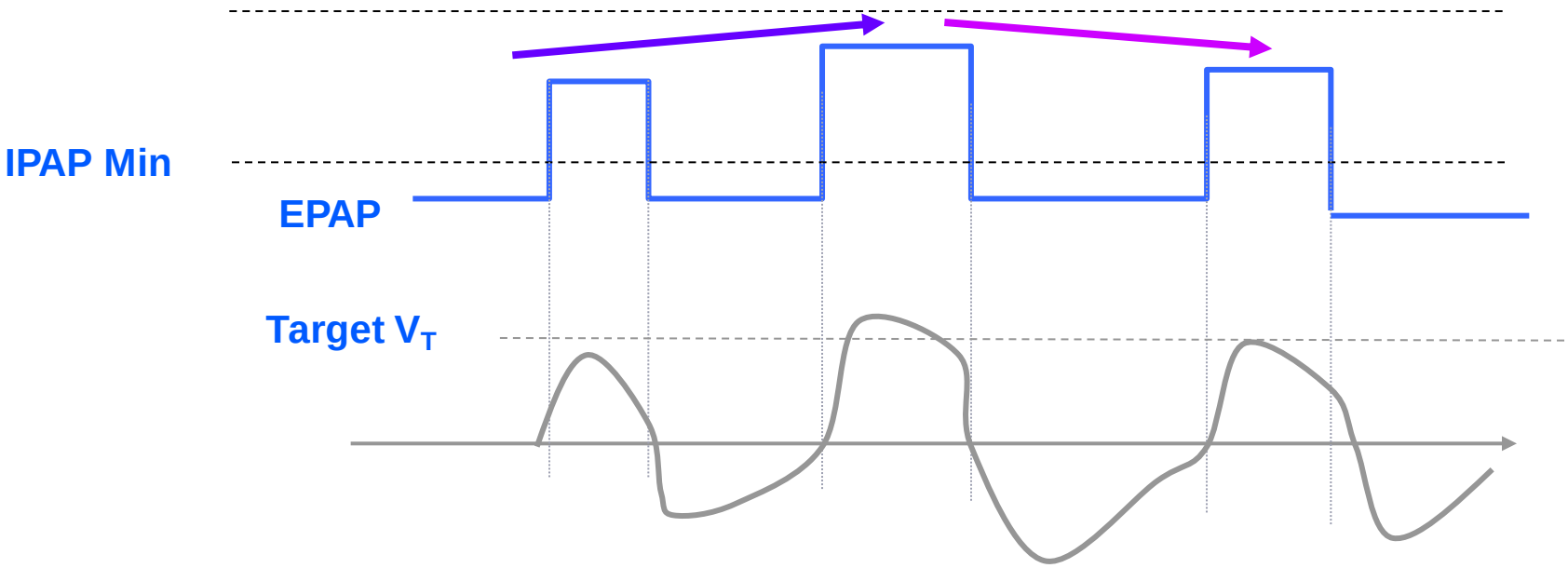
Average volume-assured pressure support

AVAPS automatically adapts pressure support (< 2.5 cmH_2O) per minute to guarantee an average tidal volume



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Proportional Pressure Ventilation (PPV)

- Represents a new mode available during NIV that prioritizes management and response to patient effort, work of breathing and comfort

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So what is PPV?

- Proportional Pressure Ventilation = Proportional Assist Ventilation (PAV) as described in multiple peer-reviewed articles
- PPV allows the patient to assist in controlling his own work of breathing
- "PAV (PPV), was developed as a mode to enhance ventilator responsiveness to patient breathing effort"[1]
  - Provides inspiratory flow and pressure in proportion to the patient's spontaneous effort[1]
  - A form of synchronized partial ventilatory support designed to generate, on a breath-to-breath basis, inspiratory positive airway pressure in proportion with the patient's instantaneous inspiratory effort[2]

[1]Gay, P., Hess, D., Hill, N. Noninvasive Proportional Assist Ventilation for Acute Respiratory Insufficiency; *Am J Respir Crit Care Med 2001*; Vol 164:1606-1611

[2]Mysocki, M., et al. Noninvasive proportional assist ventilation compared with noninvasive pressure support ventilation in hyp ercapnic acute respiratory failure. *Crit Care Med 2002*; Vol.30;No.2:323-329.

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What are the advantages of PPV?

- May improve gas exchange short-term in patients with chronic respiratory failure resulting from restrictive thoracic disease or COPD[1]
- Reduces work of breathing[1]
- Assists in unloading inspiratory muscles, improves gas exchange and provides excellent patient-to-ventilator synchrony in patients with severe, stable COPD[1,2]

[1] Gay, P., Hess, D., Hill, N. Noninvasive Proportional Assist Ventilation for Acute Respiratory Insufficiency; *Am J Respir Crit Care Med 2001*; Vol 164:1606-1611

[2] Mysocki, M., et al. Noninvasive proportional assist ventilation compared with noninvasive pressure support ventilation in hypercapnic acute respiratory failure. *Crit Care Med 2002*; Vol.30;No.2:323-329.

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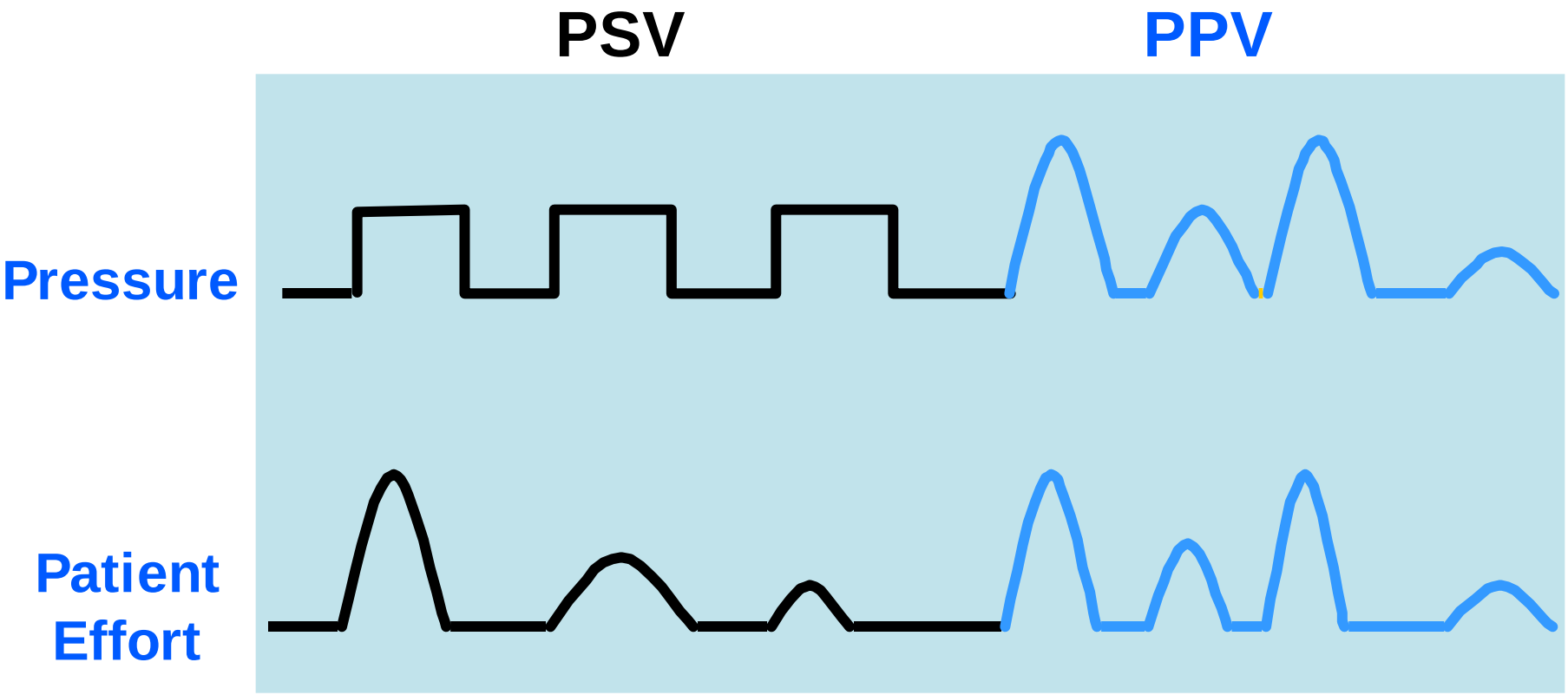
The difference between PSV and PPV



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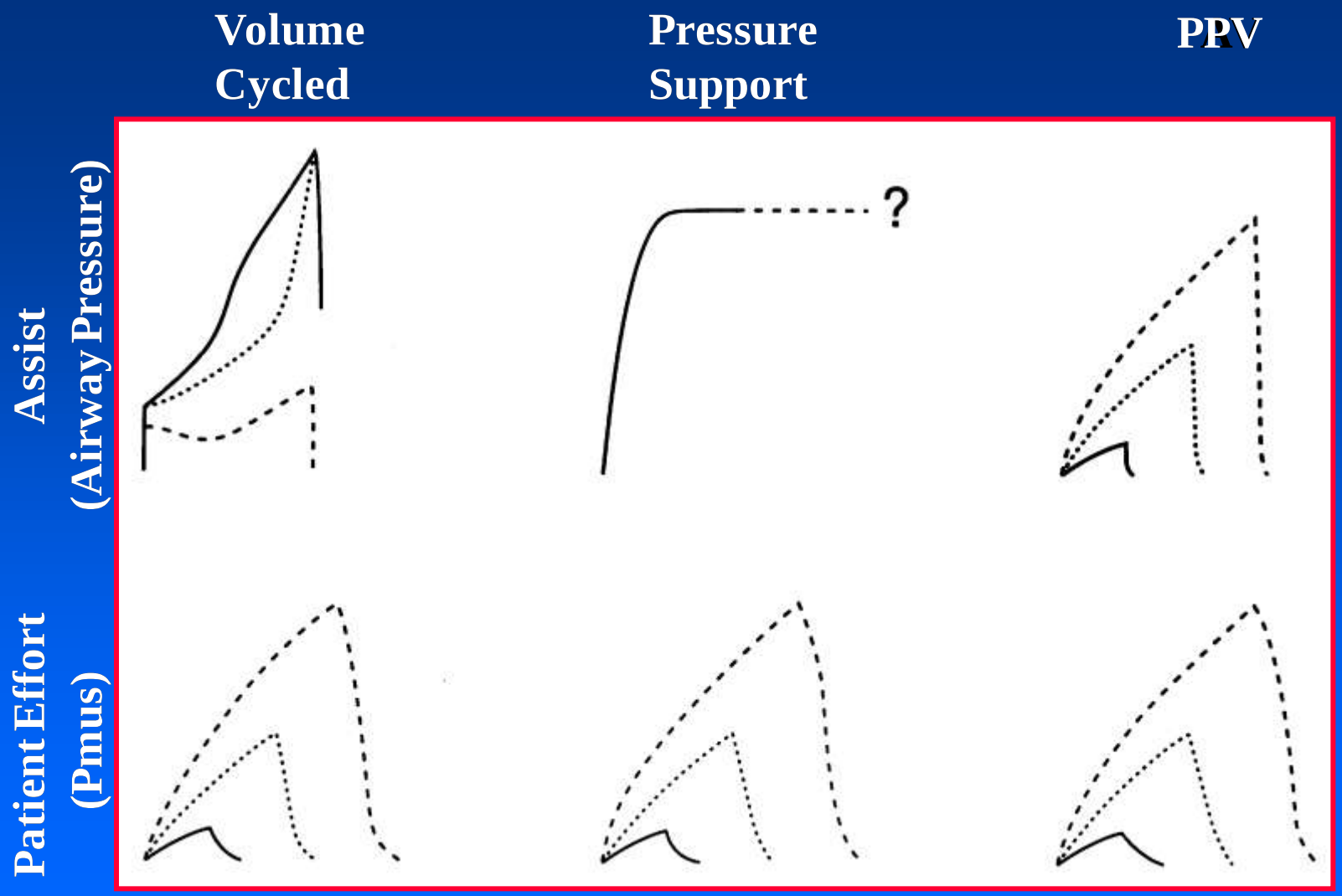
Mode Comparison



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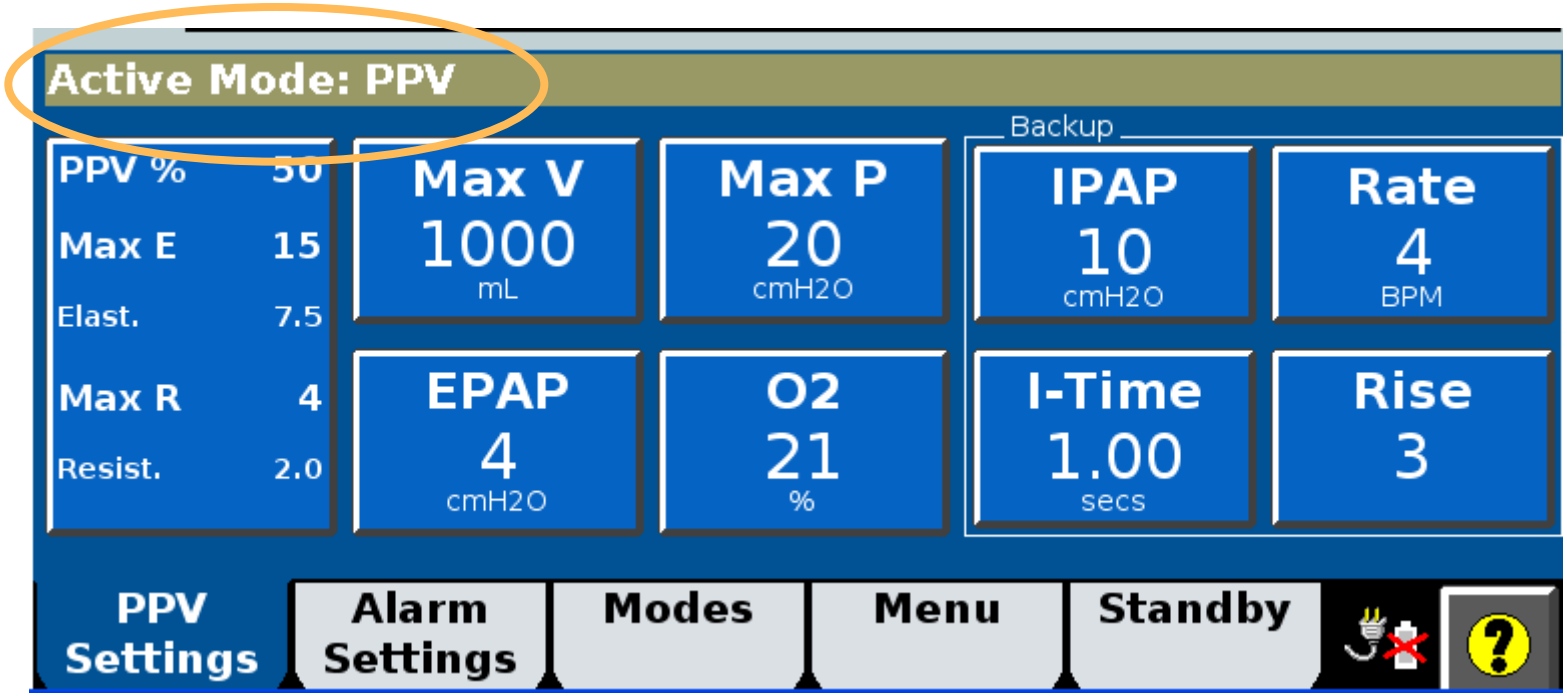
Setting PPV parameters



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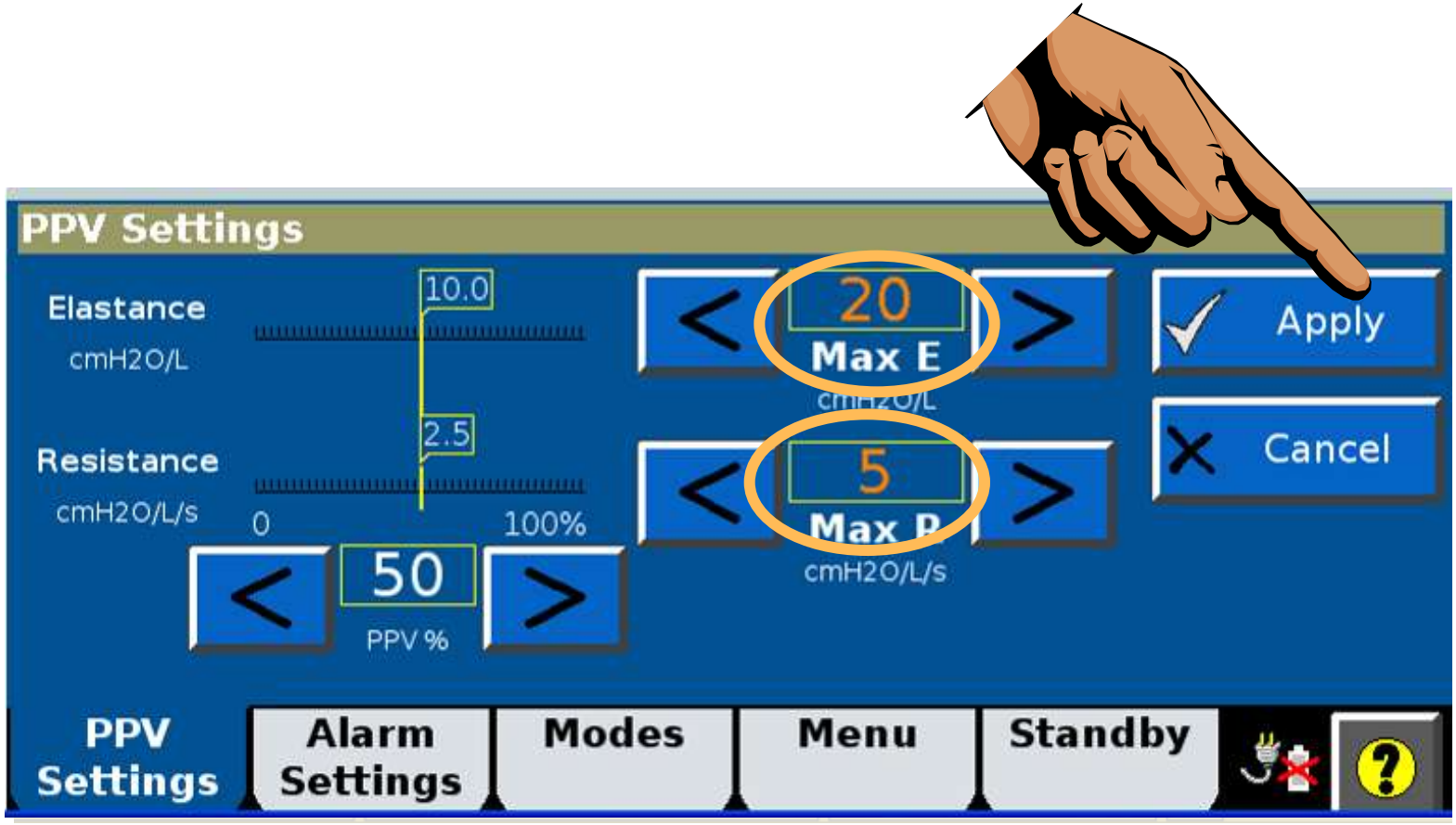
Setting Max E & Max R



Setting PPV %

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What Is Auto-Trak+ and Why Is It Needed?

- Auto-Trak+ allows the clinician to adjust Auto-Trak sensitivity thresholds
  - User can adjust the Auto-Trak algorithm for trigger sensitivity
  - User can adjust the Auto-Trak algorithm for E-cycle sensitivity
- The “Normal” setting works well for most patients
  - No need to adjust
- Selected pediatric and adult patients may benefit from Auto-Trak+
  - Pediatrics – may benefit from more sensitive trigger setting
  - Adults – may benefit from more or less E-cycle sensitivity

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Advantages of Auto-Trak+

- In selected pediatric and adult patients, altering trigger and cycling settings may:
  - allow for better patient-to-ventilator synchrony
  - help prevent missed triggers in pediatric patients (weak effort)
  - help prevent prolonged I-times seen in some COPD patients
  - help prevent shortened I-times seen in some restrictive lung disease patients

- Auto-Trak+ still has all the same auto-adaptive leak compensation attributes as the standard, non-adjustable Auto-Trak

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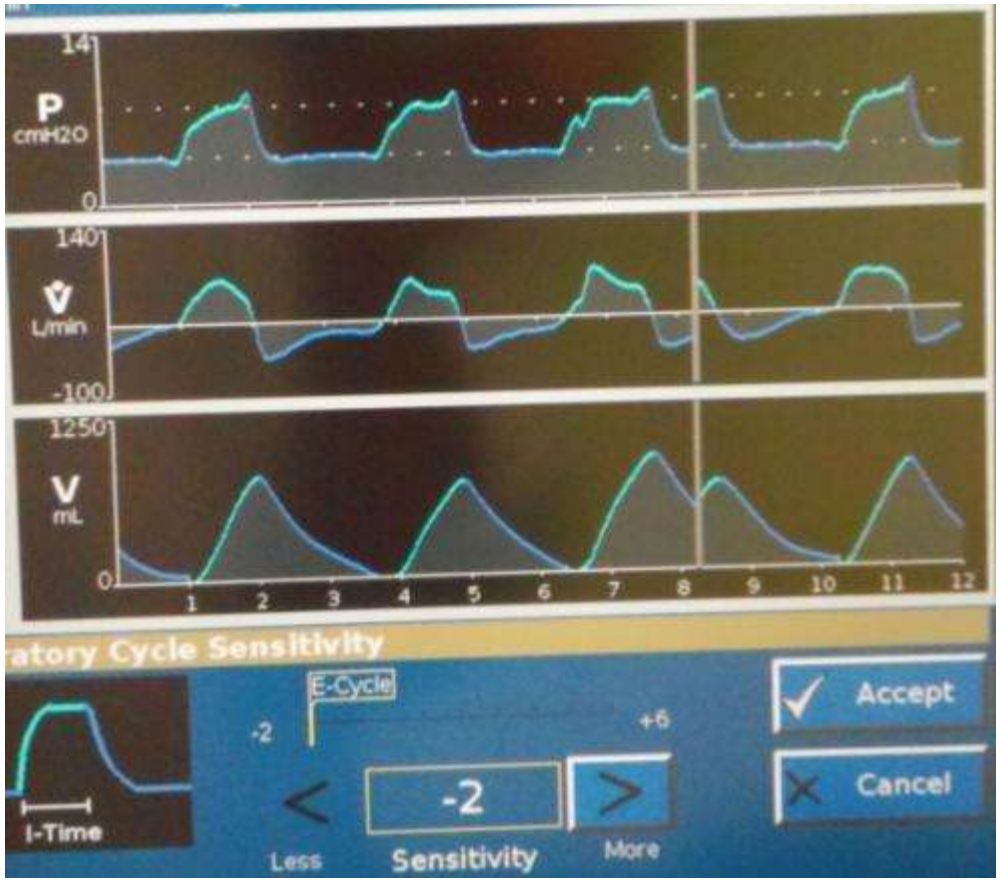
Cycle Insensitivity

Problem: Notice the pressure spikes at the end of each breath indicating added patient effort to cycle the breath from IPAP to EPAP
Solution: Increase E-cycle sensitivity setting, and re-evaluate



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E-Cycle Too Sensitive

Problem: Notice the I-time is quite short, patient may appear to still be inspiring, or patient complains the breath is too short
Solution: Decrease E-cycle sensitivity setting, and re-evaluate

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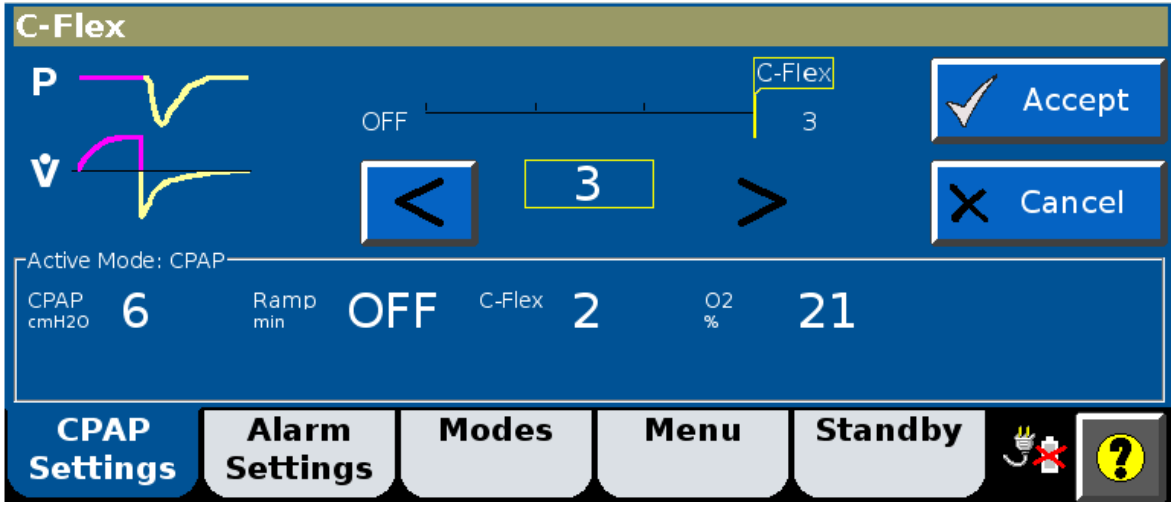
C-Flex



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What is C-Flex?

- C-Flex is a new option on the V60
  - Only available in CPAP Mode
- C-Flex enhances traditional CPAP by reducing the pressure at the beginning of exhalation
  - This is when patients are often uncomfortable with CPAP
  - C-Flex returns to the set CPAP pressure before the end of exhalation
- Should not be used in patients requiring CPAP for oxygenation purposes

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C-Flex

- The amount of pressure relief is determined by the C-Flex setting and the expiratory flow of the patient
  - The higher the setting number (1, 2 or 3)
  - And the greater the expiratory flow
  - The greater the pressure relief
    - During the active part of exhalation only

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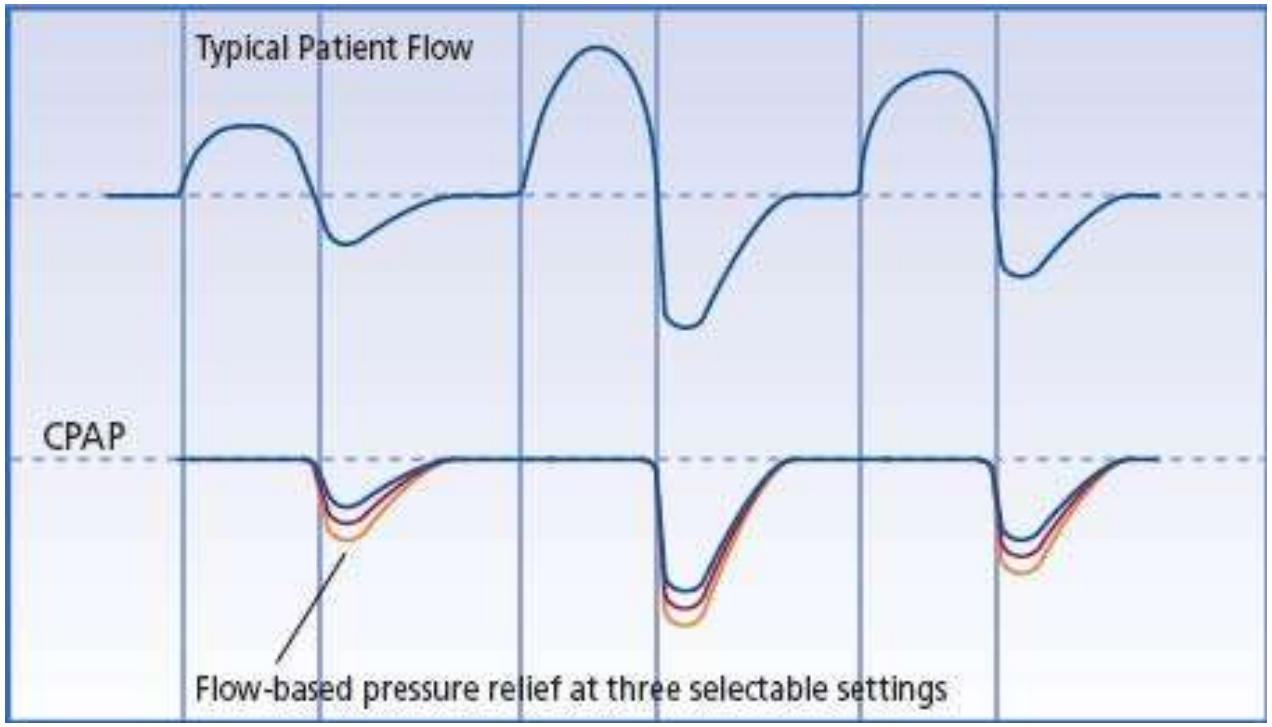
C-Flex

Reduces pressure at the beginning of exhalation and returns to therapeutic pressure just before inhalation



Pressure relief varies on flow and C-Flex setting

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Keys to Success

The Ideal NIV Therapy Experience

- Trained staff
- Appropriate mask selection
- Patient-to-ventilator synchrony
  - Optimum mask and ventilator performance
  - System compatibility
- Patient compliance
- Patient coaching and earning trust
- Appropriate use of new modes and features
- Use of specific NIV clinical protocol

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Make a difference!

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