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P930039

Memorandum

Date . MAR 29 1996

From Director, Office of Device Evaluation (HFZ-400)
Center for Devices and Radiological Health (CDRH)

Subject Premarket Approval of Medtronic, Inc.
CapSureFix® Pacing Lead, Model 4068 - ACTION

To The Director, CDRH
ORA _____

ISSUE. Publication of a notice announcing approval of the subject PMA.

FACTS. Tab A contains a FEDERAL REGISTER notice announcing:

- (1) a premarket approval order for the above referenced medical device (Tab B); and
- (2) the availability of a summary of safety and effectiveness data for the device (Tab C).

RECOMMENDATION. I recommend that the notice be signed and published.

Susan Alpert
Susan Alpert, Ph.D. M.D.

Attachments
Tab A - Notice
Tab B - Order
Tab C - S & E Summary

DECISION

Approved _____ Disapproved _____ Date _____

Prepared by Tara A. Ryan, CDRH, HFZ-450, 2/7/96, 443-8243

DEPARTMENT OF HEALTH AND HUMAN SERVICES

FOOD AND DRUG ADMINISTRATION

[DOCKET NO. _____]

MEDTRONIC, INC.; PREMARKET APPROVAL OF THE CAPSUREFIX® PACING
LEAD, MODEL 4068

AGENCY: Food and Drug Administration, HHS.

ACTION: Notice.

SUMMARY: The Food and Drug Administration (FDA) is announcing its approval of the application by Medtronic, Inc., Minneapolis, MN, for premarket approval, under section 515 of the Federal Food, Drug, and Cosmetic Act (the act), of the CapSureFix® Pacing Lead, Model 4068.

DATE: Petitions for administrative review by (insert date 30 days after date of publication in the FEDERAL REGISTER).

ADDRESS: Written requests for copies of the summary of safety and effectiveness data and petitions for administrative review, to the Dockets Management Branch (HFA-305), Food and Drug Administration, Rm. 1-23, 12420 Parklawn Drive, Rockville, MD 20857.

FOR FURTHER INFORMATION CONTACT:

Tara A. Ryan

Center for Devices and Radiological Health (HFZ-450)

Food and Drug Administration

9200 Corporate Boulevard

Rockville, MD 20850

301-443-8243.

SUPPLEMENTARY INFORMATION: On November 1, 1993, Medtronic, Inc., Minneapolis, MN 55432-3576, submitted to CDRH an application for premarket approval of the CapSureFix® Pacing Lead, Model 4068. The device is a permanent implantable cardiac pacemaker electrode (lead) and is designed to be used with a pulse generator as part of a cardiac pacing system. The lead has application where implantable atrial or ventricular, single chamber or dual chamber pacing systems are indicated.

In accordance with the provisions of section 515(c)(2) 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 duplicates information previously reviewed by this panel.

On MAR 29 1994, CDRH approved the application by a letter to the applicant from the Director of the Office of Device Evaluation, CDRH.

A summary of the safety and effectiveness data on which CDRH based its approval is on file in the Dockets Management Branch (address above) and is available from that office upon written

request. Requests should be identified with the name of the device and the docket number found in brackets in the heading of this document.

OPPORTUNITY FOR ADMINISTRATIVE REVIEW

Section 515(d)(3) of the act (21 U.S.C. 360e(d)(3)) authorizes any interested person to petition, under section 515(g) of the act (21 U.S.C. 360e(g)), for administrative review of CDRH's decision to approve this application. A petitioner may request either a formal hearing under part 12 (21 CFR part 12) of FDA's administrative practices and regulations or a review of the application and CDRH's action by an independent advisory committee of experts. A petition is to be in the form of a petition for reconsideration under 10.33(b) (21 CFR 10.33(b)). A petitioner shall identify the form of review requested (hearing or independent advisory committee) and shall submit with the petition supporting data and information showing that there is a genuine and substantial issue of material fact for resolution through administrative review. After reviewing the petition, FDA will decide whether to grant or deny the petition and will publish a notice of its decision in the FEDERAL REGISTER. If FDA grants the petition, the notice will state the issue to be reviewed, the form of the review to be used, the persons who may participate in the review, the time and place where the review will occur, and other details.

Petitioners may, at any time on or before (insert date 30 days after date of publication in the FEDERAL REGISTER), file with the Dockets Management Branch (address above) two copies of each petition and supporting data and information, identified

with the name of the device and the docket number found in brackets in the heading of this document. Received petitions may be seen in the office above between 9 a.m. and 4 p.m., Monday through Friday.

This notice is issued under the Federal Food, Drug, and Cosmetic Act (secs. 515(d), 520(h), (21 U.S.C. 360e(d), 360j(h)) and under authority delegated to the Commissioner of Food and Drugs (21 CFR 5.10) and redelegated to the Director, Center for Devices and Radiological Health (21 CFR 5.53).

Dated: _____.

D. Bruce Burlington, M.D.
Director
Center for Devices and
Radiological Health

CERTIFIED TO BE A TRUE COPY OF THE ORIGINAL



Food and Drug Administration
9200 Corporate Boulevard
Rockville MD 20850

MAR 29 1996

Mr. Keith J. Proctor
Product Regulation Manager
Cardiac Pacing Business
Medtronic, Inc.
7000 Central Avenue, N.E.
Minneapolis, Minnesota 55432-3576

Re: P930039
CapSureFix® Pacing Lead, Model 4068
Filed: November 1, 1993
Amended: December 9 and 22, 1994, February 13, June 30,
August 8, September 22, October 3, October 30,
November 6, November 9, and December 7, 1995,
January 17, February 7, and March 29, 1996

Dear Mr. Proctor:

The Center for Devices and Radiological Health (CDRH) of the Food and Drug Administration (FDA) has completed its review of your premarket approval application (PMA) for the CapSureFix® Pacing Lead, Model 4068. The device is designed to be used with a pulse generator as part of a cardiac pacing system. The lead has application where implantable atrial or ventricular, single chamber or dual chamber pacing systems are indicated. We are pleased to inform you that the PMA is approved subject to the conditions described below and in the "Conditions of Approval" (enclosed). You may begin commercial distribution of the device upon receipt of this letter.

The sale, distribution, and use of this device are restricted to prescription use in accordance with 21 CFR 801.109 within the meaning of section 520(e) of the Federal Food, Drug, and Cosmetic Act (the act) under the authority of section 515(d)(1)(B)(ii) of the act. FDA has also determined that to ensure the safe and effective use of the device that the device is further restricted within the meaning of section 520(e) under the authority of section 515(d)(1)(B)(ii) insofar as the sale, distribution, and use must not violate sections 502(q) and (r) of the act.

Page 2 - Mr. Keith J. Proctor

In addition to the postapproval requirements in the enclosure, the postapproval reports must include the following information:

Please submit a test protocol designed to confirm the long-term flex fatigue resistance of the distal aspect (distal 20 cm of lead) of the Model 4068 pacing lead. A HIMA/FDA task force is currently developing such a protocol. A draft protocol must be submitted within 6 months of the date of approval of our application.

FDA agrees to your suggested revision to the condition of approval as identified in your December 11, 1995, approvable letter.

Expiration dating for this device has been established and approved at two years. This is to advise you that the protocol you used to establish this expiration dating is considered an approved protocol for the purpose of extending the expiration dating as provided by 21 CFR 814.39(a)(8).

CDRH will publish a notice of its decision to approve your PMA in the FEDERAL REGISTER. The notice will state that a summary of the safety and effectiveness data upon which the approval is based is available to the public upon request. Within 30 days of publication of the notice of approval in the FEDERAL REGISTER, any interested person may seek review of this decision by requesting an opportunity for administrative review, either through a hearing or review by an independent advisory committee, under section 515(g) of the Federal Food, Drug, and Cosmetic Act (the act).

Failure to comply with the conditions of approval invalidates this approval order. Commercial distribution of a device that is not in compliance with these conditions is a violation of the act.

You are reminded that as soon as possible, and before commercial distribution of your device, that you must submit an amendment to this PMA submission with copies of all approved labeling in final printed form.

All required documents should be submitted in triplicate, unless otherwise specified, to the address below and should reference the above PMA number to facilitate processing.

PMA Document Mail Center (HFZ-401)
Center for Devices and Radiological Health
Food and Drug Administration
9200 Corporate Boulevard
Rockville, Maryland 20850

In addition under section 522(a) of the Federal Food, Drug, and Cosmetic Act, (the act) manufacturers of certain types of devices identified by the act or designated by FDA are required to conduct postmarket surveillance studies. FDA has identified under section 522(a)(1)(A) the above noted device as requiring postmarket surveillance.

Upon approval and within thirty (30) days of first introduction or delivery for introduction of this device into interstate commerce you will be required to submit to FDA certification of the date of introduction into interstate commerce, a detailed protocol which describes the postmarket surveillance study, and a detailed profile of the study's principal investigator that clearly establishes the qualifications and experience of the individual to conduct the proposed study. For your information, general guidance on preparing a protocol for a postmarket surveillance study is enclosed.

In addition, "Guidance to Sponsors on the Development of a Discretionary Postmarket Surveillance Study for Permanent Implantable Cardiac Pacemaker Electrodes (Leads)" is enclosed.

At that time you should submit five (5) copies to:

Postmarket Studies Document Center
1350 Piccard Drive (HFZ-544)
Rockville, Maryland 20850

Within sixty (60) days of receipt of your protocol, FDA will either approve or disapprove it and notify you of the Agency's action in writing. Do not undertake a postmarket surveillance study without an FDA approved protocol.

Failure to certify accurately the date of initial introduction of your device into interstate commerce, to submit timely an acceptable protocol, or to undertake and complete an FDA approved postmarket surveillance study consistent with the protocol, will be considered violations of section 522.

In accordance with the Medical Device Amendments of 1992, failure of a manufacturer to meet its obligations under section 522 is a prohibited act under section 301(q)(1)(C) of the Federal Food, Drug and Cosmetic Act (the act) (21 U.S.C. 331(q)(1)(C)). Further, under section 502(t)(3) of the act (21 U.S.C. 352(t)(3)), a device is misbranded if there is a failure or refusal to comply with any requirement under section 522 of the act. Violations of sections 301 or 502 may lead to regulatory actions including seizure of your product, injunction, prosecution, or civil money penalties or other FDA enforcement actions including (but not limited to) withdrawal of your PMA.

Page 4 - Mr. Keith J. Proctor

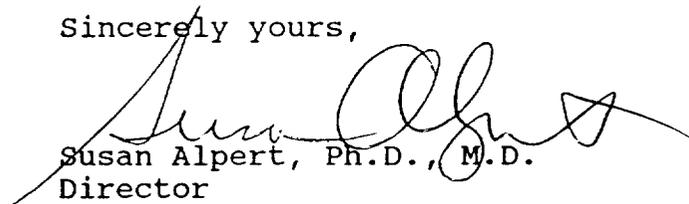
If you have any questions concerning postmarket surveillance study requirements, contact the Postmarket Surveillance Studies Branch, at (301) 594-0639.

Under section 519(e) of the act (as amended by the Safe Medical Devices Act in 1990), manufacturers of certain devices must track their products to the final user or patient so that devices can be located quickly if serious problems are occurring with the products. The tracking requirements apply to (1) permanent implants the failure of which would be reasonably likely to have serious adverse health consequences; (2) life sustaining or life supporting devices that are used outside of device user facilities the failure of which would be reasonably likely to have serious adverse health consequences; and (3) other devices that FDA has designated as requiring tracking. Under section 519(e), FDA believes that your device is a device that is subject to tracking because it is a permanent implant whose failure would be reasonably likely to have serious adverse consequences.

FDA's tracking regulations, published in the FEDERAL REGISTER on August 16, 1993, appear at 21 CFR Part 821. These regulations set out what you must do to track a device. In addition, the regulations list example permanent implant and life sustaining or life supporting devices that FDA believes must be tracked at 21 CFR § 821.20(b) and the devices that FDA has designated for tracking at 21 CFR § 821.20(c). FDA's rationale for identifying these devices is set out in the FEDERAL REGISTER (57 FR 10705-10709 (March 27, 1991), 57 FR 22973-22975 (May 29, 1992), and 58 FR 43451-43455 (August 16, 1993)).

If you have questions concerning this approval order, please contact Tara A. Ryan at (301) 443-8243.

Sincerely yours,



Susan Alpert, Ph.D., M.D.
Director
Office of Device Evaluation
Center for Devices and
Radiological Health

Enclosures

Summary of Safety and Effectiveness

I. General Information

Device Generic Name: Implantable, Transvenous, Endocardial, Bipolar, Steroid Eluting, Screw-In, Atrial/Ventricular, Pacing Lead

Device Trade Name: CapSureFix® Pacing Lead, Model 4068

Applicant's Name & Address: Medtronic Inc.
7000 Central Avenue, N.E.
Minneapolis, MN 55432

PMA Number: P930039

Date of Notice of Approval to Applicant: MAR 29 1996

II. Indications For Use

The Model 4068 lead is designed to be used with a pulse generator as part of a cardiac pacing system. The lead has application where implantable atrial or ventricular, single or dual-chamber pacing systems are indicated.

III. Description of The Device

The Model 4068 is an endocardial, bipolar, steroid eluting, screw-in, atrial/ventricular transvenous pacing lead. The Model 4068 is designed to transmit stimuli from the pulse generator to the tissues of the heart and to deliver signals from the heart to the sense amplifier in the pulse generator.

This pacing lead consists of a helical screw electrode, ring electrode, conductor coils, polyurethane insulation, Monolithic Controlled Release Device (MCRD), connector terminal assembly, anchoring sleeve, and a stylet. The helical screw electrode provides the electrical contact and positive fixation with the myocardium. This helix electrode is a platinum/iridium alloy wire formed into the helical configuration. The electrode ring is also made of a platinum/iridium alloy. The distal end of the lead contains a ring shaped MCRD that consists of a polyurethane binder containing a maximum of 1.0 mg of the steroid dexamethasone sodium phosphate. The conductors are coiled wires of MP35N, a nickel alloy that is platinum sputtered. The outer insulation is 80A polyurethane and the inner insulation is 55D polyurethane. The terminal assembly of the lead provides for the electrical connection between the lead and pulse generator. The terminal assembly consists of a stainless steel connector pin, a stainless steel connector ring, and a silicone rubber connector sleeve. A silicone rubber anchoring sleeve is also provided for securing the lead at the site of insertion. A stylet is furnished to provide

stiffness to the lead for maneuverability and placement within the heart.

The technical description of the Model 4068 follows:

Type:	Bipolar		
Chamber:	Atrium/Ventricle		
Fixation:	Screw-In		
Length:	20 - 110 cm		
Conductor Material:	MP35N		
Insulation:	Polyurethane		
Helix Electrode:	Platinum alloy		
Ring Electrode:	Platinum alloy		
Helix Surface Area:	6.3 mm ²		
Ring Surface Area:	34 mm ²		
Distance Between Electrodes:	17.8 mm		
Helix Length:	1.8 mm		
Steroid:	Dexamethasone Sodium Phosphate		
Amount of Steroid:	1.0 mg maximum		
Unipolar Resistance:	27 Ohms (58 cm)		
Bipolar Resistance:	77 Ohms (58 cm)		
Maximum Revolutions	Lead Length	Straight Stylet	J Stylet
	45 cm	10	15
	52 cm	11	17
	58 cm	12	18
	65 cm	14	21
	85 cm	18	27

IV. Contraindications

When tricuspid valvular disease is present, use of a transvenous ventricular lead is contraindicated.

The use of an endocardial ventricular lead is contraindicated in patients with mechanical tricuspid heart valves.

Do not use a steroid eluting lead in patients for whom a single dose of 1.0 mg of dexamethasone sodium phosphate may be contraindicated.

V. Warnings

An implanted lead forms a direct current path to the myocardium. Therefore, use only battery-powered equipment during lead implantation and testing to protect against fibrillation that may be caused by alternating currents. Line-powered equipment used in the vicinity of the patient must be properly grounded. Lead connector pins must be insulated from any leakage currents that may arise from line-powered equipment.

VI. Precautions

Defibrillating equipment should be kept nearby for immediate use during the implantation procedure.

Inspect the lead sterile package prior to opening. If the seal or package is damaged, contact your local Medtronic representative.

Use an anchoring sleeve with all leads. Ensure that the anchoring sleeve is positioned close to the lead connector pin. This will prevent inadvertent passage of the sleeve into the vein. If wiping the lead is necessary prior to insertion, ensure that the anchoring sleeve remains in position.

Leads should be handled with great care at all times. Any severe bending, kinking, stretching, handling with surgical instruments or excessive force when inserting a stylet may cause permanent damage to the lead. If the lead is damaged, do not implant it. Return the lead to your Medtronic representative.

Lead insulators attract small particles such as lint and dust. Therefore, to minimize contamination, protect the lead from materials shedding these substances. Handle the lead with sterile surgical gloves that have been rinsed in sterile water or equivalent.

Do not immerse leads in mineral oil, silicone oil, or any other liquid.

The maximum number of revolutions (using the fixation tool) needed to extend or retract the helix for initial placement is stated in the technical specifications supplied with each lead. Prior to implantation, the helix should be exercised, as on the initial extension more turns may be required to extend it or it may extend suddenly when torque is built up. At implantation use fluoroscopy to identify helix extension and retraction. Over rotation of the connector pin may result in fracture or distortion of the inner conductor or retraction of the helix out of its channel.

It has not been determined whether the warnings, precautions, or complications usually associated with injectable dexamethasone sodium phosphate apply to the use of this highly-localized, controlled-released device. For a listing of potentially adverse effects, refer to the dexamethasone sodium phosphate manufacturer prescribing information or the *Physicians Desk Reference*.

VII. Alternative Practices and Procedures

An alternative for patients requiring permanent pacemaker implantation is the use of another commercially available pacemaker lead.

VIII. Marketing History

The Model 4068 CapSureFix® lead is released in those countries where regulatory approval has been obtained. Since February 1992, over 15,000 leads have been implanted in Europe, Canada, Japan, Australia, and Latin America. The Model 4068 has not been withdrawn from any market.

IX. Potential Adverse Effects of the Device on Health

The potential complications related to the use of transvenous leads include, but are not limited to, the following patient-related conditions that can occur when the lead is being inserted and/or repositioned: valve damage (particularly in fragile hearts, e.g., infants), fibrillation and other arrhythmias, thrombolytic and air embolism, cardiac perforation, heart wall rupture, cardiac tamponade, muscle or nerve stimulation, pericarditis, pericardial rub, infection, myocardial irritability, thrombosis, and pneumothorax.

Other potential complications related to the lead and the programmed parameters include, but are not limited to, the following: lead dislodgement, lead conductor or helix fracture, insulation failure, threshold elevation or exit block.

See Section C for a tabulated summary of complications and observations in the clinical investigation.

X. Summary of Studies

A. In-Vitro (Laboratory) Testing

Three EtO sterilization and aeration cycles are performed to expose all leads to "worst case" (maximum exposure) manufacturing process conditions. Leads are cycled five times from -45°C to +70°C with a duration time of 30 minutes at each extreme and a maximum of five minutes transfer time. Lead test samples must pass visual inspection as well as passing the specified requirements for all subsequent qualification tests, as defined below:

1. Helix Electrode Extension/Retraction Testing

The number of revolutions required to extend and retract the helix is measured by counting the number of revolutions the connector pin requires to fully extend and retract the helix. This test is performed to verify that the extension and retraction of the helix meets the design specification.

Samples Tested	Results	Specification
30 (Extension)	7.1 ± 1.0 rotations	12 rotations
30 (Retraction)	6.9 ± 0.9 rotations	12 rotations

2. Stylet Insertion/Withdrawal Testing

The force required to fully insert and withdraw appropriate stylets is measured to verify that the stylet passage is not restricted and that the force required to insert or withdraw the stylet meets the design specification.

Samples Tested	Results	Specification
30 (Insertion)	≤ 100 grams	≤ 100 grams
30 (Retraction)	≤ 100 grams	≤ 100 grams

3. Connector Mating (Insertion/Withdrawal Testing)

The force required to fully insert and withdraw the lead connector is measured using the IS-1 go-gauge and various Medtronic pulse generator connector modules. This testing is performed to assure that the leads conform to the IS-1 Standard (ISO-5841-3(E)) and Medtronic specifications.

Samples Tested	Results	Specification
15 (Insertion)	1.4 ± 0.1 lbs	3.1 lbs
15 (Retraction)	0.9 ± 0.1 lbs	3.1 lbs

4. Tip Pressure Testing

The force required to displace the distal end of the lead by 0.15" is measured and converted to a pressure value. The results are compared to results of acceptable performing predicate leads.

Samples Tested	Results	Specification
10	1.96 ± 0.10 psi	3.6 psi

5. Leak Testing (Lead Body)

The fluid leak test is performed by subjecting the distal end of the lead to a bath of deionized water pressurized to 4 psi for 5 minutes. The purpose of the fluid leak test is to verify that fluids do not enter the lead body when subjected to pressures higher than those which would be encountered intravenously.

Samples Tested	Results	Specification
30	No Fluid Leakage	No Fluid Leakage

6. Helix Seal Leak Test

The helix seal leak test is performed by placing the proximal end of the lead in water and applying air pressure externally to the helix seal while observing for the presence of bubbles emerging from the connector pin. The purpose of the helix seal leak test is to assure that the helix seal will prevent ingress of blood into the lead during the implant procedure.

Samples Tested	Results	Specification
30	No Helix Seal Leakage	No Helix Seal Leakage

7. Composite Pull Strength

Leads are soaked for ten days in 0.9% saline at body temperature, after which the samples are pulled until failure utilizing a tensile testing machine. The composite pull strength test of a lead assures that the lead has adequate overall strength to withstand the anticipated forces that may be experienced during lead handling/placement as well as the in-vivo forces that the lead may experience chronically.

Samples Tested	Results	Specification
29 (Distal Composite)	5.7 ± 0.6 lbs	≥ 1.0 lb
30 (Proximal Composite)	7.4 ± 0.6 lbs	≥ 1.0 lb

8. Crimp/Weld Pull Strength

Crimps and welds are pulled by gripping opposite ends of each connection in a tensile test machine until failure. The purpose of the crimp/weld pull test assures that each connection can withstand the anticipated mechanical loading during lead handling.

Samples Tested	Results	Specification
15 (Helix)	8.8 ± 1.0 lbs	≥ 2.5 lbs
30 (Electrode Ring)	14.7 ± 3.1 lbs	≥ 2.5 lbs
58 (Connector Ring)	8.6 ± 3.5 lbs	≥ 2.5 lbs
20 (Connector Pin)	11.6 ± 0.9 lbs	≥ 1.0 lbs
15 (Connector Pin Cap)	18.2 ± 6.1 lbs	≥ 2.5 lbs

9. Composite Torsional Strength

Leads are soaked for ten days in 0.9% saline at body temperature after which 0.5 inch-ounces are applied to the lead body. The composite torsional strength of a lead is measured to assure the lead has adequate overall strength to withstand the anticipated torque that may be experienced during lead handling, implant, and explant.

Samples Tested	Results	Specification
30	No Visible Damage	No Visible Damage

10. Anchoring Sleeve Suture Test

Anchoring sleeves are sutured to lead bodies at a specified force and the breakaway force is then measured. This test is performed to assure the lead will be held securely in place and does not damage the lead body when the anchoring sleeve is sutured according to the instructions in the manual.

Samples Tested	Results	Specification
15	0.82 ± 0.07 lbs	≥ 0.25 lbs

11. Flex Testing

Lead bodies are mounted in a fixture and flexed ± 90° over a 0.236" radius until an electrical continuity failure occurs in each specimen. This test is performed to assure reliability of the lead body due to the anticipated in-vivo flexing that may be experienced chronically.

Samples Tested	Results	Specification
22	6.4 x 10 ⁵ cycles (median)	2.0 x 10 ⁵ cycles (B50)

12. D.C. Resistance

Electrical resistance is measured between the connector pin and the electrode, and between the connector ring and the electrode ring. This test is performed to assure conformance to the design specification and to verify electrical continuity.

Samples Tested	Results	Specification
30 (Inner)	$26.0 \pm 0.2 \Omega$	$23 \pm 5 \Omega$
30 (Outer)	$49.5 \pm 0.6 \Omega$	$52 \pm 10 \Omega$

13. IS-1 Offset Block/AC Impedance Testing

Leads are inserted into IS-1 connector blocks as defined in the IS-1 Standard and soaked in 0.9% saline at body temperature for a minimum of ten days. AC Impedance is measured between all combinations of conductors and an indifferent electrode to assure conformance to the IS-1 Standard.

Samples Tested	Results	Specification
15	$\geq 50K \Omega$	$\geq 50K \Omega$

14. In-Vitro Elution Rate Studies

In-vitro steroid elution rate studies were performed to ensure that the 1.0 mg maximum amount of steroid eluted is not exceeded.

Eight distal subassemblies of the Model 4068 lead were immersed in sealed glass jars of a 50/50 methanol/deionized water solution. Lead tips in solution were shaken in a heated lab bench top shaker at 37° C. Solutions were withdrawn and replaced with fresh methanol/deionized water (50/50) at .25, 1, 2, 3, 4, 8, 24, 72 hours, and then 1, 2, and 3 weeks. The decanted solutions were analyzed for steroid content by High Performance Liquid Chromatography (HPLC).

At three weeks, the average total cumulative amount of steroid eluted per lead subassembly was 0.636 milligrams. The range is 0.516 to 0.749 milligrams. This is below the 1.0 mg maximum level.

15. Biocompatibility Testing

The materials used in the Model 4068 that are directly exposed to body tissue are polyurethane, silicone rubber, platinum alloy, and Medtronic PUR. These materials have been shown to be biocompatible through many years of use in Medtronic permanent implantable endocardial/myocardial permanent pacing leads (with the exception of the polymer matrix [Medtronic PUR] used in the MCRD component). In addition to extensive implant experience with these materials, standard biocompatibility tests (Hemolysis, Tissue Culture, USP Pyrogen, USP Biological Test for Plastics Class V, Intramuscular Implants, Ames Mutagenicity Assay, and Sensitization) have been performed to verify the biocompatibility of the materials. Testing has demonstrated that all materials are nonhemolytic, nonpyrogenic, nontoxic, nonmutagenic and biocompatible.

Medtronic developed the polymer (Medtronic PUR) in order to provide a consistent, manufacturable matrix for steroid delivery in conjunction with extendable/retractable screw-in leads. The Medtronic PUR has passed all standard biocompatibility testing. Additional biocompatibility testing was also performed on the MCRD. Two leads were implanted in each of ten dogs; one lead in the atrium and one in the ventricle. Five animals (10 leads) were implanted with a Model 4068 lead containing the steroid MCRD and five control animals (10 leads) were implanted with Model 4058M leads. The Model 4058M leads were used as controls in that they did not contain a steroid MCRD.

At 12 weeks the animals were euthanized and tissues were harvested for histopathological review. The criteria used to assess the biocompatibility of the steroid MCRD was based on a comparison of the tissue reaction it elicited, to the reaction elicited by the electrode without the steroid MCRD. If the tissue reactions were similar, the steroid MCRD would be considered biocompatible.

For both test and control leads, based upon the histopathological evaluations, the tissue response at the electrode/endocardium interface showed similar evidence of inflammation and fibrous reaction. Since both the test and control leads exhibited a similar tissue response, the steroid MCRD is considered biocompatible.

16. Shelf Life Testing

All of the materials, components and packaging for the Model 4068 lead are similar to those used in currently marketed leads, with the exception of the MCRD. The current shelf-life for packaged polyurethane, tined, steroid leads is two years. Thus the materials, components (with the exception of the MCRD) and packaging used in the Model 4068 lead were previously proven to be stable for a two year shelf-life. The only previously undetermined component for determining the lead shelf-life was the MCRD.

17. MCRD Shelf Life Testing

Twenty-five (25) MCRD samples were set aside for dexamethasone sodium phosphate (DMP) steroid elution studies using Ultraviolet Spectrophotometry (UV) analysis at each of the 0, 12, 24, 30, 36, and 45 month intervals. In addition, five (5) MCRD samples were set aside for DMP elution studies using HPLC analysis at the 24, 30, 36, and 45 month intervals. All the samples tested using the HPLC technique met the specification (≤ 1.0 mg) for the amount of DMP eluted.

18. Biostability Testing

The objective of this section is to present information relative to the biostability of Medtronic polyurethane pacing leads. Several modifications have been developed over the years to improve Environmental Stress Cracking (ESC) and Metal Ion Oxidation (MIO) resistance of processed polyurethane tubing extruded from 80A and 55D resins. These modifications are discussed in the following section.

a. Biostability Screening Tests Performed on 55D inner and 80A outer Polyurethane Insulation

Lead Model 4016A is a bipolar polyurethane lead which utilizes 55D inner and 80A outer polyurethane insulation. The insulation material and configuration of the Model 4068 is identical to the Model 4016A (the Model 4016A is the predecessor to the Model 4058M) lead. Testing performed on the Model 4016A indicates the combination of 55D inner insulation coupled with 80A outer insulation to be a reliable lead body.

b. Polyurethane Lead Reliability

Medtronic utilizes two systems to monitor performance of its brady pacing leads. The analysis of returned product is used to identify lead failure mechanisms. However, it cannot be used to estimate clinical performance since all leads/lead segments are not explanted or returned. Clinical performance is monitored through the Medtronic Chronic Lead Study (CLS), a multi-center study involving eleven representative U.S. clinical centers and over 20,000 leads. Lead performance in the CLS is presented as actuarial survival from clinical complications resulting in lead explants or abandonment. Specific complication criteria have been established. Since all leads are not explanted it is not always possible to relate a clinical complication to a specific failure mechanism and not all lead complications are associated with lead failure.

The biostability/lead performance for the Model 4068 can be estimated by comparing it to similar lead designs. The lead models used for comparison are the Model 4058M, the Model 4016A and the Model 4016 with survival probabilities determined by the CLS.

Comparing these bipolar lead bodies shows: all the leads used the same outer insulation, the same inner insulation material with similar dimensions, and the same outer coil (except the Model 4016 which uses non-barrier coated wire). There is a difference in

inner coil design, however, testing has shown their performance to be similar. Given these similarities in lead body construction and materials the survival probability for the Model 4068 should be the same as the Model 4058M or the Model 4016A. The survival probabilities for the comparison models as determined by the CLS are as follows:

Model 4058M (3405 CLS implants; 83,556 total implants)

Atrium - 97.8% at 60 months
Ventricle - 95.1% at 60 months

Model 4016A (138 CLS implants; 3,846 total implants)

Atrium - 98.1% at 36 months
Ventricle - 100% at 18 months

Model 4016 (403 CLS implants; 8,199 total implants)

Atrium - 97.5% at 60 months
Ventricle - 95.1% at 60 months

Both the Model 4058M and the Model 4016A have excellent clinical performance in the atrium as well as the ventricle. The Model 4016 was included to show that the survival probability for a similar lead body without barrier-coated coils exceeds 95% after 60 months implantation in both the atrium (97.5%) and the ventricle (95.1%).

B. Animal Studies

Canine studies were conducted to evaluate the performance of the steroid eluting extendable/retractable screw-in lead. The following tests were conducted:

1. In-Vivo Electrical Testing

Canine testing has been conducted to evaluate in-vivo electrical performance and pathological characteristics of the Model 4068 lead. In this analysis Model 4068 canine data was compared to the Model 4058M (retractable screw-in lead) canine data. The Model 4058M served as the control for both the canine and human clinical evaluations due to the similarity in design.

Eight model 4068 leads were implanted in both the right atrial appendage and right ventricle of healthy canines. Electrical characteristics for each lead were measured at implant, and again at intervals of 1, 2, 3, 4, 8, and 12 weeks post implant. Data collection included pacing voltage thresholds and P and R-wave amplitudes as appropriate.

There were no statistically significant differences between the Models 4068 and 4058M

for chronic atrial or ventricular voltage thresholds, chronic P-wave amplitudes, chronic R-wave amplitudes. The Model 4068 did not exhibit the threshold peaking phenomenon of the Model 4058M lead.

2. Gross and Histopathological Analysis

Gross findings confirmed that all but 1 electrode had secure lead placement sites; 13 screws were firmly embedded in the myocardial tissue with no untoward findings noted. The 14th lead, a 4058M, had dislodged after three weeks into the study. Necropsy confirmed that a repositioning attempt was not fully successful as both an x-ray and the necropsy showed that the helix tissue attachment was not adequate. Data from this animal was not used in the electrical analysis. Histopathological results indicated lead/electrode/tissue responses were typical of well fixed, stable, steroid eluting leads. No untoward responses were noted.

C. Summary of Clinical Studies

The Model 4068 extendable/retractable, screw-in, steroid lead was clinically evaluated to validate the safe and effective performance of the lead when used for cardiac pacing and sensing. The Model 4068 clinical study was a randomized concurrent controlled study using a 3:1 randomization ratio of patients receiving the Model 4068 leads to patients receiving the control lead (the control lead was the currently marketed Model 4058M, a bipolar, non-steroid, extendable/retractable, screw-in lead). Patients received either a single or dual chamber implant. If a dual chamber study lead implant was performed, the same lead was implanted in both the atrium and ventricle. Subjects were stratified into two groups according to whether or not they had a prior history of exit block. Those patients with a history of exit block were initially not randomized with the control lead due to the preference of the investigators not to subject this group of patients to potential implant of a non-steroid control lead due to their prior complications. However, as study progressed the exit block patients were randomized to the control lead under a separate 3:1 randomization schedule.

The non-exit block pacing patients represent the majority of patients enrolled in the study (92.4%). These patients' data form the basis for the comparative analyses (Model 4068 study lead vs. the Model 4058M control lead).

Implant handling data was collected at implant in addition to electrical data (pacing thresholds, P/R-wave amplitude, and impedance), these data were also gathered at all follow-up visits. Complications were required to be reported whenever they occurred.

1. Subject Selection and Exclusion Criteria

The patient selection criteria utilized in this investigation included candidates for first pacing system implantation or current pacemaker patients in need of bipolar lead replacement. Patients may have had indications for either single chamber or dual chamber pacing. There were no specific patient exclusion criteria beyond those contraindications stated in the device labeling. Patients who were eligible and willing to participate (documented by signing the informed consent) were enrolled in the study.

2. Objectives

The objectives of the Model 4068 clinical study were to determine the safety and effectiveness of the Model 4068 lead in comparison to the Model 4058M lead. The safety objectives are: the Model 4068 will not have reduced survival from lead-related events, the Model 4068 will not have reduced survival from lead-related complications, the Model 4068 atrial or ventricular lead-related event rate will not exceed 12% for any individual event, and the ventricular perforation rate will not exceed 5%. To evaluate the effectiveness of the steroid on lead performance a comparison to the Model 4058M lead were: the acute Model 4068 stimulation thresholds (up to six weeks post implant) will be superior to the Model 4058M thresholds, the Model 4068 will not exhibit stimulation threshold peaking, the acute Model 4068 sensing performance will not be statistically lower than the Model 4058M, the acute Model 4068 pacing impedance will not be statistically lower than the Model 4058M, the chronic (12 weeks post implant) Model 4068 stimulation thresholds will not be statistically higher than the Model 4058M, the chronic Model 4068 sensing performance will not be statistically lower than the Model 4058M, and the chronic Model 4068 pacing impedance will not be statistically lower than the Model 4058M.

3. Study Population

There were no statistical differences between the population of 413 randomized patients who received 669 (298 atrial and 371 ventricular) Model 4068 leads and 134 randomized patients who received 215 (98 atrial and 117 ventricular) Model 4058M leads. The mean age of the Model 4068 randomized group was 67.4 years, and the mean age of the Model 4058M group was 69.3 years. There were 263 males (63.7%) and 150 females (36.3%) in the Model 4068 group. In the Model 4058M group, there were 83 (61.9%) males and 51 (38.1%) females. One-hundred and sixty-three (163) patients in the Model 4068 group received a single chamber study lead (Model 4068) implant, and 253 patients received dual chamber study lead implants in that group. Fifty-three (53) patients in the Model 4058M group received a single chamber Model 4058M lead, and 81 patients received dual chamber Model 4058M implants in that group.

Investigators were asked to record the indications for pacing at implant. As indicated in Table 1 a statistical comparison of the randomized Model 4068 vs. Model 4058M groups shows no statistically significant difference in the two populations.

TABLE 1
INDICATIONS FOR PACING
MODEL 4068 RANDOMIZED VS. MODEL 4058M RANDOMIZED GROUPS

Comparison Variable	Sample Size	Results	P-value
Patient Age	4068 (n = 413)	67.4 ± 14.5	0.1362 Student's T-test
	4058M (n = 134)	69.3 ± 12.4	
Patient Gender	4068 (n = 413)	Male 263 (63.7%) Female 150 (36.3%)	0.717 Chi-squared
	4058M (n = 134)	Male 83 (61.9%) Female 51 (38.1%)	
Atrial Normal Rhythm	4068 (n = 122) 4058M (n = 38)	Not Applicable	0.794 Chi-squared
Atrial Tachyrrhythmia	4068 (n = 162) 4058M (n = 51)	Not Applicable	0.810 Chi-squared
Atrial Sinus Bradycardia	4068 (n = 193) 4058M (n = 64)	Not Applicable	0.836 Chi-squared
Ventricular Normal Rhythm	4068 (n = 254) 4058M (n = 73)	Not Applicable	0.150 Chi-squared
Ventricular Tachyrrhythmia	4068 (n = 31) 4058M (n = 15)	Not Applicable	0.181 Chi-squared
Ventricular Other Rhythms	4068 (n = 26) 4058M (n = 10)	Not Applicable	0.636 Chi-squared
First Degree Block	4068 (n = 40) 4058M (n = 18)	Not Applicable	0.221 Chi-squared
Second Degree Block	4068 (n = 57) 4058M (n = 23)	Not Applicable	0.338 Chi-squared
Third Degree Block	4068 (n = 180) 4058M (n = 65)	Not Applicable	0.319 Chi-squared
Congestive Heart Failure	4068 (n = 81) 4058M (n = 18)	Not Applicable	0.106 Chi-squared
Pacemaker Dependence	4068 (n = 115) 4058M (n = 43)	Not Applicable	0.502 Chi-squared
Previous Myocardial Infarct	4068 (n = 73) 4058M (n = 26)	Not Applicable	0.652 Chi-squared
Previous Cardiac Surgery	4068 (n = 92) 4058M (n = 30)	Not Applicable	0.978 Chi-squared

Note: Using the Hochberg Multiple Comparison Procedure- No P-values are considered to be statistically significant.

4. Gender Bias Analysis

Medtronic's leads registration data base indicates that 49% of the patients implanted within the last five years are male and 48% are female (3% are unknown). The clinical study of the Model 4068 lead indicates that 64% (263) were males and 36% (150) were females, the Model 4058M lead had 62% (83) males and 38% (51) were females. Since the indications for the device are not gender related and since there is a sizable number of both males and females enrolled for both the study and control devices in the study, there is no concern related to the performance of the Model 4068 in either gender.

5. Effectiveness Data

Data and information reported on all implant, 4 week, 3 month, 6 month, 18 month, and 24 month follow-up forms for the 547 patients in the randomized group (with no prior history of exit block) were included in the evaluation of the Model 4068 lead performance.

a. Comparison of Electrical Performance of the Randomized Groups

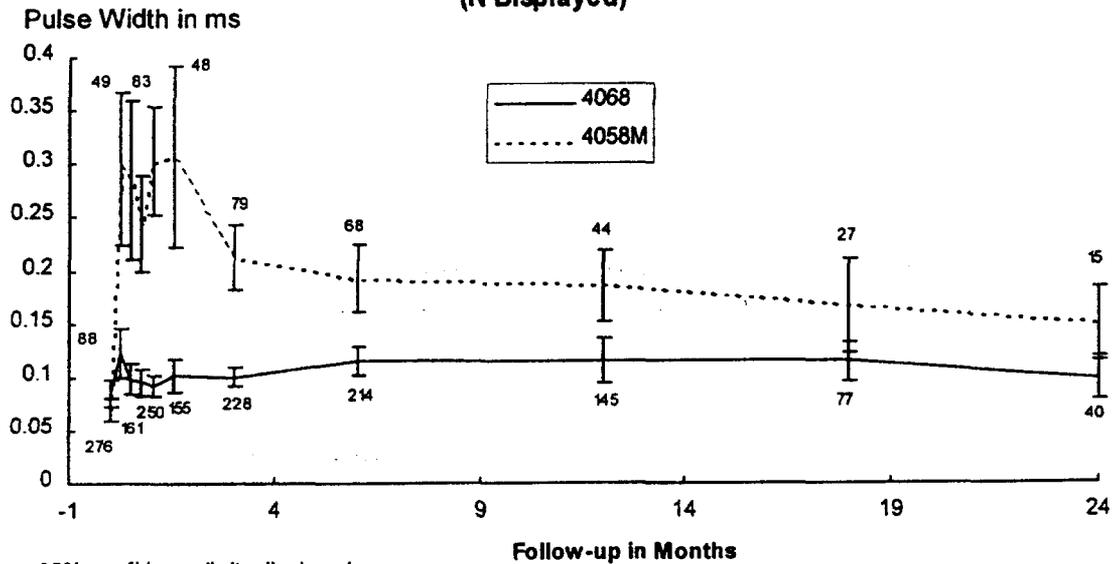
The analyses for pacing thresholds were done on the data collected at 2.5 Volts. This voltage was chosen since it represents the amplitude at which the most patients in both groups (Models 4068 and 4058M) had pulse width thresholds which were neither too high (unable to capture) nor too low (unable to lose capture). This amplitude therefore offered the most accurate comparison. The atrial and the ventricular comparative electrical data are presented separately in graphical form.

i. Atrial Pacing Thresholds

The Model 4068 atrial pulse width thresholds are statistically significantly lower than the Model 4058M acutely at implant and 4 weeks. The Model 4068 atrial pulse width thresholds are also statistically significantly lower chronically at 3 months, 6 months, 12 months, 18 months, and 24 months post implant. The Model 4068 atrial pulse width thresholds do not exhibit a "peaking phenomenon" during the acute period of implant to 6 weeks.

FIGURE 1

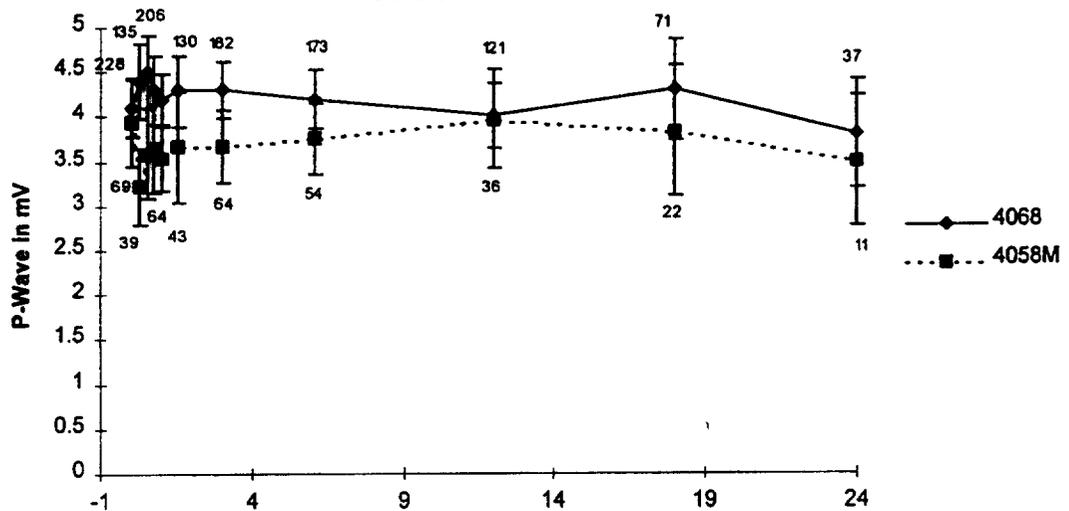
**Model 4068 vs. 4058M
Atrial Pulse Width Thresholds at 2.5V
(N Displayed)**



ii. P-wave amplitude

The Model 4068 P-wave amplitude is not statistically significantly different from the Model 4058M acutely at implant and 4 weeks, it is statistically significantly different at 3 months, but not at 6 months, 12 months, 18 months, or 24 months post implant.

FIGURE 2
Atrial P-Wave Sensing
4068 vs. 4058M



Note: 95% confidence limits displayed
N displayed

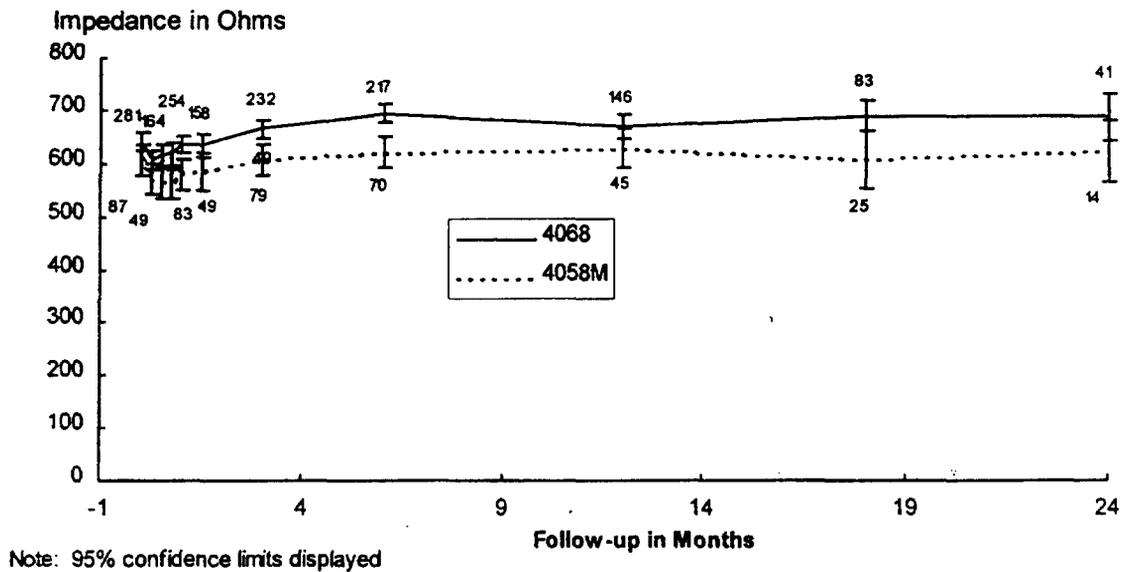
Follow-up in Months

iii. Atrial Impedance

The Model 4068 atrial pacing impedance is statistically significantly higher from that of the Model 4058M at implant and 4 weeks, and it is statistically significantly higher at 3 months, and 6 months, but not significant at 12 months, is statistically significantly higher at 18 months, but not significant at 24 months post implant.

FIGURE 3

Model 4068 vs. 4058M
Atrial Impedance at 2.5V/0.5 ms
(N Displayed)

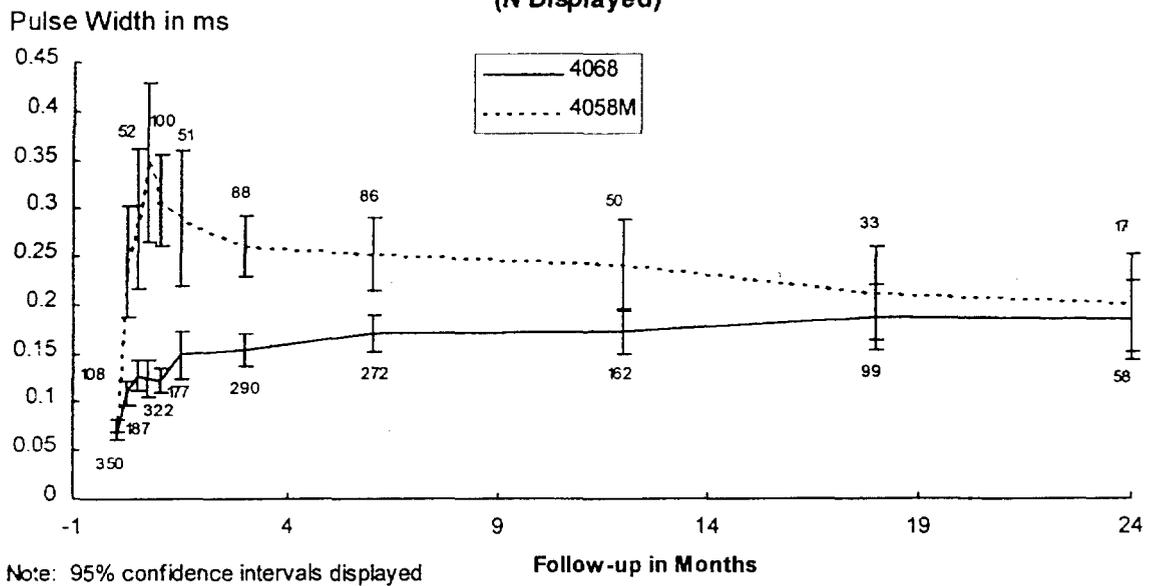


iv. Ventricular Pacing Thresholds

The Model 4068 ventricular pulse width thresholds are statistically significantly lower than the Model 4058M acutely at implant and 4 weeks. The Model 4068 also has statistically significantly lower thresholds than the Model 4058M chronically at 3 months and at 6 months, and at 12 months. There is no statistically significant difference at 18 months or 24 months post implant. The Model 4068 ventricular pulse width thresholds do not exhibit a "peaking phenomenon" during the acute period of implant to six weeks.

FIGURE 4

Model 4068 vs. 4058M
Ventricular Pulse Width Thresholds at 2.5V
(N Displayed)

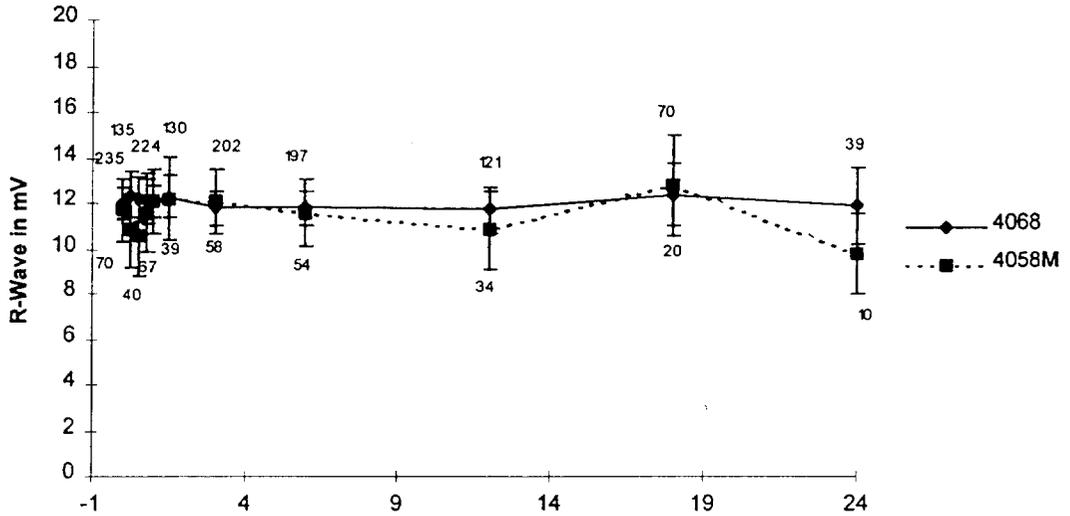


v. R-wave Amplitude

The Model 4068 R-wave amplitude is not statistically significantly different than the Model 4058M at implant and 4 weeks, nor is it statistically significantly different at 3 months, 6 months, 12 months, 18 months, or 24 months post implant.

FIGURE 5

Ventricular R-Wave Sensing
4068 vs. 4058M



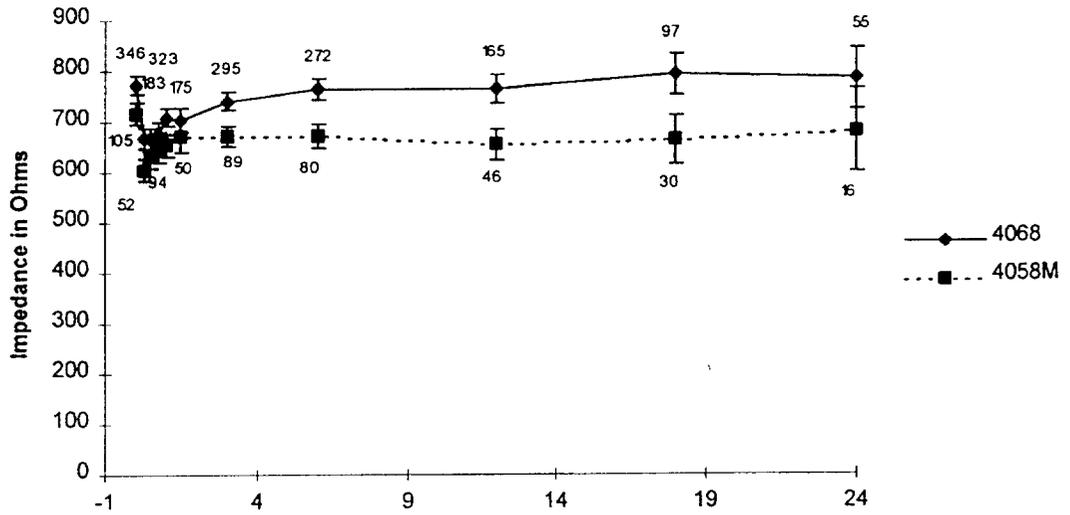
Note: 95% confidence limits displayed
N displayed

vi. Ventricular Impedance

The Model 4068 ventricular pacing impedance is statistically significantly higher than that of the Model 4058M acutely at implant and 4 weeks. The ventricular pacing impedance is also statistically significantly higher chronically at 3 months, 6 months, 12 months, and 18 months, but it is not statistically significantly higher at 24 months post implant.

FIGURE 6

Ventricular Impedance at 2.5V/0.5 ms
4068 vs. 4058M



Note: 95% confidence intervals displayed
N displayed

6. Safety Data

a. Complications

The clinical investigation of the Model 4068 Pacing Lead studied 669 devices implanted in 413 patients for a total of 7753 cumulative device months of experience (3516 Atrial, 4237 Ventricular). Thirty-eight patients with Model 4068 pacing leads died during the course of the clinical study. One of these deaths was a result of cardiac perforation following lead placement. None of the remaining deaths was determined to be lead related. Adverse events (lead related), including 28 complications and 36 observations, were reported during the clinical investigation. The adverse events which occurred more than one time are summarized in the tables below. Lead related observations are defined as adverse events which are corrected by non-invasive measures (e.g. reprogramming). Lead related complications are defined as adverse events that are corrected using invasive measures which result in the loss of a significant device function.

Atrial Leads

Type of AE ¹	# of Leads (n=298)	% of Leads	# of Patients (n=297)	% of Patients [CI]
Observations²				
Loss of Sensing/Undersensing	8	2.68	8	2.69 [0.9-4.5%]
Difficulty with Placement/Fixation	3	1.01	3	1.01 [0.4-3.0%]
Muscle or Nerve Stimulation	3	1.01	3	1.01 [0.4-3.0%]
Loss of Capture/Elevated Thresholds	2	0.67	2	0.67 [0.3-2.5%]
Oversensing	2	0.67	2	0.67 [0.3-2.5%]
Total Observations	18	6.04	18	6.06 [3.3-8.8%]
Complications³				
Lead Dislodgement	7	2.35	7	2.36 [0.6-4.1%]
Difficulty with Placement/Fixation	3	1.01	3	1.01 [0.4-3.0%]
Exit Block	2	0.67	2	0.67 [0.3-2.5%]
Total Complications	12	4.03	12	4.04 [1.8-6.3%]

¹ AE is defined as lead related adverse event(s).

² Observations are adverse events which are corrected by non-invasive measures (e.g. reprogramming).

³ Complications are adverse events that are corrected using invasive measures to correct or which result in the loss of a significant device function.

Ventricular Leads

Type of AE ¹	# of Leads (n=371)	% of Leads	# of Patients (n=369)	% of Patients [CI]
Observations²				
Loss of Capture/Elevated Thresholds	5	1.35	5	1.35 [0.6-3.2%]
Muscle or Nerve Stimulation	3	0.81	3	0.81 [0.3-2.4%]
Cardiac Perforation	2	0.54	2	0.54 [0.2-2.0%]
Exit Block	2	0.54	2	0.54 [0.2-2.0%]
Loss of Sensing/Undersensing	2	0.54	2	0.54 [0.2-2.0%]
Total Observations	14	3.77	14	3.79 [1.8-5.7%]
Complications³				
Lead Dislodgement	7	1.89	7	1.90 [0.5-3.3%]
Cardiac Perforation	6	1.62	6	1.63 [0.3-2.9%]
Muscle or Nerve Stimulation	2	0.54	2	0.54 [0.2-2.0%]
Total Complications	15	4.04	15	4.06 [2.1-6.1%]

¹ AE is defined as lead related adverse event(s).

² Observations are adverse events which are corrected by non-invasive measures (e.g. reprogramming).

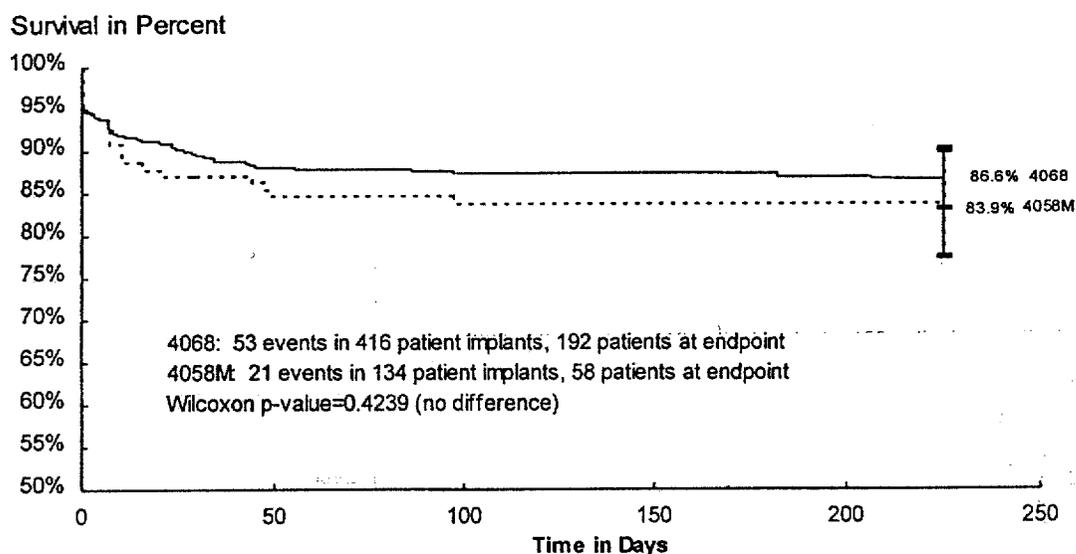
³ Complications are adverse events that are corrected using invasive measures to correct or which result in the loss of a significant device function.

b. Clinical Event Analysis

Kaplan-Meier Survival Analysis for the lead related events (complications and observations) to six months of the randomized Model 4068 population compared to the Model 4058M population shows no statistically significant difference.

FIGURE 7

Survival Analysis to 6 Months Overall Lead-Related Clinical Events 4068 vs. 4058M



Survival analysis of each type of lead related event shows that the observed event rate for any type of atrial event is less than 3% and for any type of ventricular event is less than 3%. Also, the 95% confidence upper bound for any atrial lead related event is 5% or less and for any ventricular lead related event is 5% or less.

c. Unanticipated Adverse Device Effects (UADE)

In May of 1992, Medtronic filed a supplement to their IDE application reporting a UADE due to four ventricular perforations at implant (out of 67 ventricular implants) with a Model 4068 lead. Three patients developed cardiac tamponade and one patient developed moderate pericardial effusion. Of the three patients with tamponade, one patient died and two recovered after pericardial taps. The patient with effusion recovered without intervention. After evaluation of the lead design and conclusion that design was not the issue, the corrective action taken by Medtronic consisted of distribution of ventricular implant guidelines for avoiding perforation. These guidelines were developed by investigators in the study who routinely use screw-in leads in the ventricle. Since the corrective action, there have been 398 ventricular Model 4068 implants with four further cases of perforation at implant (of these four reported perforations, one was a suspected perforation (reported as such due to pain felt by patient during implant). In another of the incidences, the ventricular implant guidelines were admittedly not followed.) All four patients recovered and no further events were noted at follow-up.

7. Patient Discontinuation

There were 91 patients who did not complete the study. Fifty-four (54) patients died during the course of the study. There were 36 deaths in the Model 4068 randomized group, 15 deaths in the Model 4058M randomized group, 2 deaths in the 4068 Exit Block group, and 1 death in the non-randomized exit block group. Fifteen (15) patients had their study leads removed and did not have them replaced. These 15 patients did not have any study leads left in, and therefore no longer continued in the study. Twenty-two (22) patients were lost to follow-up.

8. Device Failures and Replacements

There were no device failures during the course of this study.

XI. Conclusions Drawn From The Studies

The results of the laboratory and animal testing and human clinical trials of the CapSureFix® Model 4068 show that it performs according to the design intent and is reasonably safe and effective for use.

Nonclinical laboratory studies included electrical, functional, and mechanical/environmental testing. All requirements were satisfied and the devices performed according to specification. Animal testing conducted included electrical, biostability and biocompatibility evaluation at the component and device level. Results demonstrated proper device operation. All of the tissue-contacting materials in the Model 4068 pacing lead has been tested for biocompatibility. All components and devices tested met all test requirements and performed within design specification. Several changes

were made to the labeling as a result of the clinical experience, notably the implant guidelines, which were modified to reduce the potential of ventricular perforation.

It is concluded that the clinical evaluation of the Model 4068 lead has demonstrated that, when implant guidelines are followed, the lead is safe and effective, and that its pacing threshold is lower than that of the Model 4058M during the acute period. In addition, the Model 4068 lead will support a longer pulse generator battery life for the atrial or ventricular screw-in lead recipient at 2.5 Volts due to its lower acute thresholds and higher chronic impedance (than the Model 4058M).

XII. Panel Recommendation

Pursuant to section 515(f)(2) of the act as amended by the Safe Medical Devices Act of 1990, this PMA was not referred to the Circulatory Support Devices Panel, as an FDA advisory panel, for review and recommendation because the information in the PMA substantially duplicated information previously reviewed by this panel.

XIII. FDA Decision

The company was in compliance with the Good Manufacturing Practice (GMP) regulations 21 CFR Part 820.

XIV. Approval Specification

Continued approval of the device is contingent upon the submission of post-approval reports to the Food and Drug Administration as described in the "Conditions of Approval" enclosed in the approval letter. An additional condition of approval is that, within 6 months of the date of approval of the PMA, a test protocol designed to confirm the long term flex fatigue resistance of the distal aspect of the Model 4068 lead be submitted.

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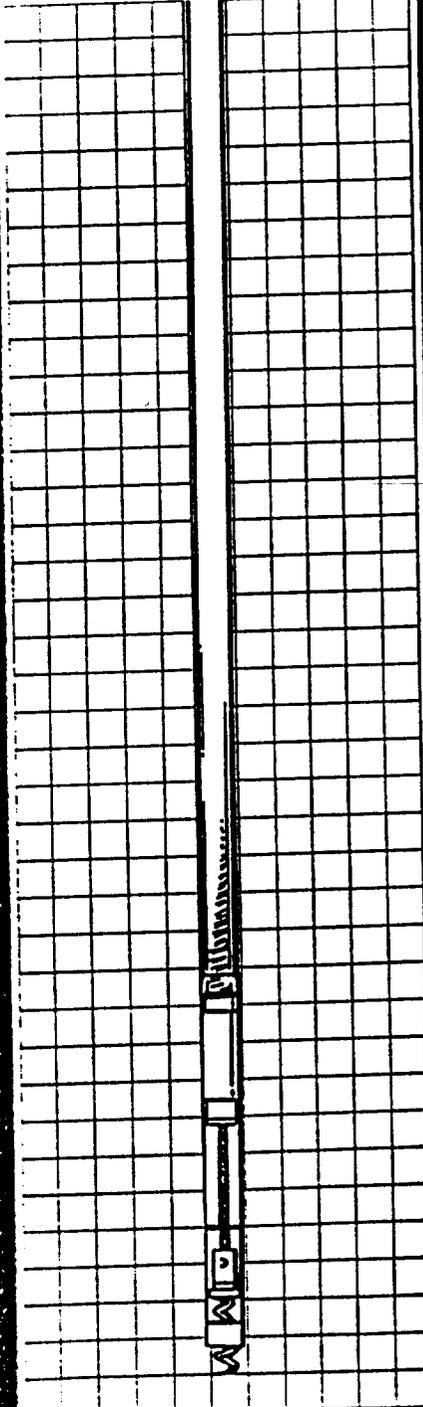
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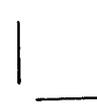
CAPSUREFIX®

4068

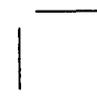
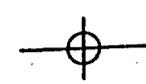
Energy Storage for External Use
Screw-In, Variable Voltage, Energy Storage Device



Technical Manual



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TECHNICAL MANUAL

CAPSUREFIX[®] STEROID ELUTING, BIPOLAR, IMPLANTABLE, SCREW-IN, VENTRICULAR/ATRIAL, TRANSVENOUS LEAD



MODEL 4068



Caution: Federal Law restricts this device to sale by or on the order of a physician
(or properly licensed practitioner).

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TABLE OF CONTENTS

Device Description	1	Directions for Use	17
Contents of Package	1	Verifying the Mechanical Functioning of the Helix Electrode	17
Indications for Use	1	Using the Stylet Guide and Stylets	18
Contraindications	1	Selecting an Insertion Site	19
Warnings	2	Using the Vein Lifter	20
Precautions	2	Positioning the Lead in the Ventricle	20
Necessary Hospital Equipment	2	Positioning the Lead in the Atrium	22
Inspecting the Package	2	Securing the Electrode into the Endocardium	22
Before Inserting the Lead	2	Taking Electrical Measurements	25
Handling the Lead	2	Anchoring the Lead	27
Steroid Elution	3	Connecting the Lead to a Pulse Generator	29
Steroid Elution and Exit Block	3	Detailed Device Description	31
Chronic Repositioning	3	Specifications	31
Ensuring Product Integrity	4	Special Notice	32
Adverse Events	5	Service	32
Potential Complications	8		
Clinical Trials	10		
Summary	10		

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DEVICE DESCRIPTION

The Medtronic® Model 4068, CapSureFix®, Screw-In, Steroid Eluting, Bipolar, Implantable, Ventricular/Atrial, Transvenous Lead is designed for pacing and sensing applications in either the atrium or ventricle.

The distal tip contains a maximum of 1.0 mg dexamethasone sodium phosphate. Upon exposure to body fluids, the steroid elutes from the lead tip. The steroid is known to suppress the inflammatory response that is believed to cause threshold rises typically associated with implanted pacing electrodes.

The lead has a helical tip electrode made of platinum alloy that can be actively fixed in the endocardium. The helix can be extended or retracted by rotating the lead connector pin with a special fixation tool. An active fixation lead is particularly beneficial for patients who have smooth or hypertrophic hearts where lead dislodgement may be a potential problem.

The lead also has a second, larger electrode proximal to the tip electrode and an IS-1* Bipolar (BI) connector with one terminal pin. It features MP35N nickel-alloy conductors and polyurethane insulation.

*IS-1 BI refers to an International Connector Standard (ISO 5841-3:1992 [E]) whereby pulse generators and leads so designated are assured of a basic mechanical fit.

Contents of Package

The leads is supplied sterile. Each package contains:

- 1 lead with anchoring sleeve, stylet, and stylet guide
- 1 vein lifter
- 2 fixation tools
- Extra stylets
- Product literature

INDICATIONS FOR USE

The Model 4068 lead is designed to be used with a pulse generator as part of a cardiac pacing system. The lead has application where implantable atrial or ventricular, single chamber or dual chamber pacing systems are indicated.

CONTRAINDICATIONS

When tricuspid valvular disease is present, use of a ventricular transvenous lead is contraindicated.

The use of an endocardial ventricular lead is contraindicated in patients with mechanical tricuspid heart valves.

Do not use a steroid eluting lead in patients for whom a single dose of 1.0 mg of dexamethasone sodium phosphate may be contraindicated.

WARNINGS

An implanted lead forms a direct current path to the myocardium. Therefore, use only battery-powered equipment during lead implantation and testing to protect against fibrillation that may be caused by alternating currents. Line-powered equipment used in the vicinity of the patient must be properly grounded. Lead connector pins must be insulated from any leakage currents that may arise from line-powered equipment.

PRECAUTIONS

Necessary Hospital Equipment

Defibrillating equipment should be kept nearby for immediate use during the implantation procedure.

Inspecting the Package

Inspect the lead sterile package prior to opening. If the seal or package is damaged, contact your local Medtronic representative.

Before Inserting the Lead

Use an anchoring sleeve with all leads. Ensure that the anchoring sleeve is positioned close to the lead connector pin. This will prevent inadvertent passage of the sleeve into the vein. If wiping the lead is necessary prior to insertion, ensure that the anchoring sleeve remains in position.

Handling the Lead

Leads should be handled with great care at all times. Any severe bending, kinking, stretching, handling with surgical instruments or excessive force when inserting a stylet may cause permanent damage to the lead. If the lead is damaged, do not implant it. Return the lead to your Medtronic representative.

Lead insulators attract small particles such as lint and dust. Therefore, to minimize contamination, protect the lead from materials shedding these substances. Handle the lead with sterile surgical gloves that have been rinsed in sterile water or equivalent.

Do not immerse leads in mineral oil, silicone oil or any other liquid.

The maximum number of revolutions (using the fixation tool) needed to extend or retract the helix for initial placement is stated in the section titled "Specifications." Prior to implantation, the helix should be exercised, as on the initial extension more turns may be required to extend it or it may extend suddenly when torque is built up. At implantation, while using fluoroscopy, refer to Figure 13 to identify helix extension and retraction. Overrotation of the connector pin may result in fracture or distortion of the inner conductor or retraction of the helix out of its channel.

Steroid Elution

It has not been determined whether the warnings, precautions, or complications usually associated with injectable dexamethasone sodium phosphate apply to the use of this highly-localized, controlled-released device. For a listing of potentially adverse effects, refer to the dexamethasone sodium phosphate manufacturer

prescribing information or the *Physicians' Desk Reference*.

Do not allow the electrode surface to come in contact with surface contaminants. Do not wipe or immerse the electrode in fluid. Such treatment of a steroid eluting lead will reduce the amount of steroid available when the lead is implanted and may adversely affect low-threshold performance.

Steroid Elution and Exit Block

Although the addition of steroid to passive fixation leads has been shown to reduce pacing thresholds in patients with a history of exit block, the frequency of redevelopment of exit block was not statistically different between the steroid eluting and non-steroid eluting screw-in leads in this clinical trial.

Chronic Repositioning

Chronic repositioning or removal of screw-in leads may not be possible because of blood or fibrotic tissue development into the helix mechanism. Removal of the lead may result in avulsion of the endocardium, valve or vein. In addition, the lead junctions may separate, leaving the lead tip and bare wire in the heart or vein. In most clinical situations, it is preferable to abandon unused leads in place.

However, if a lead must be removed or repositioned, proceed with extreme caution. If a helix does not disengage from the endocardium by rotating the connector pin, rotating the lead body counterclockwise may withdraw the helix and decrease the possibility of damage to the cardiovascular structures during removal. If a lead is removed, inspect it carefully for insulator or conductor coil damage. (Medtronic requests that all removed or unused leads or portions thereof be returned for analysis).

If a lead is abandoned, it should be capped to avoid transmitting electrical signals from the pin to the heart. A lead that has been cut off should have the remaining lead end sealed and it should be sutured to adjacent tissue to avoid migration into the heart.

Chronic repositioning may adversely affect a steroid lead's low-threshold performance.

See additional cautions in the section titled "Directions for Use."

Ensuring Product Integrity

Carefully inspect the sterile package before opening. It is not recommended that you use the product after its expiration date.

If the integrity of the sterile package has been compromised prior to the product expiration date, place the contents in a gas-permeable package and resterilize it with ethylene oxide as described below.

CAUTION: Use ethylene oxide only. Do not resterilize more than one time.

The process should not exceed temperatures of 55°C (130°F). Allow proper aeration of ethylene oxide residues prior to implantation. Use some acceptable method to determine sterilizer effectiveness, such as a biological indicator.

Due to the variability between sterilizers, precise sterilization instructions cannot be provided. Contact your sterilizer manufacturer for more information regarding sterilization procedures.

ADVERSE EVENTS

The clinical investigation of the Model 4068 Pacing Lead studied 669 devices implanted in 413 patients for a total of 7753 cumulative device months of experience (3516 Atrial, 4237 Ventricular). Mean duration of implantation was 12 months (range 0 - 33 months). Thirty-eight patients with Model 4068 pacing leads died during the course of the clinical study. One of these deaths was a result of cardiac perforation which occurred during lead implant. None of the remaining deaths was determined to be lead related. Lead related adverse events, including 28 complications and 36 observations, were reported during the clinical investigation. The adverse events, which occurred more than one time, are summarized in Tables 1 and 2 on the following pages.

Frequency of Adverse Events for Atrial Leads

Type of AE ¹	# of Leads (n=298)	% of Leads [CI]	# of Patients (n=297)	% of Patients [CI]
Observations²				
Loss of Sensing/Undersensing	8	2.7% [0.8 - 4.5%]	8	2.7% [0.9 - 4.5%]
Difficulty with Placement/Fixation	3	1.0% [0.4 - 3.0%]	3	1.0% [0.4 - 3.0%]
Muscle or Nerve Stimulation	3	1.0% [0.4 - 3.0%]	3	1.0% [0.4 - 3.0%]
Loss of Capture/Elevated Thresholds	2	0.7% [0.3 - 2.5%]	2	0.7% [0.3 - 2.5%]
Oversensing	2	0.7% [0.3 - 2.5%]	2	0.7% [0.3 - 2.5%]
Total Observations	18	6.0% [3.3 - 8.7%]	18	6.1% [3.3 - 8.8%]
Complications³				
Lead Dislodgement	7	2.4% [0.6 - 4.1%]	7	2.4% [0.6 - 4.1%]
Difficulty with Placement/Fixation	3	1.0% [0.4 - 3.0%]	3	1.0% [0.4 - 3.0%]
Exit Block	2	0.7% [0.3 - 2.5%]	2	0.7% [0.3 - 2.5%]
Total Complications	12	4.0% [1.8 - 6.3%]	12	4.0% [1.8 - 6.3%]

¹ AE is defined as lead related adverse event(s).

² Observations are adverse events which are corrected by non-invasive measures (e.g. reprogramming).

³ Complications are adverse events that are corrected using invasive measures to correct or which result in the loss of a significant device function

Table 1. Mean duration of implantation is 12 months (range 0 - 33 months).

Frequency of Adverse Events for Ventricular Leads

Type of AE ¹	# of Leads (n=371)	% of Leads [CI]	# of Patients (n=369)	% of Patients [CI]
Observations²				
Loss of Capture/Elevated Thresholds	5	1.4% [0.6 - 3.2%]	5	1.4% [0.6 - 3.2%]
Muscle or Nerve Stimulation	3	0.8% [0.3 - 2.4%]	3	0.8% [0.3 - 2.4%]
Cardiac Perforation	2	0.5% [0.2 - 2.0%]	2	0.5% [0.2 - 2.0%]
Exit Block	2	0.5% [0.2 - 2.0%]	2	0.5% [0.2 - 2.0%]
Loss of Sensing/Undersensing	2	0.5% [0.2 - 2.0%]	2	0.5% [0.2 - 2.0%]
Total Observations	14	3.8% [1.8 - 5.7%]	14	3.8% [1.8 - 5.7%]
Complications³				
Lead Dislodgement	7	1.9% [0.5 - 3.3%]	7	1.9% [0.5 - 3.3%]
Cardiac Perforation	6	1.6% [0.3 - 2.9%]	6	1.6% [0.3 - 2.9%]
Muscle or Nerve Stimulation	2	0.5% [0.2 - 2.0%]	2	0.5% [0.2 - 2.0%]
Total Complications	15	4.0% [2.0 - 6.0%]	15	4.1% [2.1 - 6.1%]

¹ AE is defined as lead related adverse event(s).

² Observations are adverse events which are corrected by non-invasive measures (e.g. reprogramming).

³ Complications are adverse events that are corrected using invasive measures to correct or which result in the loss of a significant device function

Table 2. Mean duration of implantation is 12 months (range 0 - 33 months).

Potential Complications

The potential complications related to the use of transvenous leads include, but are not limited to, the following patient-related conditions that can occur when the lead is being inserted and/or repositioned: valve damage (particularly in fragile hearts, e.g., infants), fibrillation and other arrhythmias, thrombolytic and air embolism, cardiac perforation, heart wall rupture, cardiac tamponade, muscle or nerve stimulation, pericarditis, pericardial rub, infection, myocardial irritability, thrombosis, and pneumothorax.

Other potential complications related to the lead and the programmed parameters include, but are not limited to, the following:

Potential Complication	Symptom	Corrective Action to be Considered
Lead dislodgement	Intermittent or continuous loss of capture or sensing*	Reposition the lead.
Lead conductor or helix fracture or insulation failure	Intermittent or continuous loss of capture or sensing*	Replace the lead. In some cases with a bipolar lead, the pulse generator may be programmed to a unipolar configuration or the lead may be unipolarized.
Threshold elevation or exit block**	Loss of capture*	Adjust the pulse generator output. Replace or reposition lead.

*Transient loss of capture or sensing may occur for a short time following surgery until lead stabilization takes place. If stabilization does not occur, lead dislodgement may be suspected.

**Evidence indicates that there is a higher frequency of exit block in the ventricle when using a screw-in lead. This should be considered when selecting a screw-in lead for use in the ventricle.

Potential acute/chronic complication associated with lead placement include, but are not limited to, the following:

Implant Technique	Potential Complication	Corrective Action
Forcing the lead through the introducer	Screw electrode and/or insulation damage	Replace the lead
Use of too medial of an approach with venous introducer resulting in clavicle and first rib binding	Conductor coil fracture, insulation damage	Replace the lead
Puncturing the pericostum and/or scadon when using subclavian introducer approach	Conductor coil fracture, insulation damage	Replace the lead
Advancing the lead into the venous insertion site and/or through the veins without the stylet fully inserted	Tip distortion and/or insulation perforation	Replace the lead

In addition, prolonged implant procedures or multiple repositions can allow blood or body fluids to build up on the helix mechanism. This may result in an increased number of revolutions required to extend or retract the helix, which may damage the lead.

CLINICAL TRIALS

SUMMARY

A multi-center, prospective, randomized control clinical study conducted at 42 investigational sites (in the United States, Canada and Europe) compared the Model 4068 steroid eluting lead to the non-steroid eluting Model 4058M active fixation lead. During the study, 413 patients received 669 Model 4068 leads and 134 patients received 215 Model 4058M leads.

Primary Objectives: Compare the Model 4068 lead to the Model 4058M control lead for:

- survival from lead related complications at three months
- pacing thresholds, sensing performance, and pacing impedance.

Results: Kaplan Meier survival from lead related complications at three months was 96.0% for the Model 4068 lead and 94.8% for the Model 4058M control lead. The Model 4068 lead exhibited lower pacing thresholds (Figures 1 and 4) than the non-steroid eluting lead acutely (1 to 6 weeks) and chronically (through 12 months). The sensing performance of the two leads was not statistically different (Figures 3 and 6). The steroid eluting lead had higher pacing impedance than the non-steroid lead acutely and chronically

which should result in increased pulse generator longevity (Figures 2 and 5). The acute threshold "peaking phenomenon" seen in non-steroid leads was not exhibited by the steroid eluting lead.

Although the addition of steroid to passive fixation leads has been shown to reduce pacing thresholds in patients with a history of exit block, the frequency of redevelopment of exit block was not statistically different between the steroid eluting and non-steroid eluting screw-in leads in this clinical trial.

Atrial Pulse Width Threshold at 2.5V
Model 4068 vs. 4058M

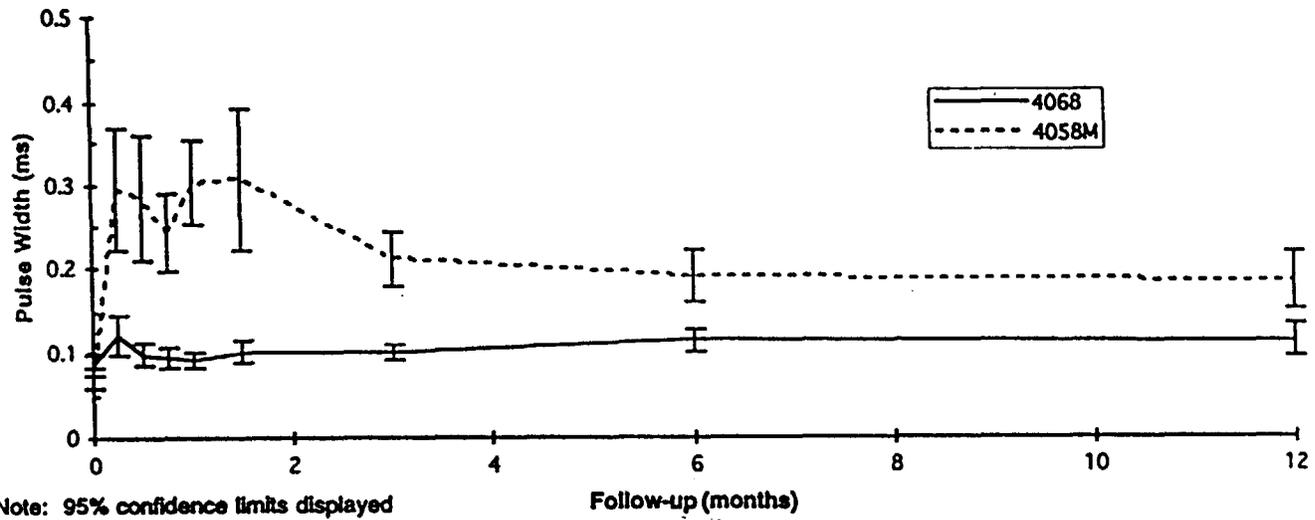


Figure 1. Atrial Pulse Width Threshold at 2.5 V, mean and 95% confidence intervals. Model 4068 steroid eluting leads (n=276 at 0, 145 at 12 months). Model 4058M non-steroid eluting leads (n=88 at 0, 44 at 12 months).

Atrial Impedance at 2.5V, 0.5ms
Model 4068 vs. 4058M

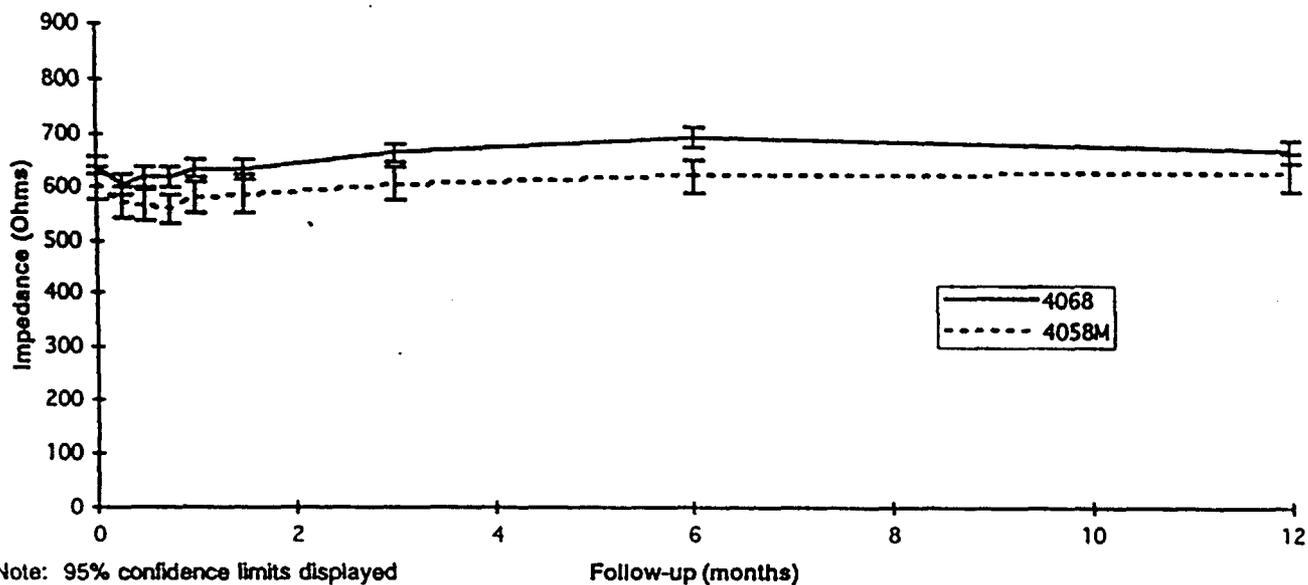


Figure 2. Atrial Impedance at 2.5 V, 0.5 ms, mean and 95% confidence intervals. Model 4068 steroid eluting leads (n=281 at 0, 146 at 12 months). Model 4058M non-steroid eluting leads (n=87 at 0, 45 at 12 months).

**Atrial P-Wave Sensing
Model 4068 vs. 4058M**

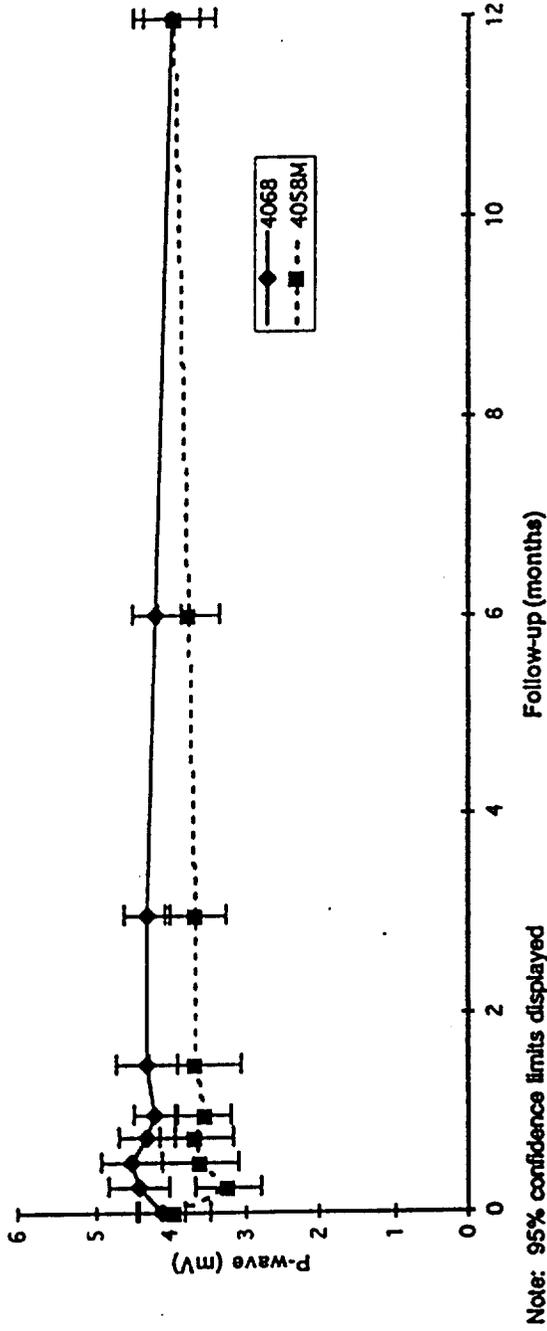


Figure 3. Atrial P-Wave Sensing, mean and 95% confidence intervals. Model 4068 steroid eluting leads (n=228 at 0, 121 at 12 months). Model 4058M non-steroid eluting leads (n=69 at 0, 36 at 12 months).

Ventricular Pulse Width Threshold at 2.5V Model 4068 vs. 4058M

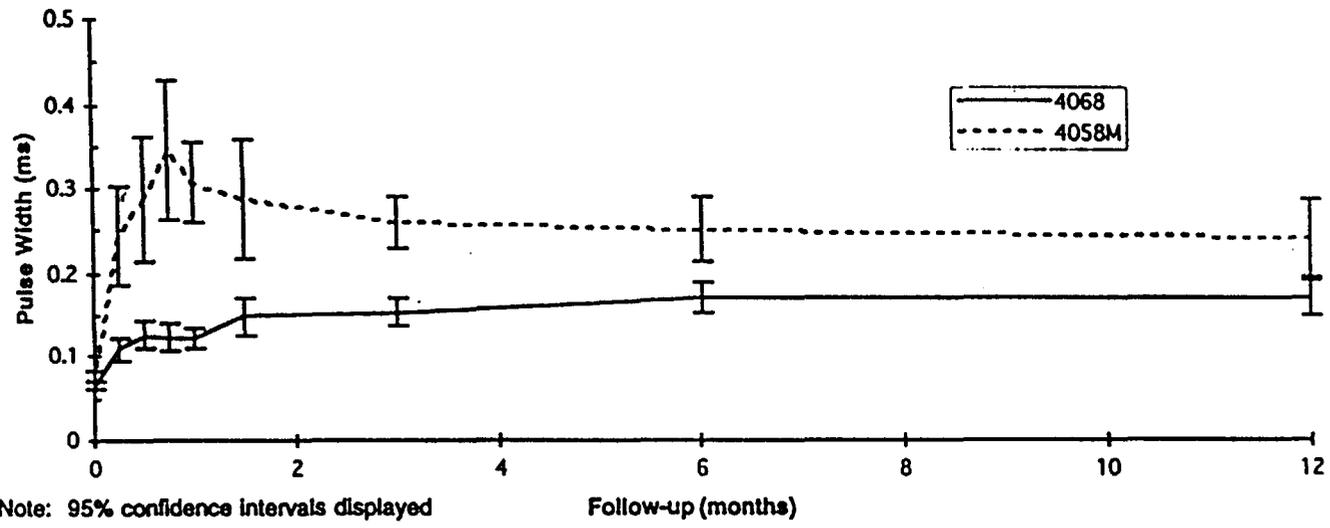
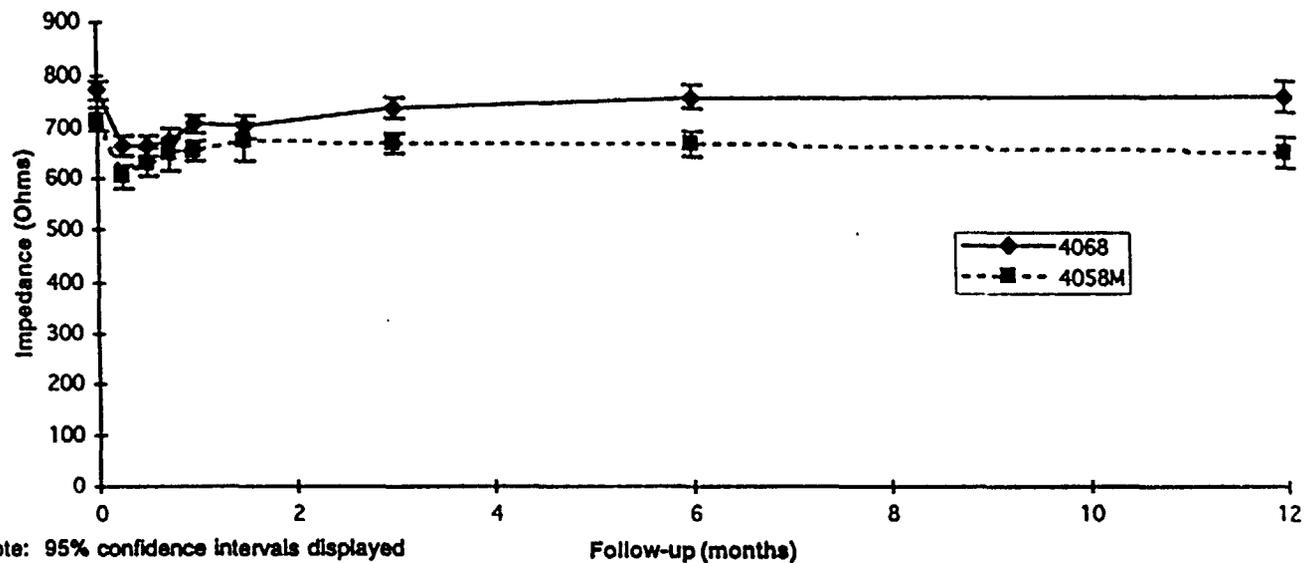


Figure 4. Ventricular Pulse Width Threshold at 2.5 V, mean and 95% confidence intervals. Model 4068 steroid eluting leads (n=350 at 0, 162 at 12 months). Model 4058M non-steroid eluting leads (n=108 at 0, 50 at 12 months).

Ventricular Impedance at 2.5V, 0.5ms
Model 4068 vs. 4058M



Note: 95% confidence intervals displayed

Figure 5. Ventricular Impedance at 2.5 V, 0.5 ms, mean and 95% confidence intervals. Model 4068 steroid eluting leads (n=346 at 0, 165 at 12 months). Model 4058M non-steroid eluting leads (n=105 at 0, 46 at 12 months).

Ventricular R-Wave Sensing Model 4068 vs. 4058M

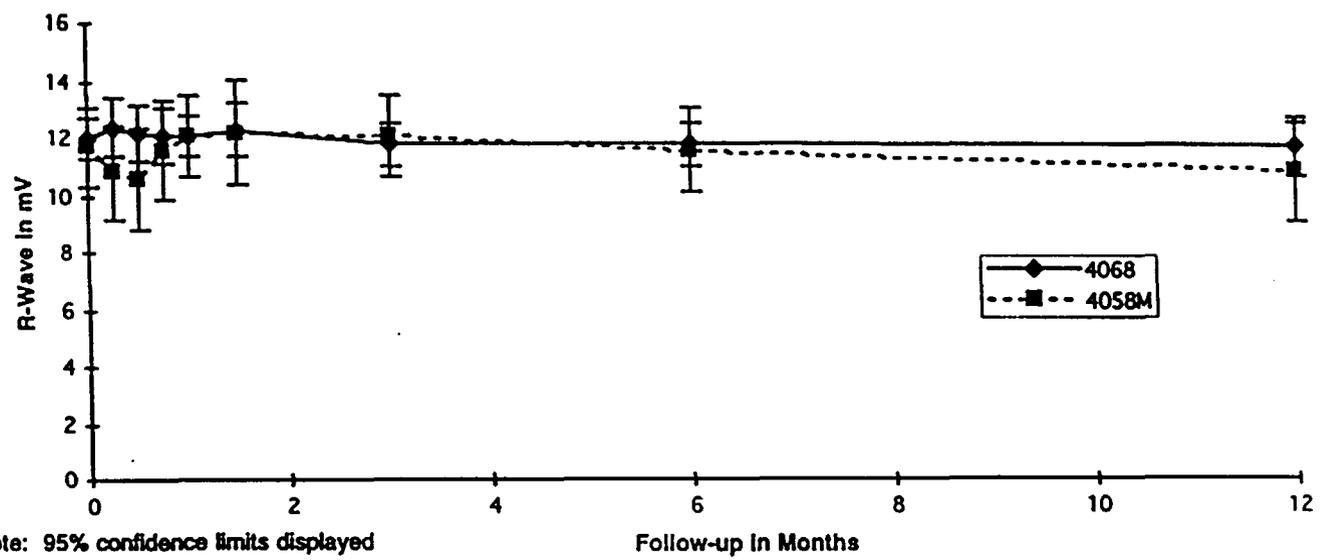


Figure 6. Ventricular R-Wave Sensing, mean and 95% confidence intervals. Model 4068 steroid eluting leads (n=235 at 0, 121 at 12 months). Model 4058M non-steroid eluting leads (n=70 at 0, 34 at 12 months).

DIRECTIONS FOR USE

The implantation procedure generally includes checking the mechanical functioning of the lead electrode before it is inserted; using a stylet guide, stylets, and vein lifter; selecting an insertion site; positioning the lead; securing the lead; taking electrical measurements; anchoring the lead; and connecting the lead to the pulse generator.

Some implantation techniques vary according to physician preference and the patient's anatomy or physical condition. As described below, the techniques for selecting an insertion site, using a stylet guide or a stylet, positioning a lead, and anchoring a lead suggest one or two possible versions, while more may exist.

Verifying the Mechanical Functioning of the Helix Electrode

Before implantation, verify the mechanical functioning of the electrode, as described below.

1. Within the sterile field, remove the lead and the accompanying stylets from the sterile packaging. Most leads are packaged with a stylet already inserted. If a stylet is not inserted, refer to "Using a Stylet and a Stylet Guide."

2. Press both legs of the fixation tool together and place the hole, marked A, of the fixation tool on the connector pin (Figure 7).

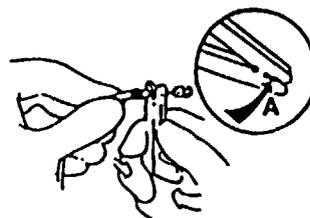


Figure 7. Attachment of the fixation tool to the connector pin.

3. Rotate the tool clockwise until the coiled electrode is completely exposed (Figure 8). Maximum electrode exposure reveals approximately 1 1/2 to 2 coils.

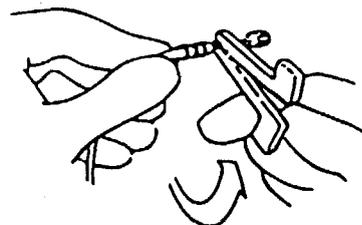


Figure 8. Rotating the fixation tool.

The maximum number of revolutions of the fixation tool needed to extend or retract the helix for initial placement is stated in the section titled "Specifications." The maximum number of revolutions depends on the particular lead model but will increase or decrease proportionately for longer or shorter leads. Any additional curvatures introduced to the stylet may increase the number of turns needed to extend or retract the helix.

CAUTION: Exceeding the number of revolutions required to extend or retract the helix may damage the lead.

4. Disconnect the fixation tool from the connector pin and release the proximal end of the lead body. Allow several seconds for the residual torque in the lead to be relieved.
5. After allowing the residual torque to be relieved, reattach the fixation tool and turn it counterclockwise until the helix tip is retracted in the sheath.

Using the Stylet Guide and Stylets

The lead is packaged with the stylet guide attached to the connector pin and a stylet already inserted. If the stylet guide has been removed, replace it by gently pushing it as far as possible onto the connector pin (Figure 9).

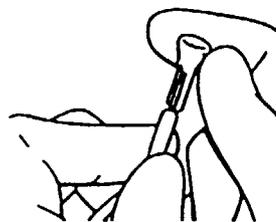


Figure 9. Stylet guide attachment

A stylet provides additional stiffness and controlled flexibility for maneuvering the lead into position. Stylets vary in stiffness to accommodate a physician's preference for lead and stylet flexibility. Each straight stylet knob is etched with the stylet diameter and length.

Insert a stylet wire through the stylet guide and into the lead body. If a slight curve is needed for the stylet wire, refer to the section titled "Positioning the Lead in the Ventricle."

CAUTION: To avoid damage to the lead or body tissue, do not use excessive force or surgical instruments to insert a stylet into the lead. To avoid lead tip distortion, the stylet should always remain fully inserted into the lead during lead introduction and while advancing the lead, especially through tortuous veins, that may cause the stylet to "back out" of the lead. When handling a stylet, avoid over-bending, kinking, or

blood contact. If blood is allowed to accumulate on a stylet, passage of the stylet into the lead may be difficult.

After the stylet is inserted, gently remove the stylet guide so that it rests alongside the stylet knob.

Selecting an Insertion Site

The lead may be inserted by venotomy through several different venous routes, including the right or left cephalic vein, other subclavian branches, or the external or internal jugular vein. The lead may also be inserted into a subclavian vein through a percutaneous lead introducer. Select the desired entry site (Figure 10).

CAUTION: When using a subclavian vein approach, avoid placing the entry site in a location where the lead body can be clamped between the clavicle and the first rib. A more lateral approach is recommended to minimize the risk of first rib clavicular crush.

Clamping of the lead may eventually cause the conductor to fracture, may cause damage to the insulation, or may cause other damage to the lead. Certain anatomical abnormalities, such as thoracic outlet syndrome, may also precipitate clamping of the lead.

Use fluoroscopy to facilitate accurate lead placement.

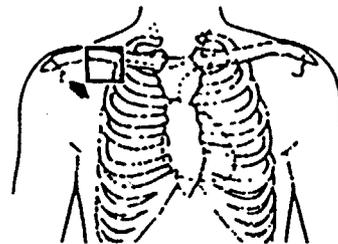


Figure 10. Suggested point of insertion.

Using the Vein Lifter

A vein lifter facilitates lead introduction. Insert its tapered end into the incised vein and gently push the lead tip underneath and into the vein (Figure 11).

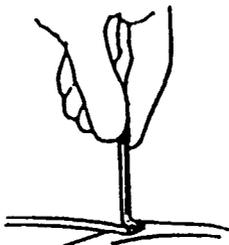


Figure 11. Using the vein lifter.

CAUTION: Avoid placing the lead under extreme tension or angulation to prevent lead dislodgement and possible lead fracture. Avoid gripping the lead with surgical instruments.

Positioning the Lead in the Ventricle

The following guidelines for implantation of the lead in the ventricle were developed with the Medtronic lead Model 4068 clinical study investigators to minimize the occurrence of ventricular perforation. Incidences of ventricular perforation and tamponade dropped significantly after the implementation of these guidelines from the study.

1. If there is reason to believe the patient has an unusually thin wall at the apex of the right ventricle, the implanter may wish to consider another site for placement of the lead.
2. If placing the lead in or near the ventricular apex, caution should be exercised if the distal end of the lead is passed directly to the apex from the valve, as too much force may be transmitted to the tip. As an alternate method, the lead can be curved up toward the outflow tract (a curved stylet may be used for this purpose (Figure 12) or the stylet may be pulled back to allow the lead to be carried by the blood flow), and then allowed to fall gently into position near the apex by pulling back on the lead body.
3. Two frequently employed techniques for final positioning which avoid transmission of pressure directly toward the tip of the lead (and thus may help prevent pushing the lead through the myocardium) are given here:

- 
- a. The stylet may be pulled back to approximately half way between the ring and the tip, after passing the lead through the tricuspid valve. This causes the distal end to be less stiff while positioning the lead against the final tissue site. The stylet can then be advanced gently to the tip of the lead before extending the helix.
 - b. A stylet, with a modest curve (Figure 12), may be used after crossing the tricuspid valve to prevent the distal end of the lead from pointing directly toward the apex.
 4. If a suitable position is not achieved and the lead needs to be repositioned, care should be taken again not to push the lead directly into the apex (one of the above methods should be repeated).
 5. If the awake patient feels a twinge of pain, the implanter may want to consider unscrewing and/or repositioning the lead, as this may be an early sign of perforation.
 6. Caution is recommended if turning of the whole lead body is employed during or after fixation of the helix.

- 
7. A cardiac electrogram (EGM) can be helpful in diagnosing perforation. The EGM from a perforated lead may exhibit an increased R-wave, decreased S, S-T depression, and T-wave inversion. In contrast, an EGM, when the lead is properly placed, should exhibit a small R-wave, a large S, S-T elevation, and possibly some T-wave inversion.
 8. In addition to measurement of cardiac electrogram (EGM), as mentioned above, non-invasive blood pressure monitoring and the use of echocardiographic methods may be valuable during implantation.

During fixation of the electrode, do not use excessive force and avoid tissue damage from helix over-rotation. To minimize the occurrence of perforation, avoid known infarcted or thin ventricular wall areas.

CAUTION: During final positioning, avoid transmission of pressure directly toward the tip of the lead to help prevent the lead from being pushed directly into the apex.

CAUTION: To avoid damage to the stylet, do not use a sharp object to impart a curve to the distal end (Figure 12).

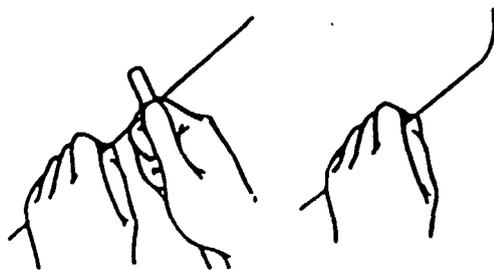


Figure 12. Imparting a curve to the stylet.

Accurate positioning of the electrode is essential for stable endocardial pacing. A satisfactory position is usually achieved when the above procedures are followed.

Use fluoroscopy (lateral position) to ensure that the tip is not in a retrograde position or is not lodged in the coronary sinus.

After placing the lead in a satisfactory position, extend the helix by following the procedure in "Securing the Electrode into the Endocardium."

Positioning the Lead in the Atrium

Advance the lead into the right atrium or the inferior vena cava using a straight stylet to facilitate movement through the veins. After the lead tip is passed into the atrium or the

inferior vena cava, replace the straight stylet with either a gently curved stylet or the J shaped stylet supplied with the lead.

Direct the lead tip into an appropriate position. Accurate positioning of the electrode is essential for stable pacing and sensing. Generally, a satisfactory position has the lead tip situated against the atrial endocardium in or near the apex of the appendage. As viewed on the fluoroscope (A-P view), the lead tip points medially and forward toward the left atrium. A successful position is usually achieved with an anterior, medial, or lateral tip location. After placing the lead tip in a satisfactory position, extend the helix by following the procedure in "Securing the Electrode into the Endocardium."

If properly positioned, the lead tip will sway from side to side with each atrial contraction (viewed under A-P fluoroscopy). In the absence of spontaneous atrial activity, movement can be produced by pacing the atrium through the lead.

Securing the Electrode into the Endocardium

The following procedure is recommended for electrode fixation.

1. Press both legs of the fixation tool together and place the hole, marked A, of the fixation tool on the connector pin (Figure 7).

2. Gently press the lead tip against the endocardium by pushing the stylet and the lead at the vein entry site. Then, rotate the tool clockwise until the coiled electrode is completely exposed (Figure 8). Maximum electrode exposure reveals approximately 1 1/2 to 2 coils.

The maximum number of revolutions of the fixation tool needed to extend or retract the helix is stated in the section titled "Specifications." The maximum number of revolutions depends on the particular lead model but will increase or decrease proportionately for longer or shorter leads.

CAUTION: Prolonged implant procedures or multiple repositionings can allow blood or body fluids to build up on the helix mechanism. This may result in an increased number of revolutions required to extend or retract the helix.

CAUTION: Exceeding the number of revolutions required to extend or retract the helix may damage the lead.

3. Use fluoroscopy to verify electrode exposure. Closing of the space between the crimp sleeve (A) and the indicator ring (B) implies complete exposure of the helix electrode (Figure 13).

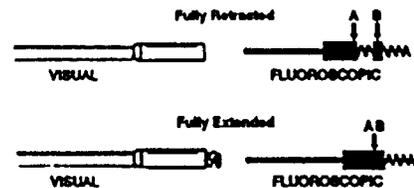


Figure 13. Possible views of the electrode.

4. Disconnect the fixation tool from the connector pin and release the proximal end of the lead body. Allow several seconds for the residual torque in the lead to be relieved.
5. Carefully withdraw the stylet partially.
6. Obtain electrical measurements to verify satisfactory placement and electrode fixation. Refer to the section titled "Taking Electrical Measurements."

For bipolar leads, optimal P-wave amplitudes can be obtained by carefully adjusting the curvature of the distal end of the lead. The amount of curvature directly affects the angle of the electrode relative to the P-wave depolarization vector and thus can affect P-wave amplitude.

7. Verify that the helix is affixed.

- a) For a lead placed in the ventricle: Gently pull back on the lead and check for resistance to verify affixation. A properly affixed helix will remain in position. If the helix is not properly affixed, the lead tip may become loose in the right ventricle.

If the helix does not remain affixed, it may be possible to fixate it during a subsequent attempt by rotating the whole lead body clockwise approximately one revolution after allowing the residual torque to be relieved in step 4. Caution is recommended if turning of the whole lead body is employed during or after fixation of the helix.

- b) For a lead placed in the atrium: Use frontal fluoroscopy to check for lateral "to-and-fro" movement of the atrial tip, which reflects atrial and ventricular contractions. Check for constancy of the movement by rotating the lead body (up to 180 degrees in either direction) while the patient breathes deeply. Poor fixation is suspected when tip movement seems random.

After confirmation of tip fixation, lead slack is built up in the atrium to prevent tip dislodgement. Enough slack is assumed present if, under fluoroscopy, the

lead assumes an "L" shape during deep inspiration. Avoid excessive slack buildup that may cause the loop of the lead to drop near the tricuspid valve.

8. If repositioning is required, reattach and rotate the fixation tool counterclockwise until the electrode is withdrawn. Use fluoroscopy to verify withdrawal. Again, as previously stated for final positioning of a lead placed in the ventricle, avoid transmission of pressure directly toward the tip of the lead to help prevent the lead from being pushed directly into the apex. Repeat one of the procedures suggested above.

CAUTION: Do not rotate the fixation tool more than the number of revolutions required to fully retract the helix. When the electrode is fully retracted, approximately 1 1/2 to 2 coils of the helix will be visible between the indicator ring and the crimp sleeve.

9. Remove the stylet guide and stylet completely. When removing the stylet guide, grip the lead firmly just below the connector pin; this will help prevent possible lead dislodgement.

10. Obtain final electrical measurements.

Taking Electrical Measurements

A notch in the stylet guide allows connection of a surgical cable for electrical measurements (Figure 14).

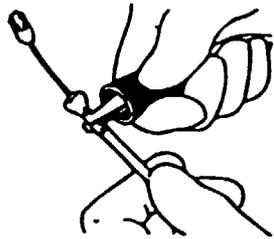


Figure 14. Surgical cable connection

Low stimulation thresholds and adequate sensing of intracardiac signal amplitudes indicate satisfactory lead placement. Medtronic recommends using a voltage source such as a pacing system analyzer for obtaining electrical measurements.

A low stimulation threshold provides for a desirable safety margin, allowing for a possible rise in thresholds that may occur within two months following implantation.

Adequate sensing amplitudes ensure that the lead is properly sensing intrinsic cardiac signals. Minimum signal requirements depend on the pulse generator's sensitivity

capabilities. Acceptable acute signal amplitudes for the lead must be greater than the minimum pulse generator sensing capabilities including an adequate safety margin to account for lead maturity.

Recommended Electrical Measurements at Implant When Using a Pacing System Analyzer

	Ventricle	Atrium
Maximum acute stimulation thresholds*	1.0V 3 mA	1.5V 4.5mA
Minimum acute sensing amplitudes	5.0 mV	2.0 mV

*at pulse duration setting of 0.5 ms.

Initial electrical measurements may deviate from the recommendations because of acute cellular trauma. If this occurs, wait five to fifteen minutes and repeat the testing procedure. Values may vary depending upon lead type, pulse generator settings, cardiac tissue condition, and drug interactions.

If electrical measurements do not stabilize to acceptable levels, it may be necessary to reposition the lead and repeat the testing procedure.

Based on clinical data, the implanter may expect the implant thresholds for the Medtronic steroid eluting screw-in lead, i.e. Model 4068 to be similar to the Medtronic non-steroid eluting screw-in lead, i.e. Model 4058M.

Check for diaphragmatic stimulation by pacing at 10 V and observing on fluoroscopy whether the left diaphragm contracts with each paced stimulus. If diaphragmatic pacing occurs, reduce the voltage until a diaphragmatic pacing threshold is determined. If the diaphragmatic threshold is less than the required programmed pacing output, the lead should be repositioned.

Pacing impedance (or resistance) is used to assess pulse generator function and lead integrity during routine pacemaker patient follow-up and to assist in troubleshooting suspected lead failures. (Additional troubleshooting procedures include ECG analysis, visual inspection, measurement of thresholds, and electrogram characteristics.)

Pacing impedance values are affected by many factors including lead position, electrode size, conductor design and integrity, insulation integrity, and the patient's electrolyte balance. Apparent pacing impedance is significantly affected by the measurement technique; therefore, comparison of pacing impedance should be done using consistent methods of measurement and equipment.

An impedance higher or lower than the typical values is not necessarily a conclusive indication of a lead failure. Other causes must be considered as well. Before reaching a conclusive diagnosis, the full clinical picture must be considered: pacing artifact size and morphology changes in 12-lead analog ECGs, muscle stimulation with bipolar leads, sensing and/or capture problems, patient symptoms, and pulse generator characteristics.

Recommendations for clinically monitoring and evaluating leads in terms of impedance characteristics are listed below.

For pacemakers with telemetry readout of impedance:

- Routinely monitor and record impedance values, at implant and follow-ups, using consistent output settings. [Be aware that impedance values may be different at different programmable output settings (e.g., pulse width or pulse amplitude) of the pacemaker or pacing system analyzer.]
- Establish a baseline chronic impedance value once the impedance has stabilized, generally within 6-12 months after implant.
- Monitor for significant impedance changes and abnormal values.

- Where impedance abnormalities occur, closely monitor the patient for indications of pacing and sensing problems. The output settings used for measuring impedance should be the same as that used for the original measurements.
- For patients at high risk such as pacemaker-dependent patients, physicians may want to consider further action such as increased frequency of monitoring, provocative maneuvers, and ambulatory ECG monitoring.

For pacemakers without telemetry:

- Record impedance value at implant. Also record the measurement device, its output settings, and the procedure used.
- At the time of pulse generator replacement, if pacing analyzer system-measured impedance is abnormal, carefully evaluate lead integrity (including thresholds and physical appearance) and patient condition before electing to reuse the lead.
- Bear in mind that impedances below 250 ohms may result in excessive battery current drain, which may seriously compromise pulse generator longevity, regardless of lead integrity.

For more information on obtaining electrical measurements, consult the technical manual supplied with the testing device.

Anchoring the Lead

Use the anchoring sleeve, supplied in the package, to secure the lead from moving and to protect the lead insulation and conductor coil from damage caused by tight ligatures (Figures 15, 16, and 17).

Anchor the lead with nonabsorbable sutures.

CAUTION: Tabs on anchoring sleeves are provided to minimize the possibility of the sleeve entering the vein. Do not remove the tabs (Figure 15). If using a large diameter percutaneous lead introducer (PLI) sheath, extreme care should be taken to prevent passage of the anchoring sleeve into the PLI lumen and/or the venous system.

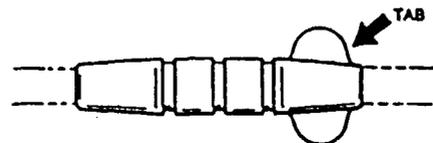


Figure 15. Triple groove anchoring sleeve with tabs.

With an anchoring sleeve, generally two or three of the grooves may be used with the following procedure (Figure 16 or 17):

The anchoring sleeve is situated at the connector end of the lead. Partially insert the anchoring sleeve into the vein.

Use the most distal suture groove to secure the anchoring sleeve to the vein.

Use the middle groove to secure the anchoring sleeve to the fascia and lead. First, create a base by looping a suture through the fascia underneath the middle groove and tying a knot. Continue by firmly wrapping the suture around the middle groove and tying a second knot.

Use the third and most proximal groove to secure the anchoring sleeve to the lead body.

Alternatively, only two of the three grooves may be used on the anchoring sleeve to tie down the lead. In that case, follow the anchoring procedure for the distal and middle groove (Figure 17).

CAUTION: Do not use the anchoring sleeve tabs for suturing.

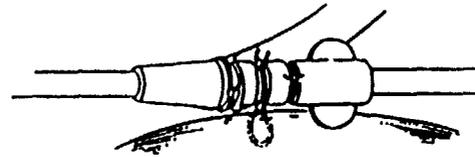


Figure 16. Triple groove anchoring sleeve secured to the lead and fascia using three grooves.

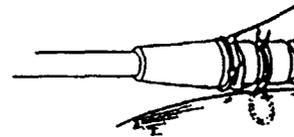


Figure 17. Triple groove anchoring sleeve secured to the lead and fascia using two grooves.

Tie the sutures securely but gently to prevent damage to the triple groove anchoring sleeve.

CAUTION: Do not secure the ligatures so tightly that they damage the vein or lead. Do not tie a ligature directly to the lead body (Figure 18). During anchoring, take care to avoid dislodging the lead tip.

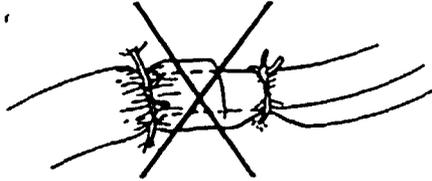


Figure 18. Do NOT secure the sutures too tightly and do NOT tie a suture to the lead body.

Connecting the Lead to the Pulse Generator

Connect the lead to the pulse generator according to the instructions in the pulse generator manual.

IS-1 Bipolar (BI) leads always have the label identification "IS-1 BI" on the connector.

CAUTION: Always remove the stylet before connecting the lead to the pulse generator. Failure to remove the stylet may result in lead failure.

CAUTION: To prevent undesirable twisting of the lead body, wrap the excess lead length loosely under the pulse generator and place both into the subcutaneous pocket (Figure 19).

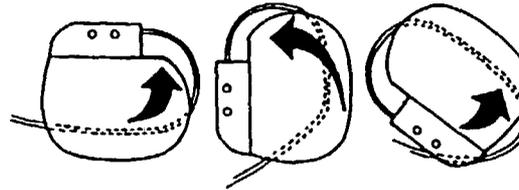


Figure 19. While rotating the pulse generator, loosely wrap the excess lead length and place it under the pulse generator.

CAUTION: When placing the pulse generator and leads into the subcutaneous pocket:

- do NOT coil the lead. Coiling the lead can twist the lead body and may result in lead dislodgement (Figure 20).
- do NOT grip the lead or pulse generator with surgical instruments.

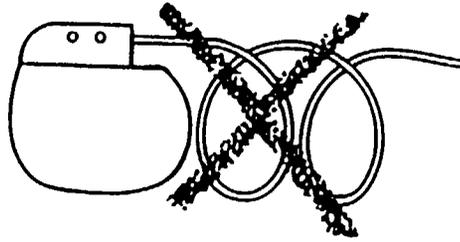


Figure 20. Do not coil the lead body.

After implantation, monitor the patient's electrocardiogram continuously during the immediate postoperative period. If a lead dislodges, it usually occurs during this time.

Special Notice

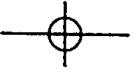
Medtronic® implantable leads are implanted in the extremely hostile environment of the human body. Leads are necessarily very small in diameter and must still be very flexible, which unavoidably reduces their potential performance or longevity. Leads may fail to function for a variety of causes, including, but not limited to: medical complications, body rejection phenomena, allergic reaction, fibrotic tissue, or failure of leads by breakage or by breach of their insulation covering. In addition, despite the exercise of all due care in design, component selection, manufacture, and testing prior to sale, leads may be easily damaged before, during, or after insertion by improper handling or other intervening acts. Consequently, no representation or warranty is made that failure or cessation of function of leads will not occur or that the body will not react adversely to the implantation of leads or that medical complications (including perforation of the heart) will not follow the implantation of leads or that the lead will, in all cases, restore adequate cardiac function.

For complete warranty information, see the accompanying card enclosed in the package.

Service

Medtronic employs highly trained representatives and engineers located throughout the world to serve you and, upon request, to provide training to qualified hospital personnel in the use of Medtronic products. In addition, Medtronic maintains a professional staff of consultants to provide technical and medical consultation to product users. For supplemental information, contact your local Medtronic representative, or call or write Medtronic at the appropriate address or telephone number listed on the back cover.

Medtronic Steroid Eluting, Screw-In Pacing Leads include various models that may be covered by one or more of the following patents: 4106512, 4498482, 4437475, 4860446, 4947866, 5040544, 4951687.



Blank inside Back Cover—For position only—Do not print!