Advanced Algorithms for Sleep Disordered Breathing

1.5 AARC and AAST CEU credits
Learning Objectives

• Restate the technology of auto adjusting expiratory pressure, servo ventilation, volume assured pressure support ventilation, automatic adjustment features, and comfort features

• Describe the disease states that the algorithm should be used for.
Advanced Algorithms

• Digital Auto-Trak
• Flex Family
  – Cflex
  – Cflex Plus
  – BiFlex
• Auto CPAP
  – CPAP-Check
• BIPAP Auto
• Servo Ventilation
  – AutoEPAP
  – Auto Back up Rate
• AVAPS
• AVAPS-AE (optional)
Digital Auto-Trak
Digital Auto-Trak

• Recognizes and compensates for leak
  – Breath-by-breath sensitivity for optimal comfort

• Automatically adjusts to changing breathing patterns throughout the night
Seven components of Digital Auto-Trak

- Leak detection
- Two triggers (Volume Trigger, Shape Trigger)
- Four cycle determinants (SET, Shape Cycle, Flow Reversal, and Max Inspiratory Time)
Triggers and cycles

**Triggers:**
1. 6 ml inspired volume
2. Wave shape trigger

**Cycle:**
1. SET
2. Wave shape cycle
3. Flow reversal
4. Max IT
Inspiratory trigger

- Leak Detection
- Inspiratory Trigger
- Volume Trigger
- Shape Trigger
- Expiratory Cycle
- SET
- Shape Cycle
- Flow Reversal
- Max Inspiratory

6 cc volume accumulated above base flow

Flow x Time = Volume

- Begin inhalation
- End exhalation
- Base flow
- 6 cc
Volume trigger

Artifact on $V_p$

Measure inspired volume only if flow is positive

Start over if flow is negative

6 ml of inspired air triggers the ventilator here
Shape trigger

Doesn’t look at the value of flow, but at the shape of inspiratory effort

- Rapid change in the breath
- Exertional breathing (anxiety)
Expiratory cycle

The SET rises in proportion to the inspiratory flow rate on each breath. When SET and actual patient flow are equal, expiration begins.

Not used in T, CV, AC, and SIMV.
Expiratory cycle

Example: a COPD patient was not cycling off bi-level

\( V_p \)

\( \text{SET} \)

End of inspiratory effort

Not acceptable to the patient

Cycle off delay
Expiratory cycle

- Leak Detection
- Inspiratory Trigger
- Volume Trigger
- Shape Trigger
- Expiratory Cycle
- SET
- Shape Cycle
- Flow Reversal
- Max Inspiratory

- Pt. flow
- DAT shape signal
- Offset and delay
- Crossover Point

Flow
Expiratory cycle

- Leak Detection
- Inspiratory Trigger
- Volume Trigger
- Shape Trigger
- Expiratory Cycle
- SET
- Shape Cycle
- Flow Reversal
- Max Inspiratory

Inhalation slowing

Lip seal breaks

Keeps breath stacking from occurring
Expiratory cycle

- Leak Detection
- Inspiratory Trigger
- Volume Trigger
- Shape Trigger
- Expiratory Cycle
- SET
- Shape Cycle
- Flow Reversal
- Max Inspiratory

Inspiratory flow
Flex Family of Pressure Relief Technologies
Flex Family of Pressure Relief Technologies

C-Flex          Bi-Flex          A-Flex

Three ways to make sleep therapy comfortable
Flex Family™ Powered by Digital AutoTrak™

• Digital AutoTrak is the “Brain” inside Flex Technology
  – Tracks entire flow pattern for every patient breath
  – Detects onset of inspiration & expiration
  – Responds by triggering Flex pressure relief

• The Results
  – Matches natural flow pattern
  – Synchronizes delivery of pressure relief according to flow pattern
  – Breath by breath sensitivity for optimal comfort
  – Recognizes and compensates for leak
  – Automatically adjusts to changing breathing patterns throughout the night.
Flex Family technologies

*Improved patient comfort with proven pressure relief*

*When air initially escapes:*
- Air escapes under HIGH pressure
- Hard to collapse

*As air continues to escape:*
- Air escapes under LOW pressure
- Easy to collapse
Flex Family technologies
A Flex option for all modes of therapy
Flex Family technologies

How it works

Green line: Pressure needed throughout breath
Red area: Unnecessary pressure delivered
Blue line: Delivered pressure
C-Flex and C-Flex Plus
C-Flex pressure profile

Typical Patient Flow

CPAP

Flow-based pressure relief at three selectable settings
C-Flex+ pressure profile

Typical Patient Flow

Three selectable settings for transition comfort

Flow-based pressure relief at three selectable settings
Pressure relief technologies are not the same

Comfort factors to consider:
• Synchronization with flow
• Amount or flexibility of pressure relief
• Pressure relief delivery throughout the entire sleep session

*Bench study to Compare Performance Capabilities of CPAP devices with Expiratory Pressure Relief Algorithms. Diesem, McCoy, Poster APSS 2006
Treatment Adherence in CPAP vs C-Flex™

P.S. Ruyak, Aloia, MS, et.al., Sleep 2005: 28; #503, A170
CONFIDENTIAL
Patient Outcomes: C-Flex Clinical Validation

- CPAP therapy with C-Flex offers patients the **same therapeutic benefits** of standard CPAP\(^1,2,3\)
- Considered to be **much more comfortable** than CPAP therapy\(^4\)
- C-Flex **improves adherence** to PAP treatment\(^5,6,7,8,9\)
- C-Flex **improves patients’ satisfaction** and confidence in their ability to tolerate CPAP, even under difficult circumstances\(^5,7\)

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1 Jerrentrup, Somnologie 2004; 8(S1): 69
2 Duntley, Sleep, Vol 28, 2005 Abstract Supplement 539
3 Loube, Sleep, Vol 26 2003 Abstract Supplement
4 REMstar Pro with C-Flex Patient Preference Trials
6 Ruyak, Sleep Volume 28 2005, Abstract Supplement 503
7 Rosenthal, Sleep, Volume 28 Abstract Supplement 532
8 Mohan, Sleep Volume 27 Abstract Supplement, A221
9 Loube, Sleep volume 27 Abstract Supplement, A228
10 McCoy, APSS, June, 2006.
A-Flex
A-Flex pressure profile

Typical Patient Flow

Three selectable settings for transition comfort

Flow-based pressure relief at three selectable settings
A-Flex Enabled by our Clinically Proven Auto Algorithm

REMstar Auto w/o Flex
Auto Algorithm with A-Flex

The result, **optimal comfort**, during the entire breathing cycle with effective therapy maintained at minimal pressures.
REMstar Auto w/ A-Flex

- **A-Flex technology takes proven C-Flex technology to a new level.**
  - Delivered Pressure Profile
    - Now more closely responds to patient breathing throughout the entire breath cycle
    - Customized to patient’s air flow demands each and every breath
    - Smooth, effortless, maximum comfort with the most natural breathing experience with treatment

- **Auto CPAP based to better help manage patient treatment needs each night and over long term.**
  - Constantly monitoring flow signal for ideal breathing pattern
  - Automatically adjusts base pressure level to maintain ideal breathing pattern
  - A clinical study shows >15% of patients on fixed CPAP have AHI return to untreated levels after 6 months of use *(Baltzan, Marcel A., Sleep, 2006)*

- **Economically feasible!**
  - Five modes of therapy in one device to support any clinical management protocol.
Patient Outcomes: A-Flex and Auto Algorithm
Clinical Validation

A-Flex Technology

- Delivered mean airway pressure up to 4cm H2O lower than mean airway pressure of traditional CPAP.¹
- PSG validation of effective therapy maintenance throughout night.¹

REMstar Auto Algorithm

- In a head-to-head comparison, the REMstar Auto provides better control of RDI at consistently lower pressure levels throughout the night.²
- REMstar Auto has the lowest effective mean pressure with the most hours of use per night.³
- The majority of patients prefer treatment with REMstar Auto verses traditional CPAP.⁴

¹Sukhdev Grover MD, Paul Wylie, MD, Pittsburgh, Pittsburgh, PA; Little Rock AR, 2007
Biflex Algorithm
Bi-Flex pressure profile

Typical Patient Flow

IPAP Three selectable settings for transition comfort

EPAP Flow-based pressure relief at three selectable settings
Clinical Validation – BIPAP Auto and Bi-Flex

**BIPAP Rescue Validation: Accepted for publication 2007**

- BiPAP with Bi-Flex therapy is an established and effective therapy for CPAP users who have been identified as non tolerant or non-responsive to CPAP therapy at home.¹

**BIPAP Auto with Bi-Flex Therapy Validation**

- The BiPAP auto with BiFlex adequately treats OSA and provides a 90% pressure which is comparable to the ‘fixed’ pressure level derived during manually titrated conventional Bi-Level therapy.²

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¹ Ballard R., Gay P., Strollo P., *Journal of Behavioral Sleep Medicine, 2007*  
² Paul Wylie, APSS 2006
Auto Algorithm
Auto CPAP

**Sophisticated Three Layered Algorithm:**

- Primary Function: Proactive Analysis

**Safety Net:**
- Apnea
- Hypopnea
- Flow Limitation
- Vibratory Snore

**Leak Tolerance**

Goals of the REMstar Auto algorithm

#1 Goal: Normalize sleep (AHI, arousals, etc.)
#2 Goal: Minimize pressure
Proactive CPAP searches

Theory of operation

Pressure

Upper Airway Resistance

P_{crit}
At the core is the proven REMstar Auto algorithm

#1 Goal: Normalize sleep (AHI, arousals, etc)
#2 Goal: Minimize pressure
Flow limitation review

Flow Limitation

Flow limitations are identified as any change in inspiratory parameters.

2 of the four parameters must fall out of trend to be considered Flow Limitation.
**Hypopnea**

A hypopnea is recorded when there is an *40% reduction in flow lasting at least 10 seconds*

CPAP pressure will increase in response to a hypopnea that shows *obstructive* characteristics,

**Note:** The Servo Ventilation algorithm (breath by breath adjustment of pressure support), will adjust PS to meet the target peak flow as the peak flow decreases with the hypopnea
During the time of decreased peak flow, the Servo Ventilation algorithm, will attempt to ‘fix’ the hypopnea.
CPAP-Check Algorithm
REMstar Pro

*with Auto-Trial* and *CPAP-Check*

**Auto-Trial:**
- This is a Trial period of 3-30 days of the *existing* breath-by-breath REMstar Auto Algorithm, after which the device will switch over to CPAP-Check

**CPAP-Check:**
- CPAP-Check will deliver a modified version of Auto-CPAP therapy which still reacts to patient events but requires a longer duration before adjustments are made and is limited in how much the pressure can be adjusted overall.
- The device continually monitors and assesses the patients events and at the conclusion of each 30 hour session of therapy, the device will adjust (increase or decrease by 1 cmH2O) or maintain pressure based upon results
  - While in *CPAP-Check*, device pressure is bound by a max pressure increase of 3 cmH2O and a max pressure decrease of 3 cm
Algorithm Definitions

• ORDI = Obstructive Respiratory Disturbance Index

• Popt = a search that increases pressure to determine if patient improves

• Pcrit = a search that decreases pressure to determine if patient can tolerate a lower pressure
CPAP-Check Mode

The CPAP-Check algorithm uses this theory to help determine ideal ORDI to effectively treat the patients…

- If a patient’s ORDI is highly variable then it will attempt to stabilize by increasing pressure
- The goal of the algorithm is low consistent ORDI and a effectively treated patient
CPAP-Check Graph

Sample CPAP-Check Graph

Pressure increased 1cmH2O
REMstar Pro: CPAP-Check

CPAP-Check compares ORDI from each 30 hours of use period

- If ORDI is increasing, pressure is increased
- If ORDI is consistent, pressure is decreased
- If ORDI is decreasing, pressure is held
CPAP-Check algorithm in a nut shell

• If a patient’s condition changes over time then the device will change to meet their needs

• If a patient puts on weight then it will increase pressure to maintain ORDI

• If a patient loses weight then it will decrease pressure

Better CPAP….Better Patient Care
CPAP-Check algorithm in a nut shell

- The goal is to provide the lowest therapeutic pressure.

- There is no magic number that the device changes; it learns the patient and adapts to meet their needs.

Better CPAP....Better Patient Care
BiPAP Auto Algorithm
BiPAP Auto algorithm

- Based primarily on the proven REMstar auto algorithm
- IPAP vs. EPAP pressure response is determined based on type of event
  - IPAP
    - Flow limitation
    - Hypopnea
  - EPAP
    - Apnea
    - Vibratory Snore
Auto Bi-level Device Settings

- Min EPAP (Adjustable)
- Max IPAP (Adjustable)
- Min Delta (Fixed @ 2cm)
- Max Delta (Adjustable 3 - 8 cm)
Servo Ventilation Algorithm
Clinical benefits of servo ventilation

• Treatment for complicated breathing patterns such as:
  – Central apnea
  – Complex apnea
  – Periodic breathing such as CSR

• Provides non-invasive ventilatory support to treat adult patients with OSA and respiratory insufficiency caused by central and/or mixed apneas and periodic breathing.
BiPAP autoSV ADVANCED: What is it?

REMstar Auto CPAP +
Advanced Apnea Detection

Auto EPAP

ASV Algorithm
(Enhanced Auto Backup Rate)

= BiPAP autoSV ADVANCED
Servo ventilation algorithm

On a breath by breath basis peak flow is captured

Peak flow is monitored over a moving 4 minute window

As 1 breath is added, the initial breath falls off

At every point within this 4 minute period an *Average Peak Flow* is calculated

The *Peak flow target* is established around that average and is based on the patient’s needs
Servo ventilation algorithm – normal breathing

IF: Peak flow is at target
THEN: autoSV Advanced delivers CPAP pressure
Servo ventilation algorithm – decreased flow

IF: Peak flow falls below target
THEN: autoSV Advanced increases pressure support
BiPAP autoSV Advanced

*Event detection algorithms*
**BiPAP AutoSV**

*Sophisticated Three Layered Algorithm:*

Primary Function: Proactive Analysis

- Safety Net
  - Apnea
  - Hypopnea
  - Flow Limitation
  - Vibratory Snore

Leak Tolerance

At the core is the proven REMstar Auto algorithm

#1 Goal: Normalize sleep (AHI, arousals, etc.)
#2 Goal: Minimize pressure
Auto EPAP

Max pressure

EPAPmax

P opt

P crit

EPAPmin
Auto EPAP - *Looks like Auto CPAP!*

SV algorithm works ‘on top’ of Auto EPAP
Max pressure

Auto EPAP - *Looks like Auto CPAP*!

EPAPmax

S = Snore  H = Hypopnea  OA = Obstructive apnea

SV algorithm works ‘on top’ of Auto EPAP

EPAPmin
Let's take a look at these terms graphically

Auto EPAP - *Looks like Auto CPAP!*

Max pressure

EPAPmax

PSmax 10 cm H$_2$O

PSmin 3 cm H$_2$O

Auto EPAP

EPAPmin
BiPAP autoSV Advanced

*Auto backup rate*
Advanced Auto backup rate

Objectives:

1. Determine clear vs. obstructed airway
2. Find the best back up rate
   - Do not overdrive the patient
   - Spontaneous breathing is encouraged
3. Synchronize each breath to patient’s breathing patterns
   - Do not deliver timed breaths when patient is still moving air
   - Backup breaths are delivered in sync with patient’s previous spontaneous breathing pattern and most recent attempts so the rate may vary breath by breath.
4. Work with autoSV algorithms to meet breath by breath peak flow targets.
5. Utilize auto EPAP algorithms to maintain optimal airway patency.
BiPAP AVAPS Algorithm
Bi-level with Average Volume Assured Pressure Support (AVAPS)

• Acts primarily as a bi-level pressure support device but is able to provide a constant tidal volume with the AVAPS feature enabled.
  – Can be used with S, S/T, PC or T modes.
• Automatically adjusts the pressure support level to maintain a consistent tidal volume
  – IPAP will automatically increase or decrease to maintain set tidal volume
AVAPS is *NOT recommended* for patients with periodic breathing

- Treatment of periodic breathing requires a variable breath by breath response system so the patients' PaCO\(_2\) stabilizes quickly
  - Prevents overshooting or undershooting the PaCO\(_2\) breath by breath
  - Does not augment the patients' tidal volume consistently

- AVAPS is does not have a quick variable response to changes in tidal volume.
  - It is designed to adjust and maintain a constant tidal volume with each breath over time.
  - This benefit often seen with patients who have slow declines in their ventilatory conditions.
Which Patients Benefit from BiPAP AVAPS?

Patients With Hypoventilation

Reduced amount of air enters the lungs, resulting in decreased levels of oxygen and increased levels of carbon dioxide in the blood.

Major Causes of Hypoventilation

<table>
<thead>
<tr>
<th>Respiratory Muscle Weakness</th>
<th>ALS, Muscular Dystrophy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restrictive Disorders</td>
<td>Scoliosis, Obesity Hypoventilation</td>
</tr>
<tr>
<td>Obstructive Lung Disease</td>
<td>COPD, Cystic Fibrosis</td>
</tr>
</tbody>
</table>
AVAPS

Automatically adjusts the pressure support level to maintain a consistent tidal volume

- IPAP will automatically increase or decrease
Improved Patient Care is Now Automatic

AVAPS Feature

• What It Does:
  – Automatically adapts pressure support to maintain a targeted tidal volume

• Why It Matters:
  – Automatically adapts to disease progression and changing patient needs
  – Improves ventilation efficacy
  – Simplifies the titration process
## AVAPS Algorithm Overview

1. **Initial IPAP**
   
   \[ IPAP_{\text{start}} = \frac{V_t_{\text{target}}}{60} + \text{EPAP} \]

2. **Average Tidal Volume**
   
   \[ V_t_{\text{avg}} = \frac{\text{SUM (V}_t_1 \text{ to V}_t_n)}{\text{Breaths}} \]

3. **Incremental IPAP**
   
   \[ IPAP_{\text{req}} = \frac{(V_t_{\text{target}} - V_t_{\text{avg}}) \times PS}{V_t_{\text{avg}}} \]

4. **Rate of Change**
   
   \[ IPAP_{\text{per breath}} = \frac{IPAP_{\text{req}}}{\text{Breaths}} \]

### Notes:

- *During the first minute, AVAPS does not change IPAP and blocks the low tidal volume alarm*.
- *The average tidal volume is measured over a one minute period.*
- *AVAPS calculates the required IPAP change after each breath.*
- *The maximum IPAP change is 1 cmH2O/min for stable Vt’s or 1 cmH2O/ 2 min for unstable Vt’s.*
Suggested starting point for AVAPS tidal volume

3 ways to choose a starting tidal volume with AVAPS:
1. MD suggestion
2. Patient comfort
3. Ideal body weight – 8 ml/kg*

*AVAPS suggested tidal volume settings based on height.

<table>
<thead>
<tr>
<th>HEIGHT</th>
<th>59&quot;</th>
<th>61&quot;</th>
<th>63&quot;</th>
<th>65&quot;</th>
<th>67&quot;</th>
<th>69&quot;</th>
<th>71&quot;</th>
<th>73&quot;</th>
<th>75&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDEAL WEIGHT</td>
<td>52.0 kg</td>
<td>55.5 kg</td>
<td>59.0 kg</td>
<td>62.5 kg</td>
<td>66.5 kg</td>
<td>70.5 kg</td>
<td>74.5 kg</td>
<td>78.5 kg</td>
<td>83.0 kg</td>
</tr>
<tr>
<td>8 ml/kg V_T</td>
<td>420 ml</td>
<td>440 ml</td>
<td>470 ml</td>
<td>500 ml</td>
<td>530 ml</td>
<td>560 ml</td>
<td>600 ml</td>
<td>630 ml</td>
<td>660 ml</td>
</tr>
</tbody>
</table>
AVAPS-AE
(available in the Trilogy only)
AVAPS-AE

AVAPS-AE is a auto-titration mode of noninvasive ventilation designed to treat respiratory insufficiency patients (OHS, COPD and NMD) in the hospital and homecare environments

- Proven performance of AVAPS
  - Maintains targeted Tidal volume
- Auto EPAP
  - Maintains patent upper airway at comfortable pressure
- Auto backup rate
  - Applies an auto backup rate near a patient’s resting rate
AVAPS-AE: Why do we need it?
AVAPS-AE: Auto EPAP

• Auto EPAP provides airway patency
  – Designed for NIV use only
  – Patient benefit: lower, more comfortable EPAP pressure

• AVAPS-AE and patient overlap
  – 29% to 40% of COPD patients have OSA\(^1\)
  – 90% of OHS patients have OSA\(^2\)

• AVAPS-AE: 1st NIV therapy with Auto EPAP designed for respiratory insufficiency and respiratory failure patients

\(^1\)Jelic International Journal of COPD 2008:3(2)269-275
\(^2\)Mokhlesi. Chest 2007:131;1624-1626
AVAPS-AE: Auto EPAP proactive analysis

Theory of Operation

Illustration courtesy of Krames Medical Illustration.
AVAPS-AE: Auto EPAP proactive analysis

Popt – Optimal Pressure Search
(High Pressure Search)

Critical Pressure Searches
(Low Pressure Search)
# Auto EPAP today

<table>
<thead>
<tr>
<th>Patient type</th>
<th>Treatment / Device</th>
<th>Pressure support requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSA</td>
<td>CPAP/REMstar Auto</td>
<td>Low to none</td>
</tr>
<tr>
<td>Cardiac</td>
<td>Servo-Ventilation / BiPAP AutoSV</td>
<td>Dynamically applied pressure support</td>
</tr>
<tr>
<td>Respiratory insufficiency</td>
<td>AVAPS-AE / Trilogy, BiPAP A40</td>
<td>High levels of pressure support</td>
</tr>
</tbody>
</table>
Comparison of Auto EPAP methods

Current PRI Auto EPAP/CPAP

AVAPS-AE

Forced oscillation technique (FOT) at 5 Hz, 1 cm amplitude during EPAP
Benefits of FOT

- FOT may improve detection of obstructed airways at higher pressure support levels
  - Not affected by high levels of pressure support
  - FOT measurements taken at end exhalation (10 breaths)

Increase in EPAP by 1 cm H₂O s
FOT – Flow resulting from pressure

FOT signal

Resulting flow
FOT – Patent vs. obstructed airway

**Patent/Normal airway**

Resulting flow (low resistance)

**Obstructed airway**

Resulting flow (higher resistance)
AVAPS-AE
Maintaining tidal volume and airway patency
Auto Backup Rate

Auto backup rate combined with the tidal volume assurance of AVAPS provides a minimum level of ventilation.

- Auto backup rate is near resting rate
- Comfortable assistance when needed
- No manual adjustments (auto-default setting)
Auto Backup rate

Targeted auto backup rate is 2 bpm below avg. spontaneous rate

Spontaneous rate

Target auto backup rate

Minimum auto backup rate

Spontaneous breaths

Bpm

Moving breath rate

Time

50 spontaneous breaths
Auto backup rate

- The buffer is reduced by timed triggers
- The patient will be guided back to the targeted backup rate

Moving breath rate

Bpm

Target auto backup rate

Auto backup rate buffer zone

Timed Breaths

Spontaneous Breaths

(Time)

(Night time session)
Auto Backup rate: Patient comfort features

• Comfort feature intent: Minimizes patient/device asynchrony
  – Rate will not exceed patient’s initial resting spontaneous rate
  – Machine breath delayed if patient is still exhaling
  – AVAPS-AE allows patient to terminate a machine delivered breath
### AVAPS-AE Settings

AVAPS-AE mode is available in Trilogy Only

<table>
<thead>
<tr>
<th>Settings</th>
<th>Range BiPAP A40</th>
<th>Range Trilogy v 13.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate</td>
<td>From 0.5 AVAPS to 5 cmH2O/min in 0.5 cmH2O increments</td>
<td>From 1.0 AVAPS to 5.0 cmH2O/min in 1.0 cmH2O increments</td>
</tr>
<tr>
<td>Tidal volume</td>
<td>200 – 1500 ml</td>
<td>50 – 2000 ml</td>
</tr>
<tr>
<td>Maximum pressure</td>
<td>6 – 40 cmH2O</td>
<td>6 – 50 cmH2O</td>
</tr>
<tr>
<td>Pressure support Max</td>
<td>2 – 36 cmH2O</td>
<td>2 – 40 cmH2O</td>
</tr>
<tr>
<td>Pressure support Min</td>
<td>2 – 36 cmH2O</td>
<td>2 – 40 cmH2O</td>
</tr>
<tr>
<td>EPAP Max pressure</td>
<td>4 – 25 cmH2O</td>
<td>0/4 – 25 cmH2O</td>
</tr>
<tr>
<td>EPAP Min pressure</td>
<td>4 – 25 cmH2O</td>
<td>0/4 – 25 cmH2O</td>
</tr>
<tr>
<td>Breath rate</td>
<td>Auto/0 – 40BPM</td>
<td>Auto/0 – 60BPM</td>
</tr>
</tbody>
</table>
# AVAPS-AE suggested settings

<table>
<thead>
<tr>
<th></th>
<th>OHS*</th>
<th>COPD – OSA*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vt Target</td>
<td>8 -10 ml/Kg of ideal bodyweight</td>
<td>8 ml/Kg of ideal bodyweight</td>
</tr>
<tr>
<td>Max P</td>
<td>35 cmH2O</td>
<td>30 cmH2O</td>
</tr>
<tr>
<td>PS Max</td>
<td>19 - 35 cmH2O</td>
<td>30 cmH2O</td>
</tr>
<tr>
<td>PS Min</td>
<td>14 -19 cmH2O</td>
<td>12 cmH2O</td>
</tr>
<tr>
<td>EPAP Max</td>
<td>14 cmH20</td>
<td>14 cm H2O</td>
</tr>
<tr>
<td>EPAP Min</td>
<td>4 cmH2O</td>
<td>4 cm H2O</td>
</tr>
<tr>
<td>Breath Rate</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>AVAPS Rate</td>
<td>2</td>
<td>N/A</td>
</tr>
</tbody>
</table>

* AVAPS-AE protocol Dr. N. Hart, Dr. P. Murphy, Lane Fox Respiratory unit, St. Thomas’ Hospital London UK
* AVAPS-AE Multi Center Trial protocol I, Prof Jean François MUIR, France
AVAPS-AE

- Proven performance of AVAPS
  - Confidence that tidal volume targets are being met

- Auto EPAP
  - Auto adjusting EPAP to meet changing patient needs
  - Maintains a patent airway

- Auto backup rate
  - Maintains a breath rate designed for patient comfort (easy to use)
Summary

• Sophisticated algorithm technology

• Algorithms assist in:
  – Treating specific diseases
  – Delivering comfortable therapy
  – Synchronizing with the patient’s breathing pattern
CEU certificate

• To obtain your CEU certificate log on to
  – Log in or create a log in if you are a new user
  – Complete the evaluation and print out your certificate.

• If you are claiming AARC credits, you must compete the evaluation within 30 days or you will not receive credit for the program.