Tech Corner

Rest Rate

NOTE: PLEASE NOTE THAT THE FOLLOWING INFORMATION IS A GENERAL DESCRIPTION OF THE FUNCTION. DETAILS AND PARTICULAR CASES ARE NOT DESCRIBED IN THE ARTICLE. FOR ADDITIONAL EXPLANATION PLEASE CONTACT YOUR SALES REPRESENTATIVE.

MicroPort™ CRM

Table of Contents

Rest Rate

Rest rate is related to rate adaptive pacing. While rate adaptive pacing increases the pacing rate to address patient demands, the rest rate algorithm uses similar data to slow the pacing rate below the programmed basic rate. In this manner, it can reproduce circadian variations without the constraint of being set by a clock schedule. In addition, rest rate has the added benefits of potentially reducing percent pacing and therefore extending battery life, and may offer patients a more physiological pacing rate.

AVAILABILITY

This algorithm is available on following models:

- REPLY™ CRT-P
- KORA™ 100 DR, KORA 100 SR
- KORA 250 DR, KORA 250 SR
- REPLY 200 DR, REPLY 200 SR
- REPLY DR, , REPLY D, REPLY SR, REPLY VDR
- ESPRIT™ D
- SYMPHONY® DR 2550, SYMPHONY VDR 2350

DESCRIPTION OF OPERATION

Rest rate is a programmable pacing rate below the basic rate which is applied when the patient is considered to be at rest. To declare rest status, the device uses three variables:

1. Cardiac rest
2. Respiratory rest
3. Normal cardiac rhythm

Cardiac rest

The device logs groups of 32 consecutive beats (either intrinsic or paced), and examines the absolute rate of each cardiac cycle. Provided 28 out of the 32 cycles have a cycle length between the basic interval and the basic interval minus 25%, the patient is said to be in cardiac rest.

For example (image 1), if the basic rate is set at 60 bpm, then cardiac cycles in the 1000 ms to 750 ms range would be considered acceptable for declaring cardiac rest. Since the device is looking for 28/32 cycles, then up to four outliers are tolerated.

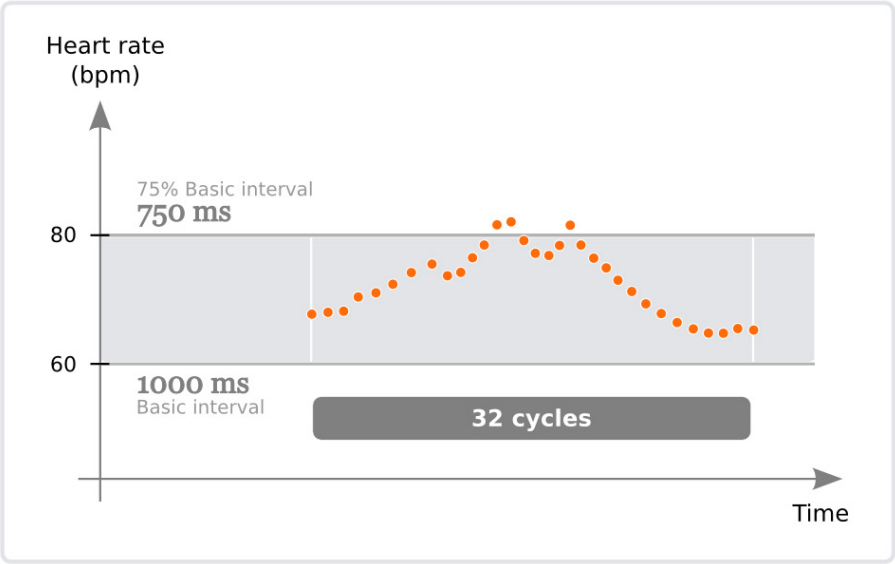

Image 1 - Cardiac rest = If 28/32 cycles are within [basic interval and 75% of basic interval]

Respiratory rest

Respiratory rest is confirmed via the MV sensor. Every 32 cardiac cycles, the last 128 respiratory cycles are averaged (MV_{128}) and this value is compared to the average MV signal over the last 24 hours.

- The patient is considered to be active if the 128-cycle average is greater than the 24-hour average.
- The patient is considered to be at rest if the 128-cycle average is less than the 24-hour average.

Thus the patient may be deemed to have multiple rest periods throughout any 24 hour period depending on the MV measurements.

Note that the MV sensor **must** be enabled to use the rest rate. The device has to be programmed to allow rate response (RR auto or RR fixed) or to the Learn mode, with MV sensor or Dual sensor (Twin Trace) enabled. Using the G sensor alone will not allow programming of the rest rate, and the parameter will not appear on the programming screen.

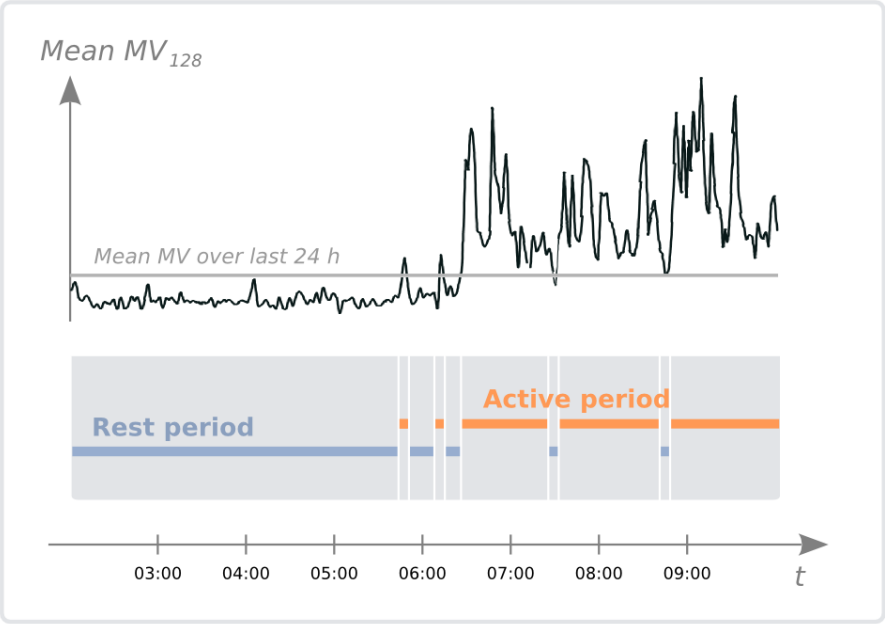

Image 2 - Rest periods: mean ventilation is below the limit (blue line). Active periods: mean ventilation is above the limit (orange line). In this example sleep and awakening periods of the patient are clearly identified.

Normal cardiac rhythm

A third criterion is required to enter into rest rate: the patient must have a “normal” cardiac rhythm.

Every 32 cardiac cycles, the number of atrial and ventricular extrasystoles (PACs and PVCs) occurring during these 32 cycles is calculated. If the number of PACs or PVCs is 5 or less, the rhythm is assumed to be “normal”. Otherwise (i.e. 6 extrasystoles or more) the excessive number of premature beats prevents the rest rate being activated.

As extrasystoles can be caused by bradycardia, it would not be desirable to allow excessive numbers of extrasystoles within the rest rate. This is why this criterion is applied.

Entering and exiting rest rate

When all three criteria are satisfied, the basic rate is gradually reduced to the programmed rest rate.

For example (image 3), if basic rate is programmed to 70 bpm and rest rate to 50 bpm, basic rate is decreased over a 36 minute time period until it reaches programmed rest rate at 50 bpm (image 3).

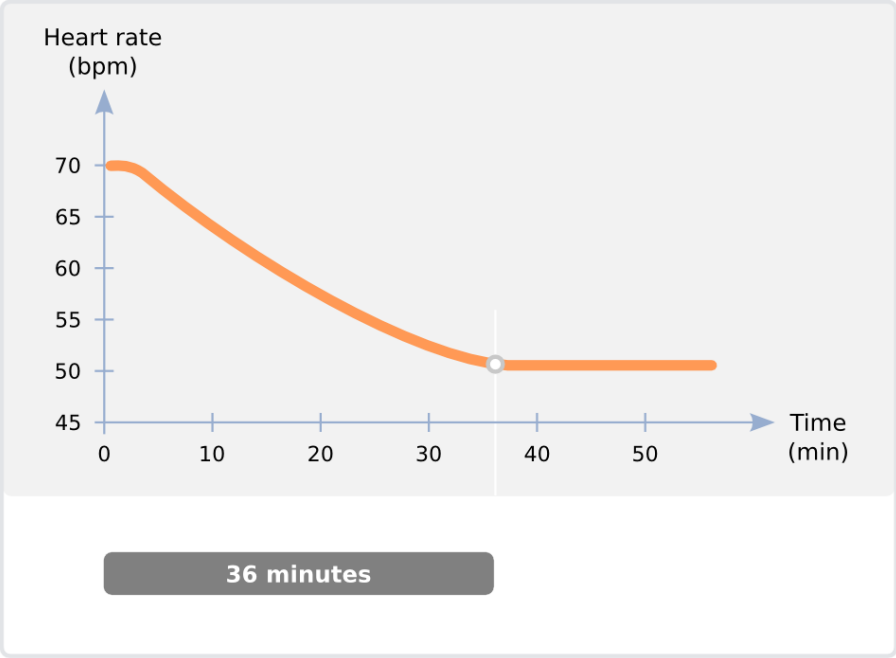

Image 3 - Entering rest rate when all 3 criteria are met: basic rate gradually decreases to programmed rest rate.

Rest rate defines the slowest rate at which the pacemaker would pace, should the patient require pacing. All three criteria are analyzed continuously when the rest rate algorithm is enabled.

The device exits rest rate when one of the three criteria is no longer satisfied. It is considered that the patient is no longer at rest but is active if one of the following conditions is true:

- Minute ventilation activity (128-cycle average greater than 24 hour cycle average) in one out of 3 consecutive groups of 32 cardiac cycles.
- Heart rate activity (less than 28 out of 32 cycles between basic interval and 75% of basic interval) in 3 groups of 32 cardiac cycles.

- Abnormal incidence of premature beats in the last group of 32 cycles (either 6 PACs or more, or 6 PVCs or more).

The algorithm then increases the pacing rate back to the programmed basic rate. The return to basic rate is faster when the criterion for leaving rest rate is the presence of premature beats.

For example (image 4), if basic rate is programmed to 70 bpm and rest rate to 50 bpm, rest rate is increased over a 12 minute time period until it reaches programmed basic rate at 70 bpm (orange curve). If the reason for leaving rest rate was an abnormal incidence of premature beats, the return to basic rate is performed in 4 minutes (gray curve).

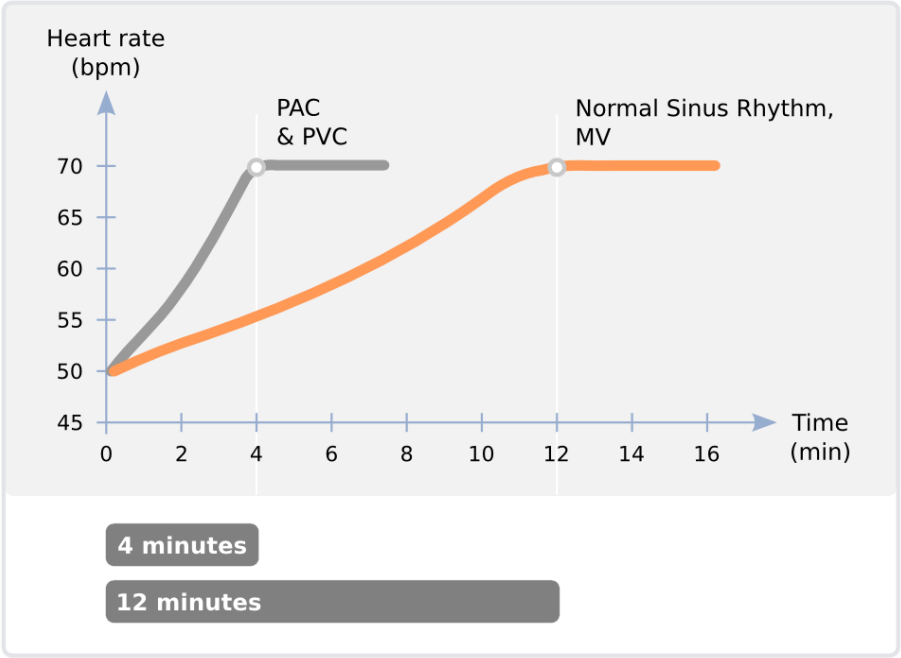

Image 4 - Exiting rest rate: pacing rate gradually increases to programmed basic rate

Programming Rest rate

The rest rate algorithm is available in SafeR, Dplus, DDD, DDI, VDD[1], VVI and DDT[1] pacing modes.

Programming constraints

This algorithm operates when:

- Sensor is programmed to Dual sensor (Twin Trace) or Minute Ventilation (MV). Rate Response is programmed on RR auto or RR fixed.
- No sensor is programmed and Rate Response is programmed on Learn
- Rest rate is programmed lower than basic rate

Otherwise, the algorithm uses the programmed basic rate.

STUDIES AND RESULTS

Circadian Variation of the Basic Rate in a DDD-R Pacemaker driven by a Minute Ventilation Sensor, *Ph.Viard et coll. Cardiostim 98, 133-4*.

Refer to user's manual furnished with the device for complete instructions for use (www.microportmanuals.com).

[1] *Not available in the US.*