

Evita Series Option ATC and PPS

Breathing Support Package



Proportional
Pressure
Support

Automatic
Tube
Compensation

A major step forward in pressure support

- Improved synchrony between patient and ventilator
- Patient retains own breath control mechanism
- Real-time adaptation to patient demand
- Electronic Extubation

About this brochure

This brochure will introduce you to new facilities in breathing support. Automatic Tube Compensation ATC™ eliminates the additional work of breathing due to the ET tube while Proportional Pressure Support PPS* compensates for the additional work-load due to pathological increased resistance and decreased lung compliance of your patient.

Proportional Pressure Support PPS™ has its origins in Proportional Assist Ventilation PAV™ which was introduced by Prof. Magdy Younes [1] in the early 90's. The principle is now used under license.

The distinctive feature of this mode in comparison to other support modes is that positive pressure delivered at the airway is directly proportional to patient effort [2].

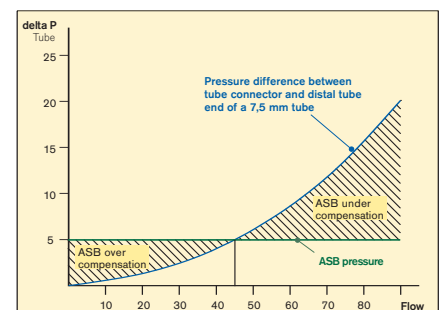
* PPS is not available in the USA

Therefore the name Proportional Pressure Support best describes this feature. We are very happy to introduce this new development that applies basic physiology to the care of the critically ill.

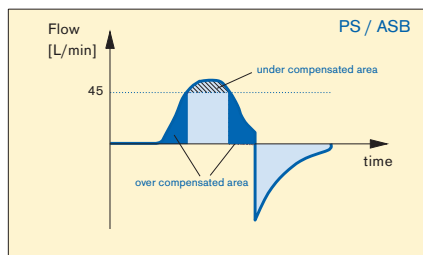
Common problems in breathing support

Premature extubation

A certain amount of conventional pressure support (PS) is often provided to compensate for the tube. The pressure needed to compensate a tube depends



on the amount of flow which passes through the tube. Because conventional PS only provides a fixed pressure, it often over or under compensates during the inspiratory phase. At the time of extubation it is difficult to know whether a patient will have to work more or less after extubation.



Patient could become lazy with normal PS

During normal PS, the patient just has to trigger the ventilator and it provides complete support to fill the lungs without further patient effort.

Ventilator versus individual patient breath control

In order to terminate an inspiratory pressure support that has been set too high the patient must use expiratory muscle effort which leads to increased WOB.

On the other hand, if normal PS is set below the desired volume of the individual patient breath control mechanism, inspiration of additional volume must be generated totally at the cost of the patient WOB because the support level is fixed.

Asynchrony

In all current ventilation modes, trigger and regulation of ventilation are based on Flow and Pressure in the breathing hose system. For this reason, the patient might already have started inspiration or expiration before the ventilator has recognised it. This delay leads to asynchrony between the pattern of patient muscle force and the ventilator cycle. Asynchrony means discomfort for the patient.

How can PPS + ATC improve the situation?

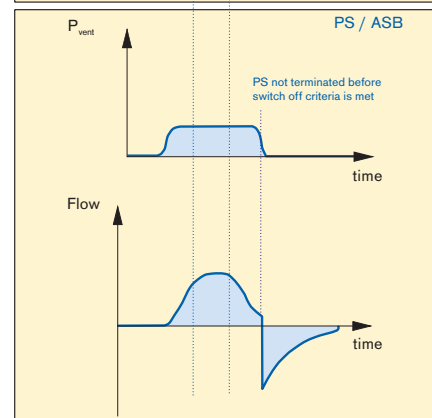
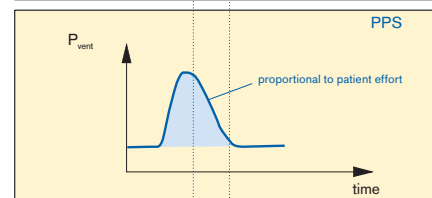
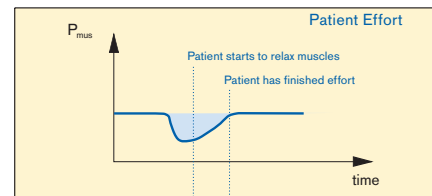
ATC continuously calculates the required pressure to compensate the tube related WOB for the actual flow which passes through the tube. ATC generates the required compensation pressure in the hose system in real-time. The patient muscle effort should therefore feel as if there were no tube. ATC could also be termed »Electronic Extubation«™.

With ATC and PPS the support pressure in the hose system is directly proportional to patient effort. The support pressure in the hose system will be immediately reduced when the patient relaxes its inspiratory muscles, whilst with normal PS, pressure will not be decreased by the ventilator before switch off criteria (25 % of peak flow in most ventilators) is detected.

PPS minimises the risk of asynchrony between ventilator pressure and muscle effort.

In principle ATC combined with PPS does not allow the patient to become lazy. Even if PPS is set to a level at which the ventilator takes over nearly all of the workload, the patient has to maintain a small effort to determine inspiration pattern. There are no pressure or volume targets under PPS.

Therefore every breath can show different peak pressures, flows and tidal volumes. But boundaries in terms of maximal pressure and volume limitations can be set. The more the patient wants the more he gets, the less he wants, the less he gets [1].



What you get?

The combination PPS and ATC creates one of the best support and weaning modes for patients who have unaffected individual breath control but who are unable to generate the full increased workload against pathological lung mechanics. Nevertheless there are some considerations:

- As in normal PS the patient must make a continuous spontaneous breathing effort.
- PPS generates pressure support directly proportional to patient effort. In other words it amplifies patient effort. If the level of pressure support is set too high, then as a result oversteering which is called »run away« could occur. In this case, the support pressure would increase even if the patient has already relaxed its inspiratory muscles, so PPS level needs to be reduced. It is important to note that support under »runaway« conditions is terminated by the set pressure or volume limits or by active patient expiration. During PPS, it is especially important to set appropriate pressure and volume limits.

How to set up ATC

ATC is easily set using the following parameters:

- The type of tube:
endotracheal or tracheostomy
- The inner diameter (ID) of the tube.
Normally indicated on the tube itself.



- The amount of compensation in %. Where 100 % means complete compensation while with values below 100 % a certain training of patient inspiratory muscle can be expected.

How to set up PPS

The following procedure principle is suggested by Prof. Magdy Younes on how to operate proportional support techniques. [1]

First, compliance and resistance should be measured during volume controlled constant flow ventilation. Resistance of the tube should be subtracted from total resistance.

Volume and Flow Assist should be set to approximately 80 % of the calculated R and C values. Tube compensation should be set accordingly.

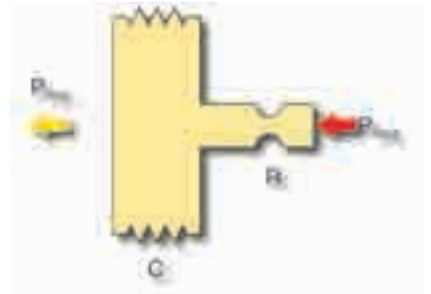
Pressure and volume limits are to be set before ventilator is switched to PPS. In case of runaway, volume assist needs to be reduced.

Elastance (1/Compliance) should also be measured during PPS.

Volume assist should then be adjusted to 80 % of the new measured elastance.

How can the muscular effort of the patient be measured?

Muscular effort of the patient can principally be measured with gastric and oesophageal pressure sensors. Due to many possible artefacts they cannot be used for regulation of a ventilator.



The principles of PPS are therefore based on real-time calculation of the additional workload related to pathological resistance and compliance (= 1/Elastance).

Additional workload to be generated by muscle effort can be calculated:

for decreased compliance as:

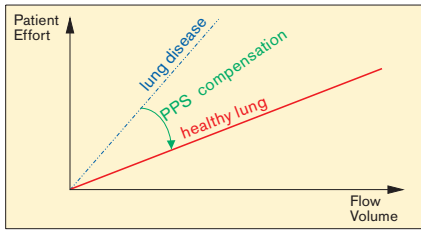
$$\Delta P_{\text{mus}} = \frac{1}{C} \cdot V$$

for increased resistance as:

$$\Delta P_{\text{mus}} = R \cdot \dot{V}$$

The total additional workload for the patient due to increased Resistance and decreased Compliance can then be calculated as:

$$\Delta P_{\text{mus}} = R \cdot \dot{V} + \frac{1}{C} \cdot V$$



This workload can be taken over by the ventilator by generating the same amount of pressure on the other side of the tube.

Summary

The main difference to other support techniques lies in the fact that PPS and ATC calculate and generate the required pressure automatically and in real-time.

Therefore the generated pressure support is directly proportional to the patient effort and asynchrony between patient effort and ventilator support is minimised.

The aim of PPS and ATC is to bring the ratio between patient effort and minute ventilation back to normal.

Technical data

Tube compensation

ID (inner diameter) setting for

adults	5 ... 11 mm
paed.	2,5 ... 8 mm
neon.	2,5 ... 5 mm

PPS

Flow Assist	0 ... 30 mbar/L/s
Volume Assist	0 ... 99,5 mbar/L

Order list

Retrofit kit for Evita 4 *edition*
Breathing Support Package (ATC and PPS)

Retrofit kit PPS for Evita 4 *edition*
(only if ATC is already installed)

Retrofit kit ATC for Evita 4 *edition* and Evita 2 *dura*

Retrofit kit PPS for EvitaXL

*Order no. 84 14 240

[1] Younes M., Proportional Assist Ventilation, Principles and Practice of Mechanical Ventilation, Tobin M.J., McGraw-Hill 1994

[2] Laurent Brochard; Intensive Care Medicine in Dialog; 6th International Workshop; Schloss Wilhelminenberg; Vienna; Austria

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