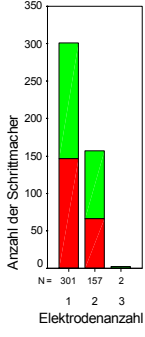


# Programmed Parameters in Pace Makers explanted post-mortem

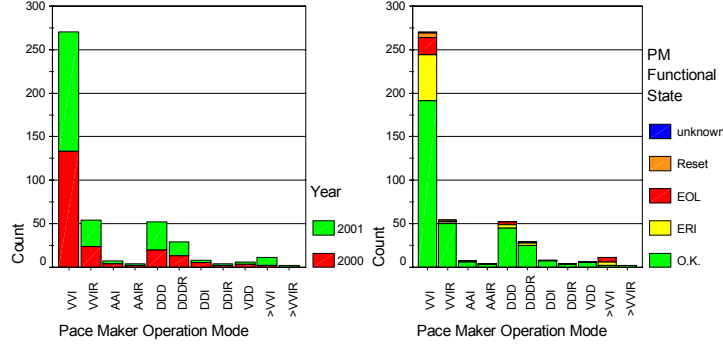
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**Elektroden**



**Diagram 1:**  
Number of electrodes per pacemaker. The units with 3 electrodes were biventricular pacemakers from Guidant cooperation.

**Pace Maker Operation Mode vs. Functional State of the Pace Maker**



**Diagram 2 und 3:**  
Frequency distribution of the pacemaker operation modes independent of their type of construction. Please note the increase in numbers of the automatic degradation of the pacemaker parameters (DDx-> VVI bzw. DDx-> VVIR) during 2001 in comparison to the year 2000 (Diag. 2, green vs. red).  
The large number of VVI pace makers in ERI-state (with adequate pacing impulses generated by the PM) is also of note (Diag. 3, yellow) as well as the large number of VVI PM having reached EOL or are in need of a forced Reset and thus are not able to supply correct pacing impulses (Diag. 3, red (EOL), orange (Reset)).

The functional state of pace makers (PM) and their possible involvement in the death of patients was examined in a cross-section analysis of all cases seen in the crematorium Hamburg-Ojendorf, Germany, during the years 2000/2001. The design properties as well as the state of the programmed parameters was documented.

**Materials and Methods:**  
21382 bodies were examined in the years 2000/2001 as part of the mandatory second external examination before cremation in the crematorium Hamburg-Ojendorf, Germany.  
460 pace makers (PM), 9 implantable cardioverter/defibrillators (ICD) as well as 2 neuro stimulators were explanted in accordance with federal law (Batterieverordnung BattV).  
All generators were examined as to the quality of the electrical output pulses. The generators were telemetrically interrogated in all cases were possible (443 of 460). In cases where this was not possible, the titanium case was sawn open, a new battery was connected, and the 'hybrid' was subjected to the standard testing (electrical output measurement, telemetric interrogation).  
Pacing and sensing functions were determined. Furthermore the state of the special functions like auto-capture, r-mode, pmt-options was evaluated. The statistical analysis was performed using SPSS Version 11.0 in conjunction with Mathematica 4.1. The coloration of the diagrams was done by using Lotus Freelance Graphics.

**Results:**

301 of the explanted pace makers were single chamber devices. 90 of these had a frequency adaptation (R-Mode) which was activated in half of the cases examined (48/90).

6 pace makers were programmed to operate in VDD mode. 12 pace makers had degraded themselves to VVI mode, 2 to VVIR, in all cases due to battery exhaustion.

159 of the pace makers were 2 chamber devices (81 DDD, 44 VVI, 12 DDI, 1 AAI). 81 of these had a built in r-mode feature which was activated in about half of the cases (41/80).

A PMT-detection was active in 50 of the 159 dual chamber devices, the function was activated in 24 of the 50. 101/159 featured a dynamic AV-time, which was activated in 49/101. A mode-switch was built into 71/101 of the dual chamber, it was activated in 37/71. 15 pace makers were equipped with a auto-capture function which had been activated in 11 cases.

The polarity of the lead was set to bipolar in 3 cases in spite of the implementation of a unipolar lead. The auto-capture feature was active in one patient were a unipolar, non-auto-capture lead had been implemented.

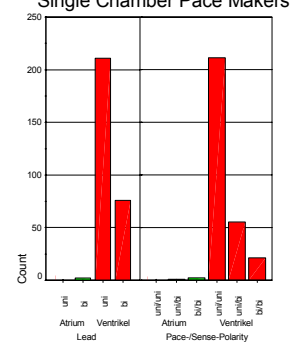
15 of the 460 examined pace makers were never touched by a PM-programmer other than the one in the factory. Out of the 460 PM 106 units were in the ERI-state or had reached their end of life (EOL).

**Conclusion:**

- The special functions of the pace makers were activated in only about half of the cases, independent of their characteristic.
- Over 90% of the pace makers examined were programmed in a patient specific manner.

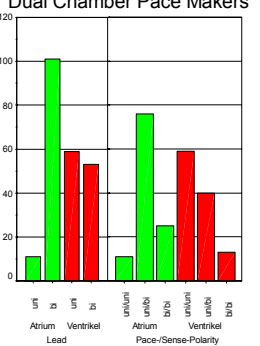
The complete study can be downloaded from the Internet at:  
<http://www.DrJunge.de>

**Leads Single Chamber Pace Makers**

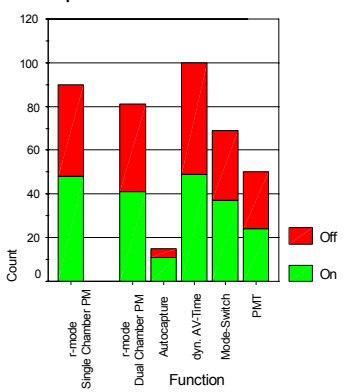


**Diagram 4 and 5:**  
Visualisation of the number of electrodes per pacemaker as well as their parameterisation.

**Leads Dual Chamber Pace Makers**

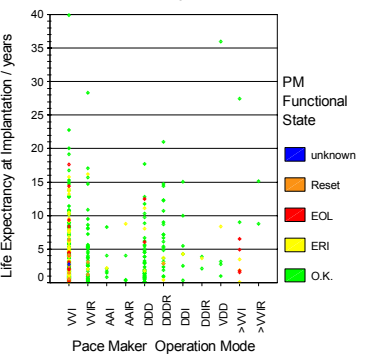


**Special Functions**



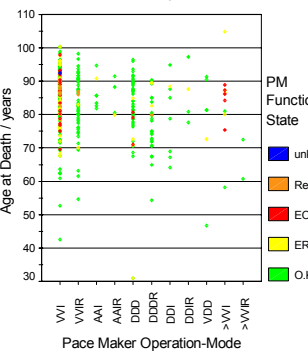
**Diagram 6:**  
Specification of the speciality functions supplied in one way or the other by most modern pace makers. The single chamber devices were checked for the frequency adaptation (r-mode) only. The dual chamber devices feature a great variety of speciality functions, only the most widely implemented are documented in the graph. Please note that the speciality functions are activated in only about 50% of the cases

**Life Expectancy at Implementation vs. Pace Maker Operation-Mode**



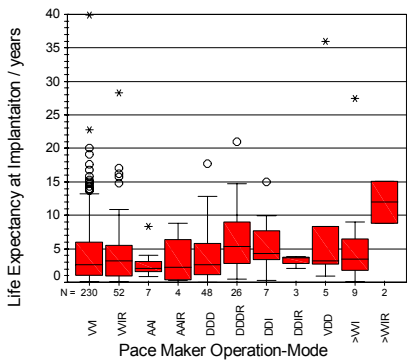
**Diagram 7:**  
Atypical scatter-plot of the life expectancy at the time of pace maker implementation in comparison to the chosen operation mode.  
The high number of not fully functioning VVI pace maker are worth a special note.

**Age at Death vs. Pace Maker Operation-Mode**



**Diagram 8:**  
Atypical scatter-plot of the age at the time of death vs. the operation mode of the last implanted pace maker.  
The increased frequency of VVI pace makers in EOL state of the >VVI column reflect the automatic down-grading modern pace makers perform when being near ERI/EOL, i.e. near battery exhaustion.

**Life Expectancy at Implantation vs. Pace Maker Operation-Mode**



**Diagram 9:**  
Life-expectancy of the standard population at the time of pace maker implementation vs. pace maker operation mode.  
There is no statistically significant difference between the VVI and DDD group of patients.