P980035

Summary of Safety and Effectiveness Data

Medtronic.KappaTM 700/600 Series Pacemakers

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Medtronic.KappaTM 700/600 Series Pacemakers

Medtronic, Inc

1. General Information

Device Generic Name:	Implantable Pacemaker Pulse Generator
Device Trade Names:	Medtronic.Kappa™ Models $K_{DR}701$, $K_{DR}703$, $K_{DR}706$, $K_{DR}721$, $K_{DR}731$, $K_{DR}733$, $K_{DR}601$, $K_{DR}603$, and $K_{DR}606$ Pulse Generators Medtronic.Kappa™ Models K_D701, K_D703 and K_D706 Pulse Generators Medtronic.Kappa™ Models and $K_{VDD}701$ Pulse Generators Medtronic.Kappa™ Models $K_{SR}701$, $K_{SR}703$ and $K_{SR}706$ Pulse Generators Medtronic.Kappa™ 700/600 (Model 9953E) Software
Applicant's Name and Address	Medtronic, Inc. 7000 Central Avenue N.E. Minneapolis, MN 55432
Pre-Market Approval Application Number:	P980035
Date of Panel Recommendation:	Not Applicable
Date of Notice of Approval to Applicant:	January 29, 1999

2. Indications and Usage

KDR700 Series pacemakers are indicated for the following:

- Rate adaptive pacing in patients who may benefit from increased pacing rates concurrent with increases in activity.
- Accepted patient conditions warranting chronic cardiac pacing which include:
  - Symptomatic paroxysmal or permanent second or third- degree AV block.
  - Symptomatic bilateral bundle branch block.
  - Symptomatic paroxysmal or transient sinus node dysfunctions with or without associated AV conduction disorders.
  - Bradycardia-tachycardia syndrome to prevent symptomatic bradycardia or some forms of symptomatic tachyarrhythmias.

– Vasovagal syndromes or hypersensitive carotid sinus syndromes.

KDR700 Series pacemakers are also indicated for dual chamber and atrial tracking modes in patient who may benefit from maintenance of AV synchrony. Dual chamber modes are specifically indicated for treatment of conduction disorders that require restoration of both rate and AV synchrony, which include:

- Various degrees of AV block to maintain the atrial contribution to cardiac output.
- VVI intolerance (e.g., pacemaker syndrome) in the presence of persistent sinus rhythm.

3. Contraindications

KDR700 Series pacemakers are contraindicated for the following applications:

- Dual chamber atrial pacing in patients with chronic refractory atrial tachyarrhythmias.
- Asynchronous pacing in the presence (or likelihood) of competitive paced and intrinsic rhythms.
- Unipolar pacing for patients with an implanted cardioverter- defibrillator (ICD) because it may cause unwanted delivery or inhibition of ICD therapy.

4. Warnings and Precautions

See WARNINGS AND PRECAUTIONS in the final draft labeling (Information for Use)

5. Device Description

The Medtronic.Kappa™ 700/600 Series of pulse generators ("Kappa 700/600 Series") are multi-programmable, rate responsive, implantable pacemakers which include dual chamber and single chamber models. The rate-responsive pacing, sensing, diagnostic algorithms, and operations of the Kappa 700/600 Series pulse generators are based upon the Thera™, Thera™-i, and Medtronic.Kappa™ 400 Series pulse generators.

The Medtronic.Kappa™ 700 Series of pulse generators contains the superset of features available in the Medtronic.Kappa family. The Medtronic.Kappa™ 600 Series of pulse generators contain a subset of these features including: Automatic Initialization of pacing therapies and diagnostics, Capture Management Monitor Mode, Sensing Assurance, Rate Response and Mode Switch. The following features are not available in KDR600 Series of pulse generators: Rate Drop Response, Sinus Preference, Search AV and Auto PVARP.

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The Kappa™ 700/600 Series of pulse generators are programmed using the Kappa 700/600 Model 9953E software and Medtronic Model 9790/9790C programmer. The major new features of the Kappa 700/600 Series of pulse generators are: Automatic Initialization, Capture Management, Sensing Assurance, and the Accelerometer.

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Model	Polarity	Primary Leads
$K_{DR}701$, $K_{DR}721$, $K_{DR}731$	Bipolar/Unipolar	IS-1[1] BI
K_D701, $K_{SR}701$, $K_{VDD}701$, $K_{DR}601$		
$K_{DR}703$, $K_{DR}733$, K_D703, $K_{SR}703$, $K_{DR}603$	Bipolar/Unipolar	Low-profile 3.2 mm bipolar or IS-1[1] BI
$K_{DR}706$, K_D706, $K_{SR}706$, $K_{DR}606$	Unipolar	Unipolar 5 or 6 mm

AUTOMATIC INITIALIZATION

The Kappa 700/600 Series of pulse generators automatically detects lead connection during the implant procedure by monitoring the path impedance during each delivered pace (Implant Detection). In response the pulse generator automatically configures the pacing and sensing polarities, enables rate response, initializes diagnostic data collection, initializes Sensing Assurance in both chambers, and starts Capture Management operation. Implant Detection and Automatic Initialization are intended to eliminate the necessity for programming the device to accomplish these actions.

Implant Detection

Implant Detection is a 30-minute period, beginning at lead insertion, during which the pacemaker verifies that a lead(s) has been connected by measuring lead impedance. After 30 minutes of continuous lead connection, the pacemaker completes Implant Detection and automatically configures the pacemaker through the Automatic Initialization process.

Automatic Polarity Configuration

During Implant Detection, bipolar pacemakers automatically configure pacing and sensing polarities through the Lead Monitor feature. Bipolar pacemakers are shipped with the Atrial and Ventricular Lead Monitor set to Configure, enabling automatic polarity determination shortly after lead connection.

Unipolar-only pacemakers are configured to unipolar pacing and sensing polarity at the time of manufacture and remain unipolar during the operational life of the pacemaker.

Lead Monitor

The Lead Monitor feature measures lead impedances during the life of the pacemaker by measuring the impedance of each pacing pulse to see if it falls within the programmed impedance range for a stable lead. When a lead is determined to be out of range, the pacemaker issues a lead warning that appears on the programmer screen at the next interrogation.

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[1] IS-1 refers to an International connector Standard (see Document No. ISO 5841-3; 1992).

CAPTURE MANAGEMENT

Capture Management provides automatic monitoring of ventricular pacing thresholds. When monitoring, the pacemaker performs a pacing threshold search for the ventricular Amplitude and Pulse Width settings that define the boundary between settings that capture the myocardium and those that do not. The rheobase and chronaxie approximations obtained during this monitoring allow the programmer to construct a strength-duration curve. Optionally, if programmed to do so, the pacemaker responds to monitoring by adapting ventricular Amplitude and Pulse Width settings automatically to maintain the programmed safety margin and minimum settings.

SENSING ASSURANCE

The Sensing Assurance feature automatically adjusts atrial and ventricular sensitivities within defined limits. At the completion of Implant Detection, the pacemaker enables Sensing Assurance and begins monitoring the peak amplitude of sensed signals. In response to monitoring, the pacemaker automatically increases or decreases sensitivity to maintain an adequate sensing margin with respect to the patient's sensed P and R waves.

The pacemaker monitors each nonrefractory sensed event (AS or VS) by measuring the ratio of the peak amplitude of the P or R wave to the Sensitivity setting. The pacemaker then compares the measured sensing margin to a target sensing margin.

Adjusting Sensing Thresholds

The pulse generator measures the amplitude of each non-refractory sensed event, and determines whether the amplitude is lower than, higher than, or within the target sensing margin. Adjustment decisions are made over the course of many sensed events. Many low events indicate a need to adjust to a more sensitive setting. Many high events indicate a need to adjust to a less sensitive setting.

At least 17 low events are required to cause an adjustment to the next more sensitive setting and 36 high events are required to cause an adjustment to the next less sensitive setting.

While Sensing Assurance is designed to adapt sensitivity margins in response to changes in sensed event amplitudes, Sensing Assurance may not eliminate all sources of oversensing.

ACCELEROMETER

The Kappa 700/600 activity sensor, the Accelerometer, operates by the same piezoelectric principle as existing Medtronic shield mounted activity sensors. The piezo-ceramic material converts mechanical energy in the form of stress, to electrical energy in the form of charge. The amount of electrical energy created by the activity sensor is converted to voltage. Voltage variation due to movement is processed to create activity detects. The activity detects are used to increase or decrease the pacing level.

Rate Response

The Kappa 700/600 Series utilizes the same workload-to-rate transfer function as the Kappa 400 Series (P970012). The Kappa 700/600 and 400 Series differ from Thera and other past devices by defining a third rate parameter in addition to the Lower Rate (LR) and Upper Sensor Rate (USR): the Activities of Daily Living Rate (ADLR). The ADLR is to be programmed to a value that is appropriate for the patient during typical daily activities (the shipping value is 95ppm). The ADLR breaks the rate transfer function into two independent zones: the lower workload, or submaximal, zone exists from LR to ADLR, and the higher workload, or maximal, zone spans the rates from ADLR to USR. Each of these zones is independently controllable. See Rate Transfer Function below.

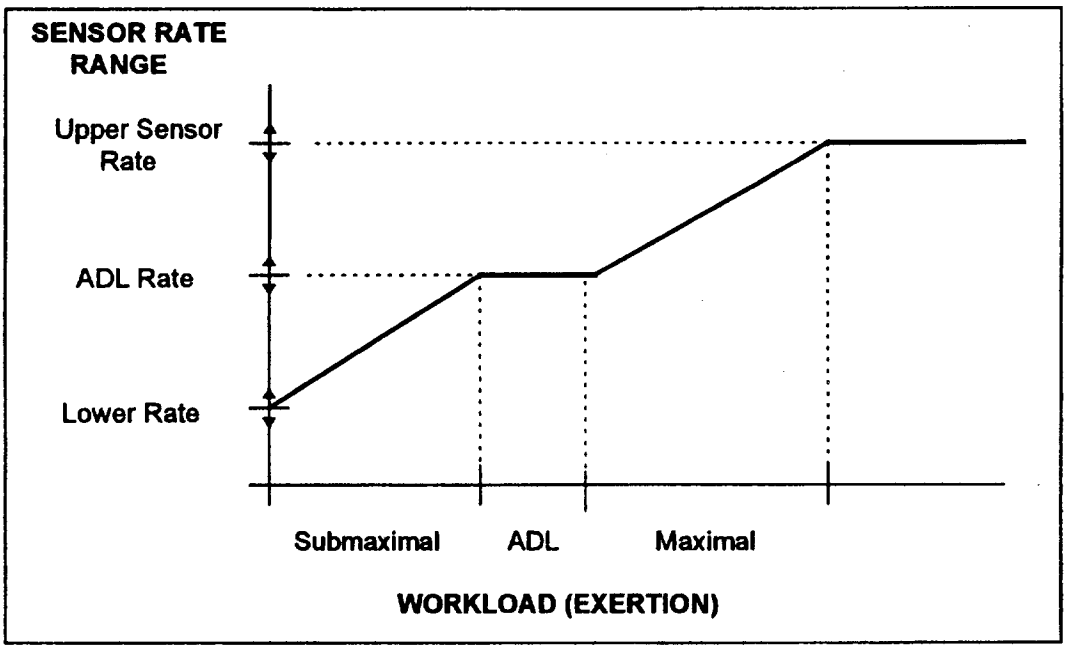

Figure 5-1. Rate Transfer Function

6. Alternative Practices or Procedures

While surgery or drug therapy may be alternatives to cardiac pacing in certain instances, cardiac pacing is the standard treatment for the indications described above. Other commercially available single chamber or dual chamber pacemakers provide alternatives to the Kappa 700/600 Series pulse generators.

7. Marketing History

The Kappa 700/600 Series pacemakers are currently distributed commercially outside the United States. Specifically, this product is approved for sale in Canada and the European Community. As of December 31, 1998, over 6000 Kappa 700/600 Series devices have been sold and/or implanted outside the United States. This device has not been withdrawn from the market in any country for any reason related to the safety and effectiveness of the device.

8. Adverse Events

Table 8-1: Adverse Events Reported in Four or More Patients

Complications[a] (Comps) and Observations[b] (Obs)

All patients implanted (N=288 in 285 patients, 133 device years)

Event	Total Number of Events[c] (Patients)	% of Patients with Comps (n=285)	Comps per Device-year (n=133)	% of Patients with Obs (n=285)	Obs per Device-year (n=133)
Any adverse events	355 (168)	17%	0.45	52%	2.22
Any device-related events[d]	182 (118)	11%	0.31	34%	1.06
Pain at pocket site	32 (31)	-	-	10.9%	0.24
Other	23 (21)	1.1%	0.02	6.3%	6.15
Inappropriate programming	11 (11)	-	-	3.9%	0.08
Atrial lead dislodgment	11 (10)	3.6%	0.08	-	-
Programmer/ software anomaly[e]	11 (8)	-	-	2.8%	0.08
Pocket infection	7 (6)	0.7%	0.02	1.4%	0.03
Intermittent undersensing	6 (6)	0.7%	0.02	1.4%	0.03
Palpitations	6 (6)	-	-	2.1%	0.05
Pocket hematoma	6 (6)	0.4%	0.01	1.8%	0.04
Ventricular lead dislodgment	6 (6)	2.1%	0.05	-	-
Elevated pacing thresholds	4 (4)	0.7%	0.02	0.7%	0.02
Syncope	4 (4)	-	-	1.4%	0.03

[a] *Complications included those adverse events which required invasive measures to correct (e.g., surgical intervention), and were related to the presence of the pacing system or procedure.*

[b] *Observations included those adverse events which did not require invasive measures to resolve, and were related to the presence of the pacing system or procedure.*

[c] *Where present, a number in parentheses indicates the number of patients with the event.*

[d] *The "Any device-related events" are a subset of "Any adverse events". The rest of the adverse event categories (rows) are "Device Related".*

[e] *Programmer software anomalies observed: screen lock-ups while saving data to diskette (8); problems printing reports outside of a patient session (2); and an incorrect parameter setting on a printout (1), which occurred in an earlier version of the software—software changes were made to eliminate reoccurrence.*

9. Summary of Preclinical Studies

Nonclinical testing of the Kappa 700/600 devices was conducted to ensure that the components and the finished device perform in accordance with their design specifications.

9.1 Bench Testing

Integrated Circuit

Electrical testing of each IC was performed on a sample of 77 units. Electrical stability of the IC was assessed through accelerated life testing. Each unit was stressed at 4.2V and 150°C for 184 hours minimum. Electrical testing of each IC was conducted prior to life testing, and following life testing using a mixed signal automated test system verifying significant performance parameters of the pacing system environment. There were no failures observed during the 184 hour life test, and no significant shifts in the electrical performance of any of the critical parameters were observed over the 184 hour life test.

Hybrid

Electrical qualification testing was performed on a sample of 154 hybrids. Electrical stability of the hybrid module was assessed through accelerated life testing. Each unit was stressed at 3.3V and 125°C for 500 hours minimum. Electrical testing of each hybrid was conducted prior to life testing, and after life testing using a computerized electronic test system verifying significant performance parameters of the pacing system environment. There were no failures observed during the 500 hour life test, and there were no significant shifts in the electrical performance of any of the critical parameters due to design or manufacturing over the 500 hours.

Battery Testing

The Kappa 700/600 Series pulse generators utilize three different power sources, the Promeon Sigma 213, 263 and 303 lithium-iodine cells. All three battery types were subjected to Accelerated Discharge (130-Sigma 213 samples, 96-Sigma 263 samples, and 62-Sigma 303 samples), Application Discharge (60-Sigma 213 samples, 24-Sigma 263 samples, and 12-Sigma 303 samples) and Environmental Tests (16-Sigma 213 samples, 16-Sigma 263 samples, and 16-Sigma 303 samples).

All the Accelerated Discharge test samples exceeded the specified requirements.

During Application Discharge Testing one test sample (Sigma 303) delivered less than the specified 1.5 Ah minimum capacity to ERI (1.42 Ah) at 26 μA rate. This observed behavior occurs randomly at very low frequency with all lithium-iodine cell designs. Lifetests of production samples have consistently demonstrated a maximum random failure rate across all lithium-iodine cells of less than 0.05% per month at 90% confidence. Excluding the lower performing cell, the remaining 11 Sigma 303 test samples exceeded the 1.5 Ah minimum capacity requirement to ERI at 26μA , delivering an average of 1.59 Ah (range 1.58-1.60 Ah). All samples exceeded the minimum three month time requirement between ERI and EOL at 20μA.

The Environmental Test results show normal and expected behavior for lithium-iodine batteries.

Current Drain Characterization

Current Drain Characterization for the Kappa 700/600 Series was performed at the hybrid level (3 hybrids), and measured current drain over various environmental and device conditions. All test results were within specification.

Connector Testing

The Kappa 700/600 Series of pulse generators uses three connector assemblies: IS-1 programmable unipolar / bipolar polarity, 5/6 mm dedicated unipolar and the 3.2 mm (IS-1 compatible) programmable unipolar / bipolar. The IS-1, 5/6 mm and 3.2 mm connectors are the same connectors as used on the Thera-*i* Series family of pulse generators and did not require requalification.

Environmental and Mechanical Testing

Environmental and mechanical qualification testing was performed with 66 samples. Test devices were subjected to 1) environmental stress tests including: temperature storage -18°C and 55°C for a minimum of six hours), mechanical vibration (5 Hz to 500 Hz to 5 Hz at 2.5 g acceleration), and mechanical shock (600 g, 1 msec/effective free-fall height of 18 inches) and 2) telemetry mapping. All devices were evaluated before and after each test for proper telemetry and output at room temperature conditions. Full functionality of each device was verified at the completion of all environmental tests.

Parameter Stability

Testing was performed on the Kappa 700/600 Series single and dual chamber pulse generators to determine the stability of the device pacing parameters when exposed to varying environmental conditions. Sensitivity, amplitude, accelerometer interface, pace current detector and capture detector were evaluated under varying load impedance, supply (battery) voltage, and temperature conditions. The test results demonstrate that the device parameters met specifications and remained stable under varying temperature, pacing load and supply voltage conditions.

Packaging Qualification

The inner and outer trays and the rest of the dual and single chamber packaging are identical or equivalent to Thera pulse generator packaging (P890003/S31, approved 1/10/95).

Predicted Reliability/Hazard Analyses

Utilizing both a fault tree analysis and a Failure Mode and Effects Analysis (FMEA) approach, a complete Hazard Analysis has been performed on all new features and critical components included in the Kappa 700/600 Series pacing system. The hazard analysis was incorporated into design and development processes of the pacing system to ensure that critical failures modes or potentially hazard situations have been identified and adequately eliminated or mitigated.

Firmware Testing

The firmware for Kappa 700/600 Series pulse generators was developed in accordance with applicable Medtronic development processes. Three levels of testing were performed on the firmware, including unit, integration and verification testing. All tests passed.

Software Validation

The Kappa 700/600 Software (Model 9953E) was developed and tested in accordance with Medtronic's formal procedures for software development and testing. These procedures include development of a Software Requirements Specification, a detailed design specification, a Hazard Analysis, a retest strategy, and a Verification Test Specification. The software was tested per the Verification Test Specification. Errors, anomalies, and inconsistencies were noted in Software Change Reports and all issues addressed. Following final retest of the software, a final configuration audit was performed by Software Quality Engineering to ensure that all documents and code were properly controlled and released.

System Testing

System Testing of Kappa 700/600 Series pacing system evaluated use of pulse generators with the programmer, Medtronic.Vision software and Kappa 700/600 Software to assure their operation is within the limits of their respective specifications. Issues associated with the technical literature and/or software were identified and resolved during testing.

Electromagnetic Compatibility (EMC) and Cell Phone Testing

Electromagnetic Compatibility (EMC) testing was performed using a minimum of twenty-two (22) pulse generators. The test devices were subjected to radiated electric fields, sinusoidal currents, electrosurgical cautery currents, ICD compatibility testing and transthoracic (high level) defibrillation pulses. In addition, characterizational testing was performed subjecting the devices to cellular phone transmission frequencies and radio frequency (RF) ablation.

The Kappa 700/600 Series of pulse generators were found to meet performance specifications for exposure to radiated electric fields. When subjected to sinusoidal currents, no devices were observed to exhibit rates above or below the specified test tolerances, and the pulse amplitude and duration of all devices were observed to remain within acceptable tolerances. Electrosurgical cautery testing demonstrated that the Kappa 700/600 Series of pulse generators meet all EMC compatibility requirements. Implantable cardio-defibrillator (ICD) compatibility testing consisted of exposing the pulse generators to ICD discharges to ensure the pulse generator does not experience electrical resets. All devices tested (40) remained fully functional and met the testing requirements. The second type of ICD testing consisted of exposing the pulse generator to high energy discharges used for defibrillation therapies. No anomalies were observed in the twenty-two (22) devices tested. The Kappa 700/600 Series of pulse generators were found to meet the performance specifications for devices exposed to in-vitro transthoracic defibrillation currents and no anomalies were observed during testing. Cell phones were tested per CDRH "In-Vitro Pacemaker EMI Test Protocol for Cellular Phones". No anomalies were observed while testing eight different analog and digital cellular phones in different modulation modes and frequencies. RF ablation testing verified that the device will function properly when exposed to RF ablation energy pulses.

EMC testing has been conducted to evaluate the effects of EMI during the time in which polarities are being configured and following lead configuration when Lead Monitor is active. A variety of unipolar and bipolar lead scenarios were tested in noise free, electrocautery, transthoracic defibrillation, ICD discharge and RF ablation environments. Testing demonstrated safe operation of the feature.

Electronic Article Surveillance (EAS) testing was completed to verify that the Kappa 700/600 devices function properly after exposure to EMI produced during EAS. No anomalies were observed during testing and the results demonstrate that Kappa 700/600 devices function according to specification.

Conclusion Concerning Nonclinical Laboratory Tests

Medtronic conducted a hazard analysis on all new features and critical components and then conducted testing to evaluate these and other device features. All test results were found to be acceptable.

9.2 Biocompatibility

The materials used in the Kappa 700/600 pulse that are directly exposed to body tissue and/or fluids are titanium, silicone rubber, polyurethane and parylene C. These materials have all been used in Medtronic pulse generators for several years and have an established history of biocompatibility

through long-term human use. Standard biocompatibility testing has been performed for these materials. All of the materials passed biocompatibility testing and are considered suitable for human implant.

9.3 Animal Testing

Canine studies were conducted to verify the function and performance of the Kappa 700/600 Series of pulse generators. The objectives of this study were to demonstrate the safety of the pulse generators through the investigation of features and therapies, including but not limited to Implant Detect, Sensing Assurance, Capture Management and Rate Response. Each feature was exercised to verify its expected operation through analysis of diagnostics, canine exercising via hallwalks and instrument initiated exercise tests, and comparison of manual measurements with automatic pacemaker adjustments. Testing results demonstrated that all general pulse generator functions of the Kappa 700/600 pacing system under observation operated according to specification.

10. Summary of Clinical Studies

10.1 Objectives

This study was a prospective evaluation of the following features of the Kappa 700 Series pacemaker: automatic polarity configuration, Capture Management, Sensing Assurance and rate response. Patient data for this report was collected at implant, pre-discharge, two week, one month, two month and/or three month, and six months post implant.

The primary effectiveness objectives were to evaluate the performance of a) Automatic Polarity Configuration (APC), b) Sensing Assurance (SA), c) Capture Management (CM), and d) rate response in relation to workload.

10.2 Methods

Automatic Polarity Configuration Objective. Appropriate performance of the automatic polarity configuration feature, in both unipolar and bipolar configurations, was verified at the pre-discharge visit through interrogation to confirm proper electrical configuration.

Sensing Assurance Objective. The Sensing Assurance (atrial and ventricular) feature was evaluated via comparison of the in-office sensing threshold measurement against the patient's automatically programmed sensitivity at all scheduled follow-ups. The rates of oversensing and undersensing were compared to a historical control to evaluate acceptable performance.

Capture Management Objective. The Capture Management feature was evaluated by comparing the ventricular output settings determined by the feature to the ventricular thresholds determined by a manual strength duration test at all scheduled follows. Again, acceptable performance was based on the resulting rate of loss of capture in the study as compared to the historical control.

Rate Response Objective. Rate response operation was evaluated to demonstrate that increases in pacing rates are concurrent with increases in workload. Patients were evaluated utilizing a modified version of the Minnesota Pacemaker Response Exercise Protocol (MPREP)[2] at their one month visit.

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[2] Benditt DGM, Editor, Rate Adaptive Pacing, Blackwell Scientific Publications, Boston, 1963, pages 63-5.

Evaluation of rate response performance for the Kappa 700 Series pacemaker was conducted using the Metabolic Chronotropic Response model described by Wilkoff as applied by Kay[3].

Secondary objectives using 24 hour Holter data evaluated the performance of the following programmable features: Capture Management, Sensing Assurance, Automatic PVARP, Search AV Adaptive, Mode Switch, Rate Adaptive AV, Rate Drop Response Sleep Rate, and Non-Competitive Atrial Pacing. The effective configuration by the APC feature was verified at the predischarge visit. The accuracy of the Capture Management Threshold Test and the effect of myopotentials on the Capture Management Threshold Test was observed. Sensing Assurance operation in the presence of provocative testing in unipolar systems and for VDD systems was observed. Finally, VDD undersensing during maximal activity was evaluated.

10.3 Description of Patients and Gender Bias

The 285 study patients included 181 (64%) males and 104 (36%) females. Inclusion and exclusion criteria were chosen to avoid gender bias. "The preponderance of male patients reflected both the gender referral pattern for cardiac disease and the severity of the disease in the centers involved. In addition, the comparability of the gender distribution is supported by U.S. epidemiological data obtained nationwide in a 1988 survey of 122,310 individuals where the age-adjusted pacemaker prevalence in males was 1.5 times that in females (60% male: 40% female)"[4].

10.4 Results

The Rate Profile Optimization (RPO) governs sensor indicated rate (SIR) output in Medtronic.Kappa 700 Series pacemakers. Figure 10-1 shows a composite of the individual graphs of the SIR vs. the Wilkoff predicted heart rate achieved using the RPO feature during the MPREP tests at 1 month.

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[3] Kay NG: Quantiation of chronotropic response: comparison of methods for rate-modulating permanent pacemakers. JACC 1992; 20(7): 1553-41.

[4] Chorus RM/Opus RM SS&E - P950029 March 3,1997

Figure 10-1: Sensor Indicated Rate (SIR) vs. Expected Rate – Individuals
All patients reaching anaerobic threshold during MPREP at one month (N=87)

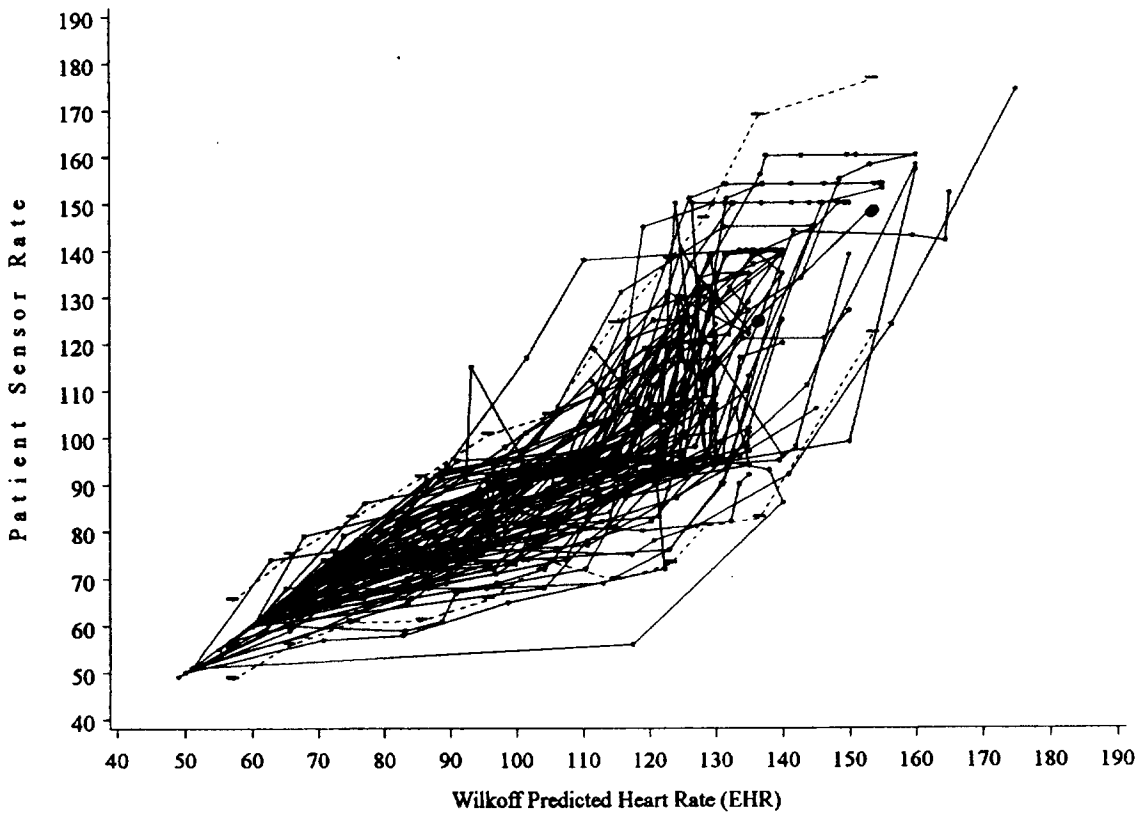

Figure 10-2 shows the same data as in Figure 10-1 following normalization (expressing as percent of maximum) for both the SIR vs. the Wilkoff predicted heart rate.

Figure 10-2: Normalized SIR vs. Expected Rate – Individuals

All patients reaching anaerobic threshold during MPREP at one month (N=87)

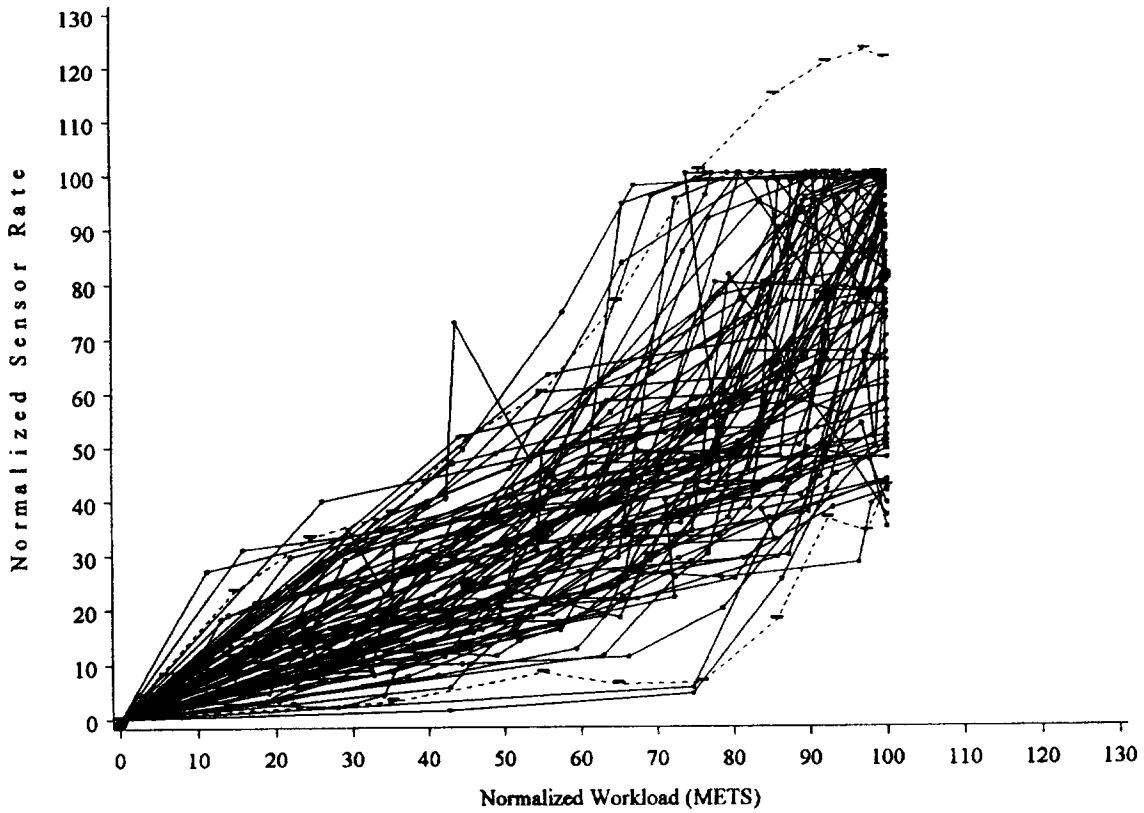

Figure 10-3 shows the mean and 95% confidence interval for the normalized SIR vs. expected rate.

Figure 10-3: Normalized SIR vs. Expected Rate – Population Mean and CI

All patients reaching anaerobic threshold during MPREP at one month (N=87)

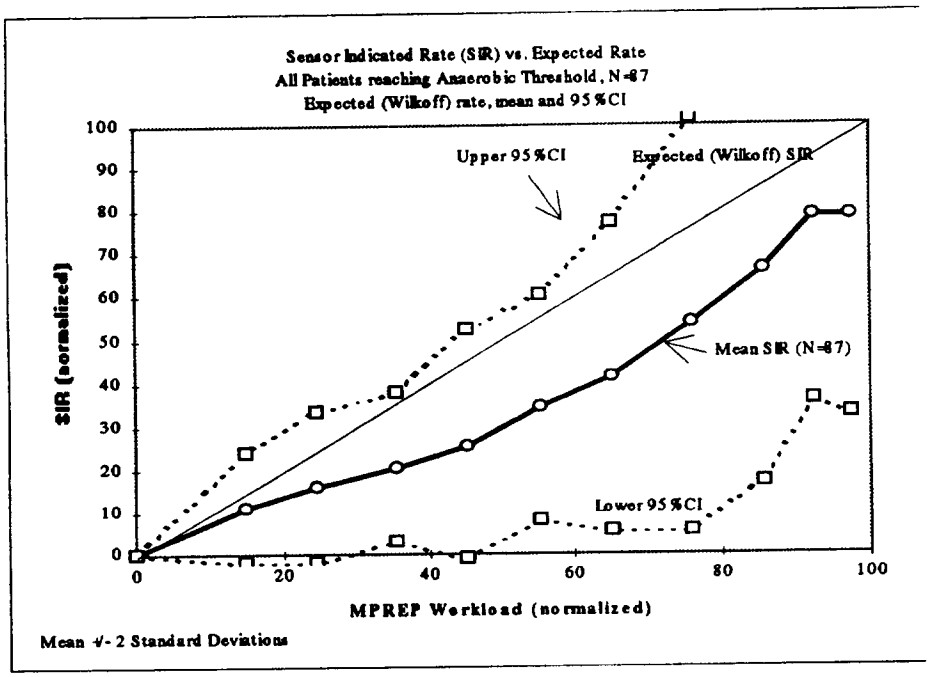

Table 10-1 provides the results from the primary objectives of the clinical study. The incidence of complications was found to be similar to that experienced by similar devices . The performance of the automatic polarity configuration, Capture Management, Sensing Assurance, and rate response features were found to meet study objectives.

Table 10-1: Summary of Primary Outcome Results

All patients implanted (N=288 in 285 patients, 133 device years)

Primary Objectives	Percent of events (n/N)	95% Confidence interval	Criteria: Upper 95% CI
Automatic Polarity Configuration (n with loss of output / N leads)			
Total Leads	0% (0/546)	[0%, 0.55%]	≤ 5%
Unipolar	0% (0/107)	[0%, 2.8%]	≤ 5%
Bipolar	0% (0/439)	[0%, 0.7%]	≤ 5%
Sensing Assurance (n with loss of sensing or oversensing / N device years)			
Atrial	13.5% (18/133)	[8.8%, 20.5%]	≤ 35.7%
Ventricular	0.8% (1/133)	[0.2%, 4.1%]	≤ 9.2%
Capture Management (n with all causes loss of capture / N device years)			
Loss of capture	5.3% (7/133)	[2.6%, 10.5%]	≤ 10.7%
Slope of MPREP rate response at 1 month (n = 87 patients)			
Mean	0.81	[0.76, 0.86]	[0.65, 1.35]

Table 10-2 summarizes the results from the secondary outcome measures of the clinical study. The incidence of complications was found to be similar to that experienced by similar devices . The performance of the automatic polarity configuration, Capture Management, Sensing Assurance, and rate response features were found to meet study objectives.

Table 10-2: Summary of Secondary Outcome Measure Results

All patients implanted (N=288 in 285 patients, 133 device years)

Secondary Objective	Results
Holter Observations	All of the features reviewed demonstrated appropriate operation.
APC Effectiveness	Appropriate configurations were determined by the feature for all 107 unipolar leads and 439 bipolar leads tested.
Capture Management Threshold Test (CMTT) Accuracy	The accuracy of the CMTT was characterized and was acceptable compared to the manual strength duration test.
Effect of Myopotentials on CMTT in Unipolar Patients	Appropriate operation and accurate results were observed when the CMTT was executed in the presence of myopotentials.
Effect of Myopotentials on Sensing Assurance (SA) in Unipolar Patients	Appropriate operation was observed during provocative testing of unipolar systems with Sensing Assurance turned ON.
Sensing Assurance (SA) during Provocative Testing in VDD Patients	Sensing Assurance appropriately adjusted the sensitivity for VDD systems. No myopotential oversensing was observed during provocative testing.
VDD Undersensing during Maximal Activity	Sensing Assurance was observed to provide appropriate sensing during exercise for VDD systems.

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Percent of Synchronization for KVDD700 Series Pacemakers

Thirteen patients with Medtronic.Kappa 700 VDD systems (Model KDR700 devices programmed to VDD mode and implanted with VDD leads) were tested one month after implant. The Percent of Synchronization (POS) was calculated according to the following formula: POS = AS-VP/(AS-VP + VP). The event sequence percentages were obtained from the device diagnostics or digital Holter data where VP was defined as ventricular paced events not preceded by an atrial sense. In twelve (12) patients, valid digital Holter recordings were used to calculate a POS during rest. Rest was defined by analysis of the Holter data between the hours of 12 am and 4 am. In these patients the POS was also calculated for the entire 24-hour Holter recording based on the pacemaker diagnostic data. Twelve (12) patients also performed maximal exercise testing. The POS was also calculated based on data from the pacemaker diagnostics representing the time of exercise.

Of the twelve patients analyzed during rest, POS ranged from 97.4 - 100% with a mean of 99.4%. The POS during the entire Holter period ranged from 91.4 - 100% with a mean of 99.9%. Of the twelve patients analyzed during exercise, eleven patients had a POS of greater than 99%. One patient had a POS of only 30.9% during exercise. This same patient had a POS greater than 91% during the entire Holter period. The mean POS during exercise was 94.2%.

The following figures show the frequency of histograms of percent of atrial synchronization for number of patients (n=12).

Figure 10-4: Atrial Synchronization at Rest

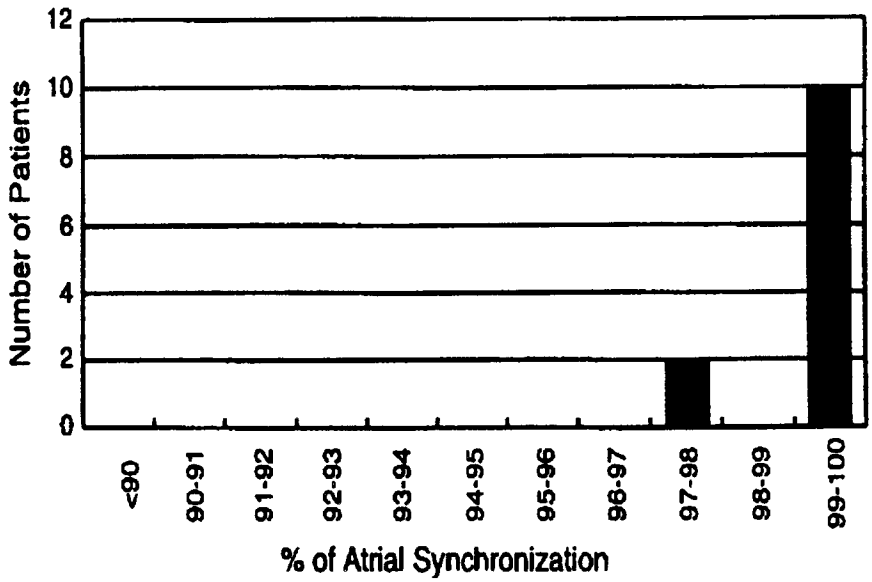


Figure 10-5: Atrial Synchronization During 24 hour Holter

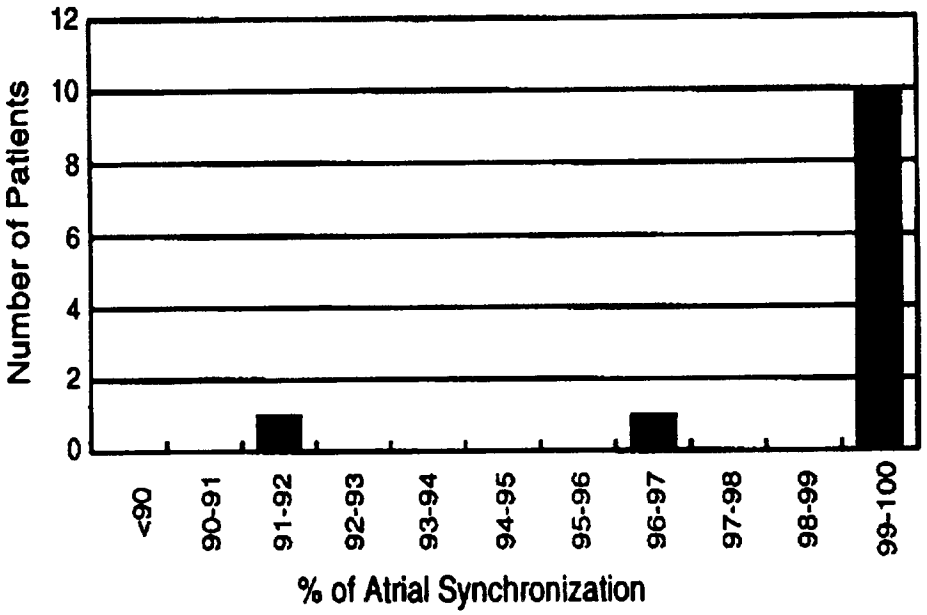
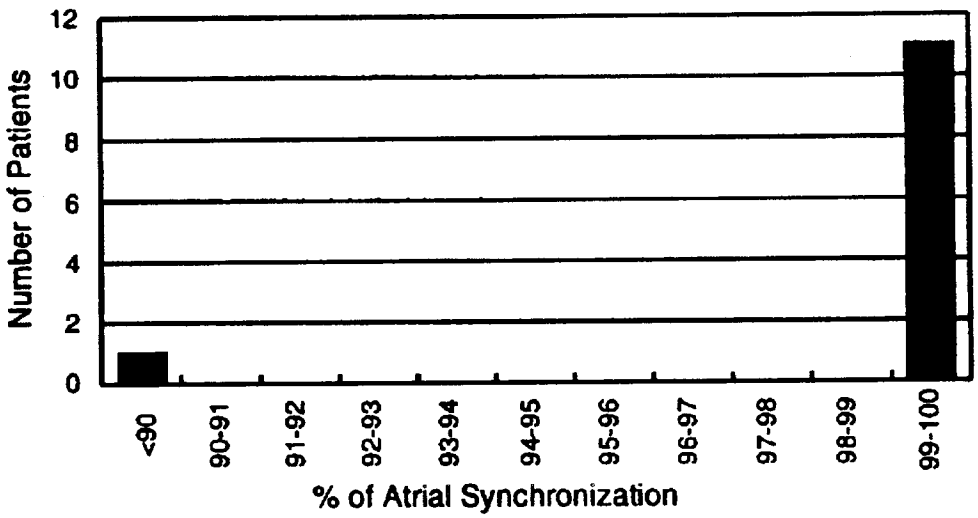


Figure 10-6: Atrial Synchronization During Exercise



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11. Conclusions Drawn from the Studies

The bench testing and clinical testing provide a reasonable assurance that the Kappa 700/600 Series devices are safe and effective when used in accordance with their labeling.

12. Panel Recommendation

Pursuant to section 515(f) of the act as amended by the Safe Medical Devices Act of 1990, this PMA was not referred to the Circulatory system Devices Panel, an FDA advisory panel for review and recommendation because the information in the PMA substantially duplicated information previously reviewed by this panel.

13. FDA Decision

FDA performed an inspection and found the applicant in compliance with the Quality System Regulation (21 CFR Part 820).

14. Approval Specifications

Directions for Use: See Final Draft Labeling (Information for Use)

Hazards to Health from Use of the Device: See INDICATIONS, CONTRAINDICATIONS, WARNINGS AND PRECAUTIONS, and ADVERSE EVENTS in the Final Draft Labeling (Information for Use).

Post-approval Requirements and Restrictions: See Approval Order