



Memorandum

Date .SEP - 6 1996

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

Subject Premarket Approval of Medtronic, Incorporated
CapSure® Epi Pacing Lead, Model 4965 - 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.

Philip J. Philizzo
for Susan Alpert, Ph.D., M.D.

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

DECISION

Approved _____ Disapproved _____ Date _____

Prepared by Christopher M. Sloan, CDRH, HFZ-450, 9/5/96, 443-8243

DEPARTMENT OF HEALTH AND HUMAN SERVICES

Food And Drug Administration

[DOCKET NO. _____]

Medtronic, Inc.; PREMARKET APPROVAL OF The Capsure® Epi Pacing
Lead, Model 4965

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 the Federal Food, Drug, and Cosmetic Act (the act), of CapSure® Epi Pacing Lead, Model 4965. After reviewing the recommendation of the Circulatory System Devices Panel, FDA's Center for Devices and Radiological Health (CDRH) notified the applicant, by letter of September 6, 1996, of the approval of the application.

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

ADDRESSES: 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, 12420 Parklawn Dr., rm. 1-23, Rockville, MD 20857.

FOR FURTHER INFORMATION CONTACT:

Christopher M. Sloan,
Center for Devices and Radiological Health (HFZ-450),
Food and Drug Administration,
9200 Corporate Blvd.,
Rockville, Maryland 20850,
301-443-8243.

SUPPLEMENTARY INFORMATION: On July 17, 1995, Medtronic, Inc., Minneapolis, MN 55432-3576, submitted to CDRH an application for premarket approval of the CapSure® Epi Pacing Lead, Model 4965. The device is a permanent implantable cardiac pacemaker electrode and is designed to be used with a pulse generator as part of a cardiac pacing system. The lead has application where implantable epicardial atrial or ventricular, single chamber or dual chamber pacing systems are indicated.

On July 15, 1996, the Circulatory System Devices Panel of the Medical Devices Advisory Committee, an FDA advisory committee, reviewed and recommended approval of the application.

On September 6, 1996, 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

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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, for administrative review of CDRH's decision to approve this application. A petitioner may request either a formal hearing under 21 CFR part 12 of FDA's administrative practices and procedures 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 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

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Food and Drug Administration
9200 Corporate Boulevard
Rockville MD 20850

Ms. Ann H. Morrissey
Manager, Brady Regulatory Affairs
Medtronic, Incorporated
7000 Central Avenue, N.E.
Minneapolis, Minnesota 55432-3576

SEP - 6 1996

Re: P950024
CapSure® Epi Pacing Lead, Model 4965
Filed: July 17, 1995
Amended: July 18 and August 23, 1995, and January 17,
April 12, May 8, June 28, and August 1, 2,
and 29, 1996

Dear Ms. Morrissey:

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 CapSure® Epi Pacing Lead, Model 4965. This device is designed to be used with a pulse generator as part of a cardiac pacing system. The lead has application where implantable epicardial 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.

In addition to the postapproval requirements in the enclosure, you must conduct a study to collect safety and effectiveness data on 50 adult patients who have been implanted with the CapSure® Epi Pacing Lead, Model 4965. Follow-up of these patients must continue for at least one year. Results from this study should be submitted in your annual postapproval reports. It may be possible to address this condition of approval as part of the postmarket surveillance study required under section 522(a) of the act which is described below.

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Expiration dating for this device has been established and approved at two years.

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 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, 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 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

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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 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.

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

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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 Christopher Sloan at (301) 443-8243.

Sincerely yours,



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

Enclosures

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**CONDITIONS OF APPROVAL
FOR CARDIAC PACEMAKERS AND PROGRAMMERS**

APPROVED LABELING. As soon as possible, and before commercial distribution of your device, submit three copies of an amendment to this PMA submission with copies of all approved labeling in final printed form to the PMA Document Mail Center (HFZ-401), Center for Devices and Radiological Health, Food and Drug Administration (FDA), 9200 Corporate Boulevard, Rockville, Maryland 20850.

ADVERTISEMENT. No advertisement or other descriptive printed material issued by the applicant or private label distributor with respect to this device shall recommend or imply that the device may be used for any use that is not included in the FDA approved labeling for the device. If the FDA approval order has restricted the sale, distribution and use of the device to prescription use in accordance with 21 CFR 801.109 and specified that this restriction is being imposed in accordance with the provisions of section 520(e) of the act under the authority of section 515(d)(1)(B)(ii) of the act, all advertisements and other descriptive printed material issued by the applicant or distributor with respect to the device shall include a brief statement of the intended uses of the device and relevant warnings, precautions, side effects and contraindications.

PREMARKET APPROVAL APPLICATION (PMA) SUPPLEMENT. Before making any change affecting the safety or effectiveness of the device, submit a PMA supplement for review and approval by FDA unless the change is of a type for which a "Special PMA Supplement-Changes Being Effected" is permitted under 21 CFR 814.39(d) or an alternate submission is permitted in accordance with 21 CFR 814.39(e). A PMA supplement or alternate submission shall comply with applicable requirements under 21 CFR 814.39 of the final rule for Premarket Approval of Medical Devices.

All situations which require a PMA supplement cannot be briefly summarized, please consult the PMA regulation for further guidance. The guidance provided below is only for several key instances.

A PMA supplement must be submitted when unanticipated adverse effects, increases in the incidence of anticipated adverse effects, or device failures necessitate a labeling, manufacturing, or device modification.

A PMA supplement must be submitted if the device is to be modified and the modified device should be subjected to animal or laboratory or clinical testing designed to determine if the modified device remains safe and effective.

A "Special PMA Supplement - Changes Being Effected" is limited to the labeling, quality control and manufacturing process changes specified under 21 CFR 814.39(d)(2). It allows for the **addition** of, but **not the replacement** of previously approved, quality control specifications and test methods. These changes may be implemented before FDA approval upon acknowledgment by FDA that the submission is being processed as a "Special PMA Supplement - Changes Being Effected." This acknowledgment is in addition to that issued by the PMA Document Mail Center for all PMA supplements submitted. **This procedure is not applicable to changes in device design, composition, specifications, circuitry, software or energy source.**

Alternate submissions permitted under 21 CFR 814.39(e) apply to changes that otherwise require approval of a PMA supplement before implementation of the change and include the use of a 30-day PMA supplement or annual postapproval report. FDA must have previously indicated in an advisory opinion to the affected industry or in correspondence with the applicant that the alternate submission is permitted for the change. Before such can occur, FDA and the PMA applicant(s) involved must agree upon any needed testing protocol, test results, reporting format, information to be reported, and the alternate submission to be used.

POSTAPPROVAL REPORTS. Continued approval of this PMA is contingent upon the submission of postapproval reports required under 21 CFR 814.84 at intervals of 1 year from the date of approval of the original PMA. Postapproval reports for supplements approved under the original PMA, if applicable, are to be included in the next and subsequent annual reports for the original PMA unless specified otherwise in the approval order for the PMA supplement. Two copies identified as "Annual Report" and bearing the applicable PMA reference number are to be submitted to the PMA Document Mail Center (HFZ-401), Center for Devices and Radiological Health, Food and Drug Administration, 9200 Corporate Boulevard, Rockville, Maryland 20850. The postapproval report shall indicate the beginning and ending date of the period covered by the report and shall include the following information required by 21 CFR 814.84:

- (1) Identification of changes described in 21 CFR 814.39(a) and changes required to be reported to FDA under 21 CFR 814.39(b).

(2) Bibliography and summary of the following information not previously submitted as part of the PMA and that is known to or reasonably should be known to the applicant:

(a) unpublished reports of data from any clinical investigations or nonclinical laboratory studies involving the device or related devices ("related" devices include devices which are the same or substantially similar to the applicant's device); and

(b) reports in the scientific literature concerning the device.

If, after reviewing the bibliography and summary, FDA concludes that agency review of one or more of the above reports is required, the applicant shall submit two copies of each identified report when so notified by FDA.

In addition to the above and in order to provide continued reasonable assurance of the safety and effectiveness of the device for its intended use, the annual postapproval reports shall include, separately for each model number (if applicable), the following information known by or reported to the applicant:

- (1) The number of pacemakers domestically implanted and the number of reported explants and deaths.
- (2) A breakdown of the reported deaths into pacemaker related and non-pacemaker related.
- (3) A breakdown of the reported explants into the numbers reported at end of battery life, having complications unresolvable by programming and for other reasons with safety and effectiveness issues which can be derived from the reports stated.
- (4) The number of pacemakers returned to the applicant for cause from domestic sources with a breakdown into the numbers currently in analysis, operating properly, at normal battery depletion and failed, with the failure mechanisms described.
- (5) A cumulative survival table for the pacemakers.
- (6) The number of programmers and modules shipped and the number of returns with a breakdown into the numbers currently in analysis, operating properly and failed, with the failure mechanisms described.

ADVERSE REACTION AND DEVICE DEFECT REPORTING. As provided by 21 CFR 814.82(a)(9), FDA has determined that in order to provide continued reasonable assurance of the safety and effectiveness of the device, the applicant shall submit 3 copies of a written report identified, as applicable, as an "Adverse Reaction Report" or "Device Defect Report" to the PMA Document Mail Center (HFZ-401), Center for Devices and Radiological Health, Food and Drug Administration, 9200 Corporate Boulevard, Rockville, Maryland 20850 within 10 days after the applicant receives or has knowledge of information concerning:

- (1) A mixup of the device or its labeling with another article.
- (2) Any adverse reaction, side effect, injury, toxicity, or sensitivity reaction that is attributable to the device and
 - (a) has not been addressed by the device's labeling or
 - (b) has been addressed by the device's labeling, but is occurring with unexpected severity or frequency.
- (3) Any significant chemical, physical or other change or deterioration in the device or any failure of the device to meet the specifications established in the approved PMA that could not cause or contribute to death or serious injury but are not correctable by adjustments or other maintenance procedures described in the approved labeling. The report shall include a discussion of the applicant's assessment of the change, deterioration or failure and any proposed or implemented corrective action by the applicant. When such events are correctable by adjustments or other maintenance procedures described in the approved labeling, all such events known to the applicant shall be included in the Annual Report described under "Postapproval Reports" above unless specified otherwise in the conditions of approval to this PMA. This postapproval report shall appropriately categorize these events and include the number of reported and otherwise known instances of each category during the reporting period. Additional information regarding the events discussed above shall be submitted by the applicant when determined by FDA to be necessary to provide continued reasonable assurance of the safety and effectiveness of the device for its intended use.

REPORTING UNDER THE MEDICAL DEVICE REPORTING (MDR) REGULATION.

The Medical Device Reporting (MDR) Regulation became effective on December 13, 1984, and requires that all manufacturers and importers of medical devices, including in vitro diagnostic devices, report to FDA whenever they receive or otherwise become aware of information that reasonably suggests that one of its marketed devices

- (1) may have caused or contributed to a death or serious injury or
- (2) has malfunctioned and that the device or any other device marketed by the manufacturer or imported would be likely to cause or contribute to a death or serious injury if the malfunction were to recur.

The same events subject to reporting under the MDR Regulation may also be subject to the above "Adverse Reaction and Device Defect Reporting" requirements in the "Conditions of Approval" for this PMA. FDA has determined that such duplicative reporting is unnecessary. Whenever an event involving a device is subject to reporting under both the MDR Regulation and the "Conditions of Approval" for this PMA, you shall submit the appropriate reports required by the MDR Regulation and identified with the PMA reference number to the following office:

Division of Surveillance Systems (HFZ-531)
Center for Devices and Radiological Health
Food and Drug Administration
1350 Piccard Drive, Room 340
Rockville, Maryland 20850
Telephone (301) 594-2735

Events included in periodic reports to the PMA that have also been reported under the MDR Regulation must be so identified in the periodic report to the PMA to prevent duplicative entry into FDA information systems.

Copies of the MDR Regulation and an FDA publication entitled, "An Overview of the Medical Device Reporting Regulation," are available by written request to the address below or by telephoning 1-800-638-2041.

Division of Small Manufacturers Assistance (HFZ-220)
Center for Devices and Radiological Health
Food and Drug Administration
5600 Fishers Lane
Rockville Maryland 20857

SUMMARY OF SAFETY AND EFFECTIVENESS DATA

CapSure® Epi Pacing Lead, Model 4965

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I. General Information

Device Generic Name:	Unipolar, Epicardial, Steroid Eluting Pacing Lead
Device Trade Name:	CapSure® Epi Pacing Lead, Model 4965
Applicant's Name & Address:	Medtronic, Inc. 7000 Central Ave. N.E. Minneapolis, MN 55432
PMA Number:	P950024
Date of Panel Recommendation:	July 15, 1996
Date of Notice of Approval to Applicant:	SEP 6 1996

II. Indications for Use

The Model 4965 pacing lead is designed to be used with a pulse generator as part of a cardiac pacing system. The lead has application where implantable epicardial atrial or ventricular, single or dual-chamber pacing systems are indicated.

III. Device Description

The Model 4965 lead is a steroid-eluting, unipolar, epicardial pacing lead designed for pacing and sensing of either the atrium or ventricle. This permanent pacemaker lead is used to provide channeled electrically-conductive pathways between the pulse generator and the heart. Two leads may be used for bipolar pacing.

The electrode tip provides the electrical contact with the myocardium and consists of a machined platinum-iridium alloy. Platinum particles are fused to the shank and to each other to create the hemispherical, porous electrode surface by a sintering process. The sintered surface is then given a thin coating of platinum black. The electrode surface is coated with a dexamethasone sodium phosphate solution which penetrates into the pores of the electrode. The monolithic control release device (MCRD) is located within the electrode.

The conductor is a coil made of several fine wires consisting of MP35N®, a nickel alloy comprised of 35% wt. Nickel, 35% wt. Cobalt, 20% wt. Chromium, and 10% wt. Molybdenum.

The insulation is made of silicone rubber. The insulation of the Model 4965, as with other currently marketed (PMA approved) Medtronic leads, has been Silacure™ treated.

The terminal assembly of the Model 4965 lead provides for the electrical connection between the lead and pulse generator. The terminal assembly consists of a stainless connector pin and a silicone rubber connector sleeve. The following technical information further describes the Model 4965 lead:

Type	Unipolar
Chamber	Atrium/Ventricle
Fixation	Suture-On
Length	15 - 110 cm
Connector	IS-1 UNI
Resistance	38 Ohms @ 50 cm
Material	
Conductor	MP35N
Insulation	Silicone Rubber with Silacure® Treatment
Electrode Tip	Platinum
Suture Pad	Silicone Rubber
Electrode	
Configuration	Hemispherical Porous Platinized, Steroid Eluting
Electrode Surface Area	14 mm ²
Steroid	
Name	Dexamethasone Sodium Phosphate
Amount of Steroid	< 1.0 mg
Steroid Binder	Silicone Rubber

Accessories

The tunneler for the lead is a tool that attaches to the connector pin and is used to pass the lead from the implant site to the pulse generator pocket.

The lead end cap is used to seal off the connector if a lead is not connected to a pulse generator.

The upsizing sleeve is used to adapt an IS-1 connector to a 5/6 mm pulse generator connector.

IV. Contraindications

The lead should not be used on a patient with a heavily infarcted or fibrotic myocardium.

It is also contraindicated for those patients whose myocardium is suffused with fat.

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

V. Warnings

An implanted lead forms a direct, low-resistance 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 patients must be properly grounded. The lead connector pin 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 acute lead system testing, implantation procedure, and whenever arrhythmias are possible or intentionally induced during post-implant testing.

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

Before implanting the lead, remove the tip protector.

Leads should be handled with great care at all times. Any severe bending, kinking, stretching, or handling with surgical instruments 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.

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 release device. For a listing of potential adverse effects, refer to the dexamethasone sodium phosphate manufacturer prescribing information or the *Physician's 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.

Chronic repositioning or removal of the lead after it has been implanted in the patient is not recommended. If removal is unavoidable, return the lead to Medtronic.

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.

Repositioning the lead after it has been implanted may adversely affect a steroid lead's low-threshold performance.

VII. Alternative Practices and Procedures

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

VIII. Marketing History

The Model 4965 lead is released to those markets where regulatory approval has been obtained. Since 1992 over 1900 devices have been implanted in Europe, Canada, Latin America, Japan, and Asia. Medtronic has not been informed of any devices that have been withdrawn from the market for reasons associated with the safety and effectiveness of the Model 4965 lead.

IX. Adverse Effects of the Device on Health

The clinical investigation of the Model 4965 lead studied 661 devices implanted in 381 patients for a total of 9681 cumulative device months of experience (3054 Atrial, 6627 Ventricular). Mean duration of implantation was 14.6 months (range 0 to 62 months). Forty eight (48) patients (12.6%) with Model 4965 leads died during the course of the clinical study. None of the deaths were determined to be lead related. Lead related adverse events (AEs), including 43 complications (6.5% of leads) and 57 observations (8.6% of leads), were reported during the clinical investigation. The adverse events that occurred more than one time are summarized in Tables 1 and 2 on the following pages.

Table 1. Frequency of Adverse Events for Atrial Leads

Mean duration of implantation is 14.6 months (range 0 - 62 months).

Type of Adverse Event (AE)	# of Leads (n=224)	% of Leads [95% CI]	# Patients (n=201)	% of Patients [95% CI]
Observations				
Muscle Stimulation	12	5.4% [2.4 - 8.3%]	12	6.0% [2.7 - 9.2%]
Undersensing	6	2.7% [0.6 - 4.8%]	6	3.0% [0.6 - 5.3%]
Oversensing	6	2.7% [0.6 - 4.8%]	6	3.0% [0.6 - 5.3%]
Elevated Thresholds	5	2.2% [1.0 - 5.2%]	5	2.5% [1.1 - 5.8%]
Total Observations¹	29	13% [8.6 - 17%]	29	14% [9.6 - 19%]
Complications (Loss of Lead)				
Lead Fracture	5	2.2% [1.0 - 5.2%]	5	2.5% [1.1 - 5.8%]
Total Complications²	5	2.2% [1.0 - 5.2%]	5	2.5% [1.1 - 5.8%]

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

2 Complications are adverse events that resulted in the loss of the lead function (e.g. unable to sense or unable to pace the heart).

Table 2. Frequency of Adverse Events for Ventricular Leads
Mean duration of implantation is 14.6 months (range 0 - 62 months).

Type of Adverse Event (AE)	# of Leads (n=437)	% of Leads [95% CI]	# Patients (n=355)	% of Patients [95% CI]
Observations				
Elevated Thresholds	10	2.3% [0.9 - 3.7%]	10	2.8% [1.1 - 4.5%]
Undersensing	9	2.1% [0.7 - 3.4%]	9	2.5% [0.9 - 4.2%]
Muscle Stimulation	7	1.6% [0.4 - 2.8%]	7	2.0% [0.5 - 3.4%]
Oversensing	2	0.5% [0.2 - 1.7%]	2	0.6% [0.2 - 2.1%]
Total Observations¹	28	6.4% [4.1 - 8.7%]	28	7.9% [5.1 - 10.7%]
Complications (Loss of Lead)				
Lead Fracture	20	4.6% [2.6 - 6.5%]	16	4.5% [2.3 - 6.7%]
Exit Block	6	1.4% [0.3 - 2.5%]	5	1.4% [0.7 - 3.3%]
Other Causes	5	1.1% [0.6 - 2.7%]	4	1.1% [0.5 - 2.9%]
Elevated Thresholds	4	0.9% [0.4 - 2.4%]	4	1.1% [0.5 - 2.9%]
Loss of Capture	3	0.7% [0.3 - 2.0%]	3	0.8% [0.4 - 2.5%]
Total Complications²	38	8.7% [6.1 - 11%]	32	9.0% [6.0 - 12%]

- Observations are adverse events which are corrected by non-invasive measures (e.g. reprogramming).*
- Complications are adverse events that resulted in the loss of the lead function (e.g. unable to sense or unable to pace the heart).*

There are additional complications related to the use of epicardial leads that include, but are not limited to, the following:

- fibrillation
- heart wall damage
- cardiac tamponade
- muscle or nerve stimulation
- pericardial rub
- infection

In addition, the lead may not perform optimally in patients with thin-walled myocardiums.

Another complication, which has been referenced in the literature, is the potential for increased risk of inducing tachyarrhythmias when using two leads for bipolar pacing. This is thought to be due to the equal surface area of the anodal and cathodal electrodes. If pacing stimuli are observed to be falling on the T-wave, it may help to unipolarize the system.

The potential complications listed above may occur at a higher rate with the use of these leads in pediatric patients.

Typical complications resulting in patient symptoms can often be resolved as outlined in the following chart.

Complication	Symptom	Corrective Action to be Considered
Lead dislodgement	Intermittent or continuous loss of capture or sensing*	Reposition the lead
Lead conductor fracture, or insulation failure	Intermittent or continuous loss of capture or sensing*	Replace the lead
Threshold elevation or exit block	Loss of capture*	Adjust the pulse generator output, or replace or reposition the lead

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

X. Summary of Studies

A. In Vitro (Laboratory) Testing

Three ethylene oxide (EtO) sterilization cycles were performed to expose all leads to “worst case” (maximum exposure) manufacturing process conditions. Leads were then 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 meet the specified requirements for all subsequent qualification tests, as defined below:

1. Connector Mating (Insertion/Withdrawal Testing)

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

Samples Tested	Results	Specification
30 (Insertion - Dry)	0.7 ± 0.1 lbs	≤ 3.0 lbs
30 (Withdrawal - Dry)	0.9 ± 0.1 lbs	≤ 2.5 lbs
30 (Insertion - Wet)	0.9 ± 0.1 lbs	≤ 3.0 lbs
30 (Withdrawal - Wet)	0.8 ± 0.1 lbs	≤ 2.5 lbs

2. Crimp Pull Strength

Crimps were pulled by gripping opposite ends of each connection in a tensile test machine until failure. The purpose of the crimp pull test is to assure that each connection can withstand the anticipated mechanical loading during lead handling

Samples Tested	Results	Specification
30 (Coil to Connector Pin Crimp)	10.2 ± 1.1	≥ 2.5 lbs
30 (Coil to Electrode Crimp)	12.7 ± 0.7	≥ 3.0 lbs

3. Composite Pull Strength

Leads were soaked for ten days in 0.9% saline at body temperature, after which the samples were 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
30 (Distal Composite)	4.7 ± 0.6	≥ 1.0 lb
30 (Proximal Composite)	3.3 ± 0.4	≥ 1.0 lb

4. Lead Body Flex Testing

The lead body was mounted in a fixture and flexed at ± 90° over a 0.118" radius until an electrical continuity failure occurred in each specimen.

Samples Tested	Results	Specification
22	1.53 × 10 ⁵ (B50-median)	≥ 0.55 × 10 ⁵ (B50-median)

5. DC Resistance

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

Samples Tested	Results	Specification
30	22.6 ± 0.2	26 ± 5

6. IS-1 Offset Block/AC Impedance

Leads were 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 was measured between all combinations of conductors and an indifferent electrode to assure conformance to the IS-1 Standard.

Samples Tested	Results	Specification
30	> 50 K ohms	> 50 K ohms

7. 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.

Twenty complete distal subassemblies of the Model 4965 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 0.25, 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 0.228 milligrams. This is below the 1.0 mg maximum level.

8. Biocompatibility Testing

The materials used in the Model 4965 lead that are directly exposed to body tissue are: silicone rubber, plasma treated silicone rubber, platinum, and platinum/iridium. These materials are identical to those used in currently marketed (PMA approved) Medtronic implantable pacing leads. 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 Implant, and Ames Mutagenicity Assay) have been previously performed to verify the biocompatibility of the materials. This prior testing has demonstrated that all materials are non-hemolytic, non-pyrogenic, non-toxic, non-mutagenic and biocompatible.

9. Shelf Life Testing

All of the materials, components and packaging for the Model 4965 lead are similar to those used in currently marketed leads. The current shelf-life for packaged silicone, tined, steroid leads is two years. Thus the materials, components, and packaging used in the Model 4965 lead were previously established as stable for a two-year shelf-life.

B. Animal Testing

Two 12-week canine studies were conducted to evaluate in-vivo electrical performance and histopathological characteristics of the Model 4965 lead. Both studies were performed with prototype leads which were similar in design to the Model 4965 lead and are considered acceptable for the pre-clinical evaluation of the Model 4965 lead. One study was in adult canines using a Model 10295¹ lead and the other study was in canine puppies using the Model 10295A² lead. In the Model 10295 study, canine data was compared to the Model 4951 lead (a currently-marketed non-steroid myocardial lead; reference K842065).

1. In-Vivo Electrical Testing

a. Canine Adult Study

The electrical performance characteristics of the Model 10295 were evaluated in canines prior to entering human clinical studies. Four canines were implanted with four Model 10295 leads each; two on the right atrium and two on the right ventricle. Electrical characteristics for each lead were measured at implant and again at intervals of 1, 2, 3, 4, 8, and 12 weeks. Data collection included pacing voltage thresholds and P-wave and R-wave (sense) amplitudes.

Results indicated that pacing thresholds of the 10295 lead were lower than the non-steroid control lead Model 4951. Additionally, the 10295 lead did not demonstrate the threshold peaking behavior characteristic of the non-steroid lead. Upon histopathological analysis, one ventricular electrode was observed dislodged from the epicardium. Specifically, the suture pad/electrode was encapsulated in a fibrotic sheath, thereby preventing the electrode from being in direct contact with the epicardium. The electrical data from this lead were deleted from the analysis post-implant.

b. Canine Puppy Study

The electrical performance characteristics of the Model 10295A lead were also evaluated in young, growing puppies. Seven puppies were implanted with three Model 10295A leads each: two on the right ventricle and one on the right atrium. One of the three leads was a non-steroid design of the Model 10295A. Electrical characteristics for each lead were measured at implant and again at intervals of 1, 2, 3, 4, 8, and 12 weeks. Data collection included pacing voltage thresholds and P-wave and R-wave amplitudes.

Results indicated that pacing thresholds of the 10295A lead were lower than the non-steroid version. Sensing performance was comparable to the non-steroid version. One puppy experienced

¹ The Model 10295 is similar to the Model 4965 except for the following differences: the Model 10295 suture pad is more rectangular in shape (the Model 4965 suture pad is triangular), the conductor coil is 7 filar (the Model 4965 conductor coil is 5 filar), the silicone rubber tubing wall is thinner and the connector is a 5mm unipolar connector.

² The Model 10295A is similar to the Model 4965 except for the following differences: the Model 10295A conductor coil is 7 filar (the Model 4965 conductor coil is 5 filar), the silicone rubber tubing wall is thinner and the connector is a 5mm unipolar connector.

asystole following surgery and did not fully recover; it was terminated five days later for humane reasons. It was the surgical veterinarian's opinion that this event was not lead-related. Another puppy died during data collection at week eight. A necropsy was performed and the cause of death was attributed to anesthesia overdose. The death was not lead specific.

2. Necropsy and Histopathological Analysis

At the 12-week study interval in both canine studies, the leads were electrically monitored and then one (canine puppy study) or two (canine adult study) of the animals was heparinized and euthanized. During necropsy, the leads were exposed and all relevant tissues were examined visually. Tissue specimens were collected at the electrode-tissue interface and other areas of the myocardium (control). Tissue samples were taken with the electrodes in-situ. Electrode-tissue samples were stored in 10% formalin for at least one week before removal of the electrode, trimming and slide preparation. Tissue slides were examined by a consulting pathologist.

There were no untoward responses noted in any of the heart tissues examined. The tissue responses noted appeared similar to those observed with non-steroid epicardial leads. All implant sites examined showed fibrous reaction and inflammation that was well circumscribed to the site of implant. These reactions are not unexpected and are typical of implanted cardiac pacing leads.

3. Conclusion

The canine studies demonstrated that prototype steroid Models 10295 and 10295A leads with similar design characteristics as the Model 4965 clinical lead could achieve acceptable in vivo performance. Lower pacing thresholds with an absence of acute peaking and comparable sensing amplitudes were observed for the steroid leads versus non-steroid control leads. The studies supported the initiation of clinical studies of the Model 4965 lead.

C. Summary of Clinical Studies

The Medtronic CapSure Epi Model 4965 epicardial, steroid-eluting, suture-on lead was evaluated in a prospective clinical study at 56 centers. Mechanical performance information (i.e., lead coil fractures) and electrical data were gathered acutely and chronically for a period of one year (i.e., follow-up at 2 weeks and 1, 3, 6, 9 and 12 months post implant). A detailed analysis of all safety and effectiveness endpoints was conducted only for the pediatric patients (< 19 years of age) enrolled in the study. The pediatric patient population is the patient group in which epicardial leads are primarily used. The analysis of the pediatric cohort is considered a worst-case analysis for the Model 4965 lead due to the underlying cardiovascular disease and patient growth and activity levels specific to pediatric patients. A summary of the Model 4965 lead experience in adult patients has also been provided for completeness.

A retrospective patient cohort implanted with a marketed non-steroid epi/myocardial lead (Medtronic Model 4951) was originally identified as a control population for comparison to the Model 4965 lead. However, this retrospective control group was not deemed to be an appropriate comparator and, therefore, data from this group will not be presented here. A *randomized* study of the Model 4965 and Model 4951 leads would have been preferred, but was not conducted due to the reluctance of investigators to randomize to a non-steroid lead given the clinical benefit exhibited by marketed endocardial leads with steroid elution capability.

1. Study Objectives

The objectives of the clinical study were to demonstrate the safety and effectiveness of the Model 4965 lead. The safety of the Model 4965 lead was evaluated by measuring four different one-year lead survival endpoints. These endpoints are:

- Lead conductor coil fracture
- Lead conductor coil fracture and "loss of capture"
- Lead conductor coil fracture, "loss of capture," elevated thresholds, and exit block
- Overall loss of lead survival, i.e., all failures mentioned above plus "other" and "loss of sensing".

To demonstrate effectiveness, acute and chronic pacing and sensing performance of the Model 4965 lead was measured.

2. Subject Selection and Exclusion Criteria

Patient selection criteria included patients who were candidates for either their first pacing system implant or for a replacement of a previous pacing system. Patients were required to be available for the specified follow-up evaluations and be willing to return for follow-up evaluations as necessary to complete the protocol. All patients were required to give a written informed consent for study participation prior to entry into the study. Patients with a heavily infarcted or fibrotic myocardium or whose heart was suffused with fat were excluded from the study. In addition, patients in whom a single dose of 1.0 mg dexamethasone sodium phosphate is contraindicated were excluded.

3. Study Population

There were 381 patients in the Model 4965 study: 349 were pediatric patients (< 19 years of age) while the remaining 32 were adults.

Six hundred (600) Model 4965 leads were implanted in the 349 pediatric patients; 394 were implanted in the ventricle and 206 in the atrium. Safety and effectiveness information is reported for 594 of these leads; 6 leads are not included in the analysis because their implantation was contraindicated by the device labeling. The majority of these leads, 498, were implanted in unipolar systems, while the remaining 102 were bipolar (51 pairs). Furthermore, because some patients had more than one implant procedure, there were 371 procedures in these 349 patients.

Sixty-one (61) Model 4965 leads were implanted in the 32 adult patients; 43 were implanted in the ventricle and 18 in the atrium. There was a fairly even distribution of unipolar (29 leads) and bipolar (32 leads - 16 pairs) systems.

As stated previously, complete analyses were conducted solely on the pediatric population. Therefore, Tables 3 - 5 contain a listing of the patient demographics, indications for implant, and implant characteristics for the Model 4965 pediatric population only.

Table 3. Model 4965 Pediatric Patient Population Demographics (N=349)

Comparison Variable	Number	Percent
Age (mean \pm SD)	4.2 \pm 4.8	N/A
Gender		
Male (n,%)	200	57.3%
Female (n,%)	149	42.7%

Table 4. Model 4965 Pediatric Patient Population Indications for Pacing (N=349)

Variable	Number	Percent
Intracardiac Congenital Heart Disease	281	80.5%
Extracardiac Congenital Heart Disease	72	20.6%
Previous Intracardiac Surgery	200	57.3%
Previous Extracardiac Surgery	74	21.2%
History of Exit Block or Elevated Pacing Thresholds	7	2.0%
Pacemaker Dependent	91	26.1%
Congenital Arrhythmia	142	40.7%
Surgically Acquired Arrhythmia	176	50.4%

Table 5. Model 4965 Pediatric Patient Population Characteristics at Implant (N = 371 Procedures)

Variable	Number	Percent
Surgical Approach		
Left Thoracotomy	97	26.2%
Subxiphoid	110	29.7%
Other ³	164	44.2%
Concomitant Surgery	94	25.3%
Abdominal Pacemaker Location	315	84.9%

4. Gender Bias Analysis

The gender distribution in the Model 4965 clinical study is similar to the distribution found in the general epicardial pacing lead population according to information gathered from Medtronic's Warranty Registration Database. The database, representing Medtronic epicardial lead uses since January, 1990, indicates that there are 40% females and 60% males in this population. Of the 349 Model 4965 pediatric patients, 149 (43%) were female and 200 (57%) were male.

5. Adverse Events (All Patients)

The frequency of lead-related adverse events (i.e., complications and observations) for all pediatric and adult patients enrolled in the study are reported in Tables 1 and 2 in Section IX. Six hundred sixty-one devices were implanted in 381 patients for a total of 9681 cumulative device months of experience (3054 atrial, 6627 ventricular). Mean duration of implantation was 14.6 months (range 0 to 62 months). Lead-related adverse events, including 43 complications (6.5% of leads) and 57 observations (8.6% of leads) were reported in the clinical study.

6. Safety Data (Pediatric Cohort)

The safety data for pediatric patients receiving the Model 4965 lead were analyzed according to the endpoints listed in the *Study Objectives* section above. The one-year survival from loss of lead results are listed in Table 6. The Model 4965 lead demonstrated acceptable survival at 12 months in the four identified categories.

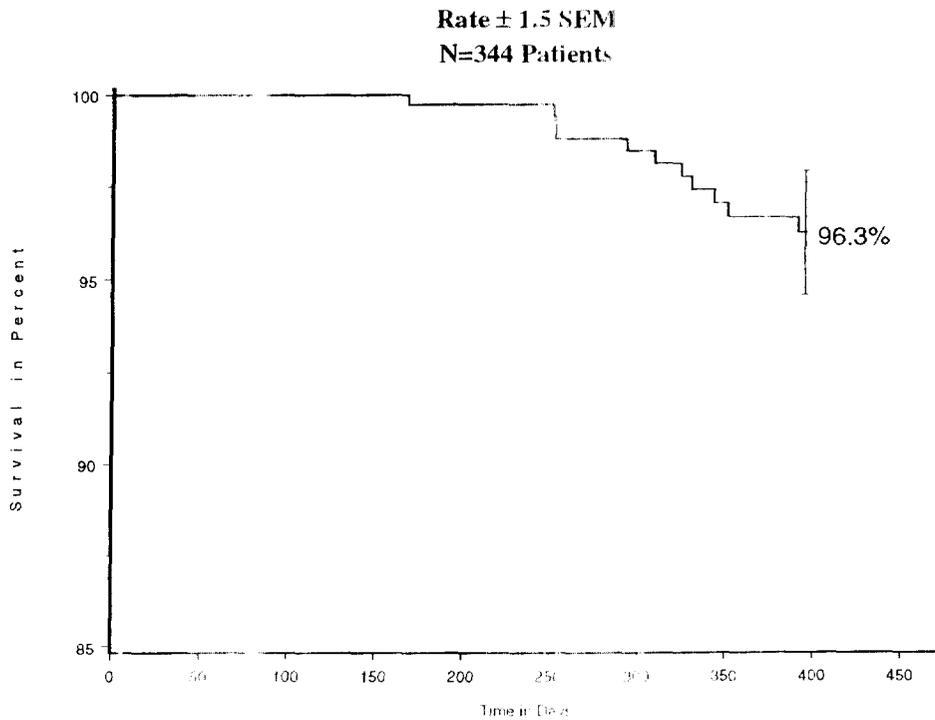
³ "Other" consists of intercostal lateral thoracotomy, anterior thoracotomy, and partial sternal split surgical approaches.

Table 6. Lead Survival at One Year

Safety Endpoint	Results (n = 594 leads)
Coil Fractures Number at 1 year Survival at 1 year	11 96.3%
Coil Fractures + Loss of Capture Number at 1 year Survival at 1 year	14 95.5%
Coil Fractures + Loss of Capture + Elevated Thresholds + Exit Block Number at 1 year Survival at 1 year	17 94.8%
Loss of Lead Number at 1 year Survival at 1 year	22 93.6%

The Kaplan-Meier survival curves showing the survival to loss of lead in each of these categories are Figures 1 through 4, below.

Figure 1. Survival from Loss Due to Lead Fracture in Pediatric Cohort



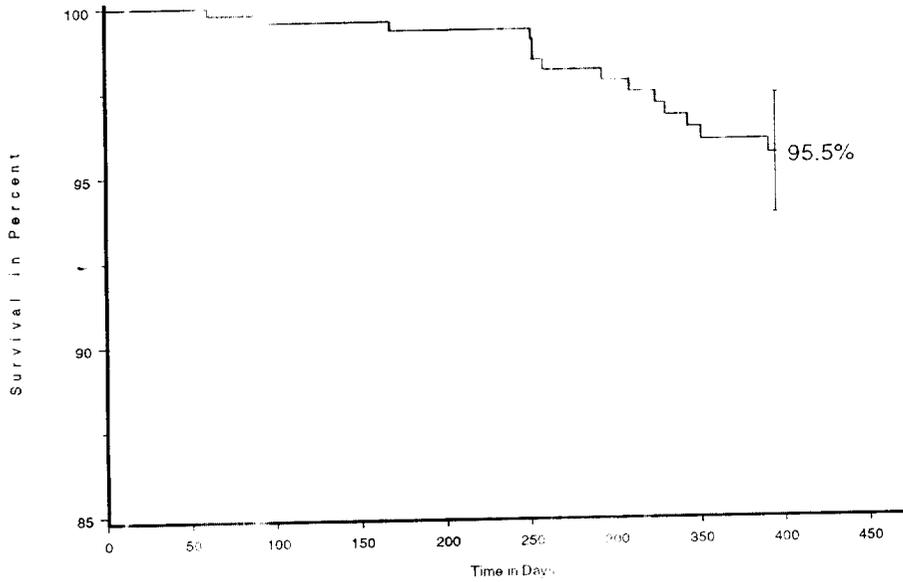
Eleven (11) failures in 594 leads; 233 leads at end-point.



Figure 2. Survival from Loss Due to Lead Fracture and Loss of Capture in the Pediatric Cohort

Rate \pm 1.5 SEM

N=344 Patients

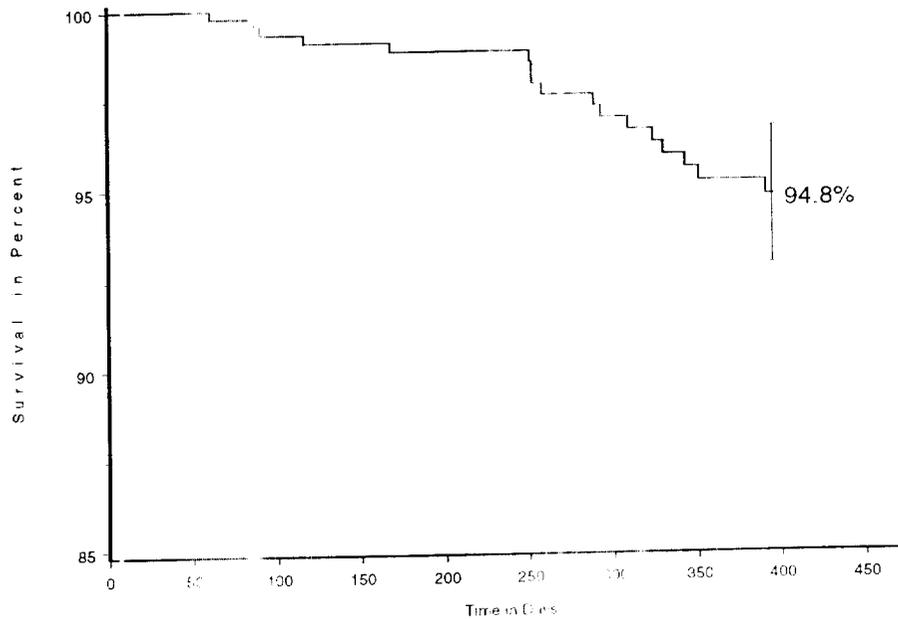


Fourteen (14) failures in 594 leads, 233 leads at end-point.

Figure 3. Survival from Loss Due to Lead Fracture, Loss of Capture, Exit Block and Elevated Thresholds in the Pediatric Cohort

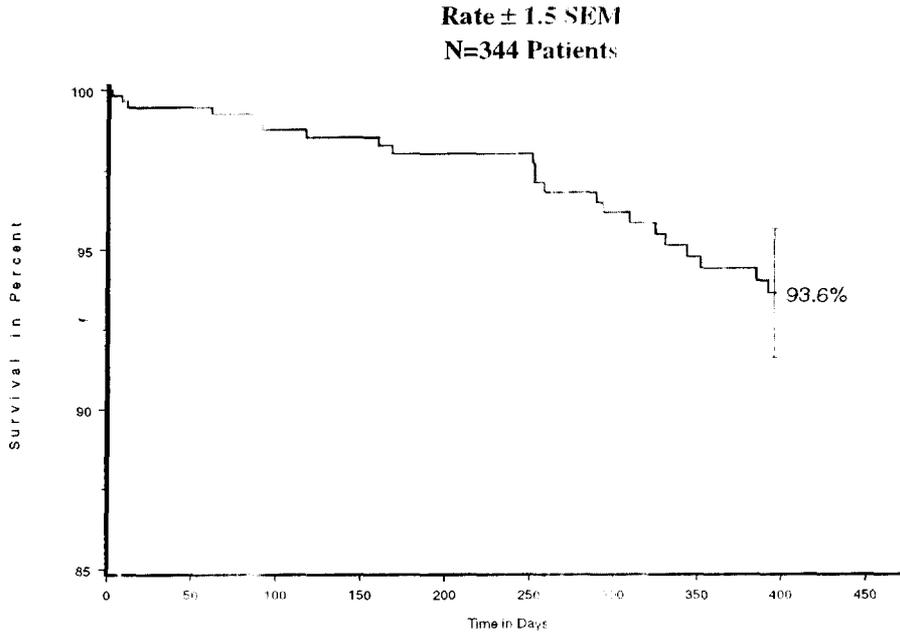
Rate \pm 1.5 SEM

N=344 Patients



Seventeen (17) failures in 594 leads, 233 leads at end-point

Figure 4. Survival from Overall Loss of Lead in the Pediatric Cohort



Twenty-two (22) failures in 594 leads, 233 leads at end-point

The risk of lead fracture associated with each type of surgical technique is computed for pediatric patients in Table 7.

Table 7. Lead Fracture Risk Associated with Implant Technique

Cox regression with surgical implant technique for effect on fracture of pediatric leads.

No effect is noted by a confidence interval of the risk ratio which contains 1.

Implant Technique	Number Fractured/Total (%) [95% C.I.]	Risk Ratio [95% C.I.]
Median Sternotomy	2/250 (0.8%) [0.2 - 2.9%]	0.1 [0.03 - 0.6]
Subxyphoid	4/149 (2.7%) [1.1 - 6.8%]	0.6 [0.2 - 1.8]
Left Thoracotomy	17/157 (10.8%) [6.0 - 15.7%]	5.2 [2.2 - 12.3]
Subcostal	1/16 (6.3%) [1.5 - 30.3%]	2.9 [0.4 - 22.8]
Other	1/22 (4.5%) [1.1 - 22.9%]	0.5 [0.06 - 3.9]

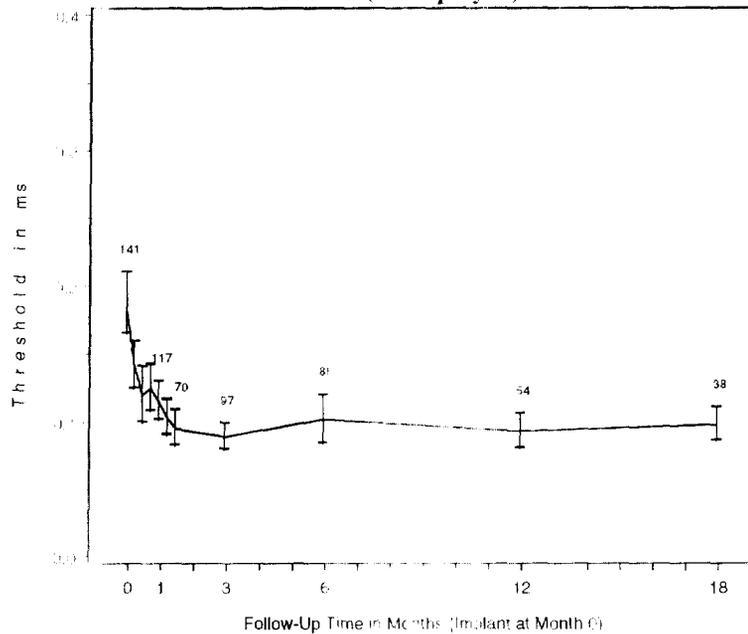
7. Effectiveness Data (Pediatric Cohort)

The evaluation of the Model 4965 lead effectiveness in pediatric patients was conducted by measuring the lead’s pacing and sensing thresholds. Low pacing thresholds are considered good as they result in a decrease in the amount of energy required to pace the heart. Large values are favorable for sensing thresholds; they indicate the strength of the electrical signal representing the patient’s intrinsic rhythm.

Figure 5 through Figure 8 illustrate the electrical results from the Model 4965 study. Acceptable pacing and sensing thresholds were demonstrated. No stimulation threshold peaking phenomenon was seen in the acute phase following implantation. In addition, the Model 4965 lead had low, stable chronic stimulation thresholds.

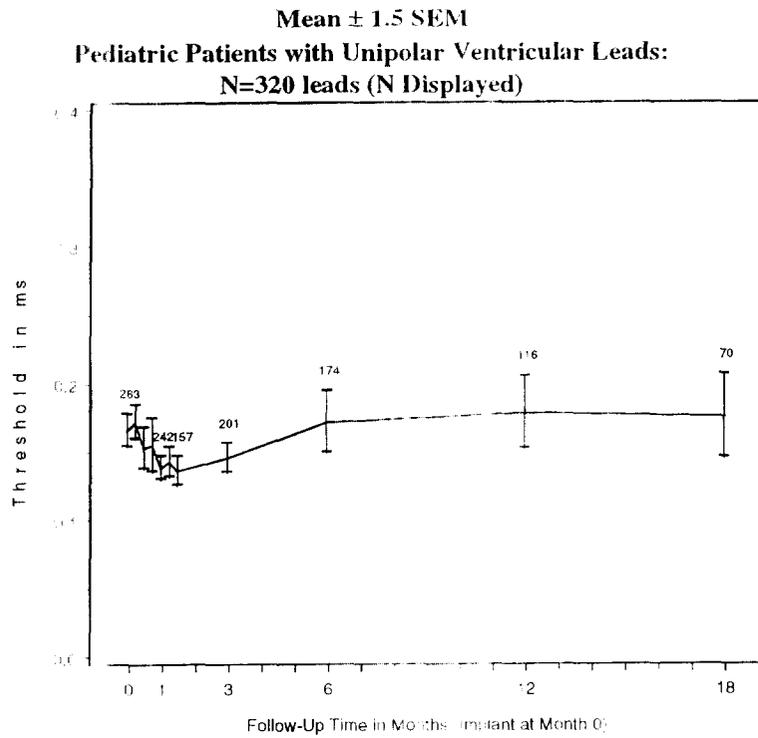
Figure 5. Unipolar Atrial Pulse Width Thresholds at 2.5V
Mean ± 1.5 SEM

**Pediatric Patients with Unipolar Atrial Leads:
N=178 leads (N Displayed)**



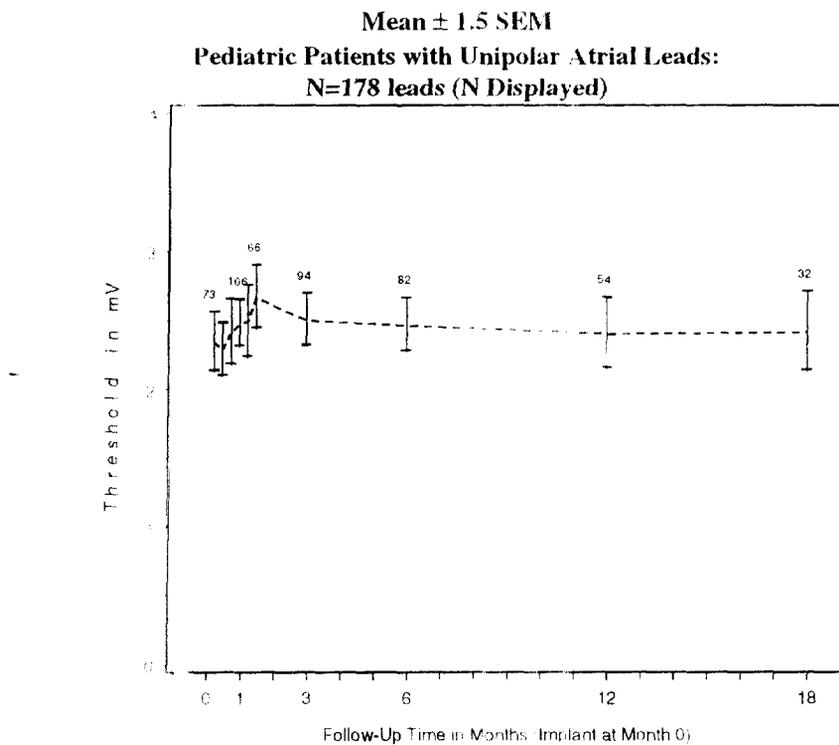
Unipolar Atrial Pulse Width Thresholds at 2.5V			
Follow-up	Model 4965		
	Mean (ms)	N	Standard Deviation
4 Weeks	0.12	117	0.10
3 Months	0.09	97	0.06
12 Months	0.09	54	0.06

Figure 6. Unipolar Ventricular Pulse Width Thresholds at 2.5V



Unipolar Ventricular Pulse Width Thresholds at 2.5V			
Follow-up	Model 4965		
	Mean (ms)	N	Standard Deviation
4 Weeks	0.14	242	0.09
3 Months	0.15	201	0.10
12 Months	0.18	116	0.19

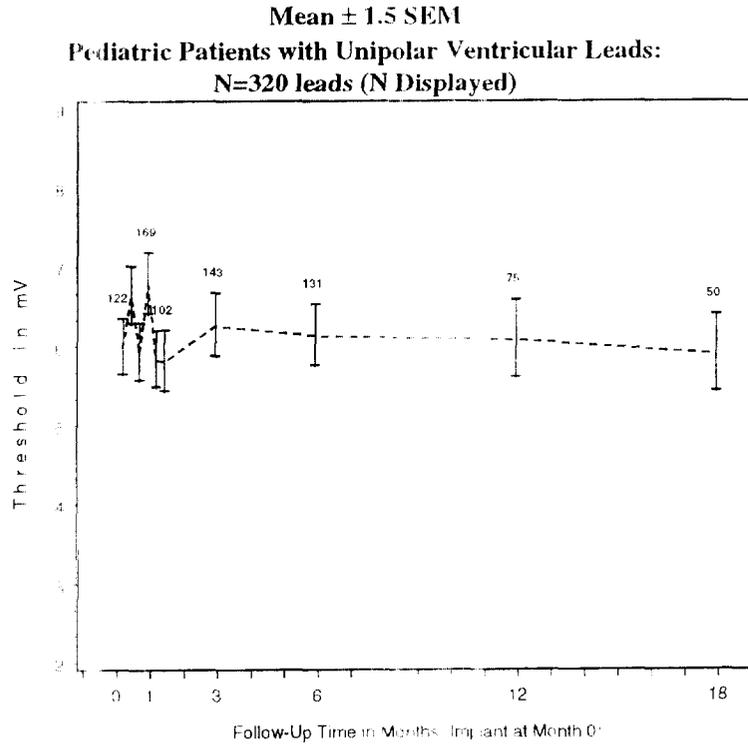
Figure 7. Unipolar Atrial Sensitivity Thresholds



Unipolar Atrial Sensitivity Thresholds			
Follow-up	Model 4965		
	Mean (mV)	N	Standard Deviation
4 Weeks	2.48	106	1.15
3 Months	2.50	94	1.21
12 Months	2.40	54	1.25

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Figure 8. Unipolar Ventricular Sensitivity Thresholds



Unipolar Ventricular Sensitivity Thresholds			
Follow-up	Model 4965		
	Mean (mV)	N	Standard Deviation
4 Weeks	6.78	169	3.32
3 Months	6.26	143	3.15
12 Months	6.07	75	2.81

8. Results Summary (Adult Cohort)

This section contains a summary of demographic, lead survival, and electrical data collected for adult patients implanted with the Model 4965 lead. Sixty-one (61) Model 4965 leads were implanted in 32 adult patients; 43 leads were implanted in the ventricle and 18 in the atrium. A total of 29 bipolar leads (16 pairs) were implanted. Tables 8-11 contain a listing of age, gender, indications for pacing, and implant characteristics for adult patients only.

Table 8. Adult Patient Age: Model 4965

Lead	N	Mean Age (years)	Standard Deviation	Median Age (years)
4965	32	38.5	18.1	34.3

Table 9. Adult Patient Gender: Model 4965

Lead	Gender	N	Percent
4965	Male	15	46.9%
	Female	17	53.1%

Table 10. Adult Patient Indications for Pacing: Model 4965

Comparison Variable	N	%
Intracardiac Congenital Heart Disease	n=24	75.0%
Extracardiac Congenital Heart Disease	n=2	6.3%
Previous Intracardiac Surgery	n=20	62.5%
Previous Extracardiac Surgery	n=2	6.3%
History of Exit Block or Elevated Pacing Thresholds	n= 0	0%
Pacemaker Dependent	n=12	37.5%
Congenital Arrhythmia	n=9	28.1%
Surgically Acquired Arrhythmia	n=14	43.8%

Table 11. Adult Patient Population Characteristics at Implant Model 4965

Comparison Variable	N	%
Surgical Approach	Left Thoracotomy n=14	43.8%
	Subxiphoid n=5	15.6%
	Other ⁴ n=13	40.6%
Concomitant Surgery	n=8	25.0%
Abdominal Pacemaker Location	n=17	53.1%

a. Lead Survival Data (Adult Cohort)

There have been no lead fractures, two ventricular leads lost due to Exit Block (at 506 days), and one ventricular lead lost due to Elevated Thresholds (at 96 days) in the adult group. The lead survival to 12 months in this group is shown in the following table. There are a total of 61 Model 4965 leads used in the analysis, with 15 leads having at least 12 months of follow-up. Only one Model 4965 event (Elevated Thresholds) occurred within the first 12 months post-implant.

Table 12. Adult Model 4965 Lead Survival to 12 months

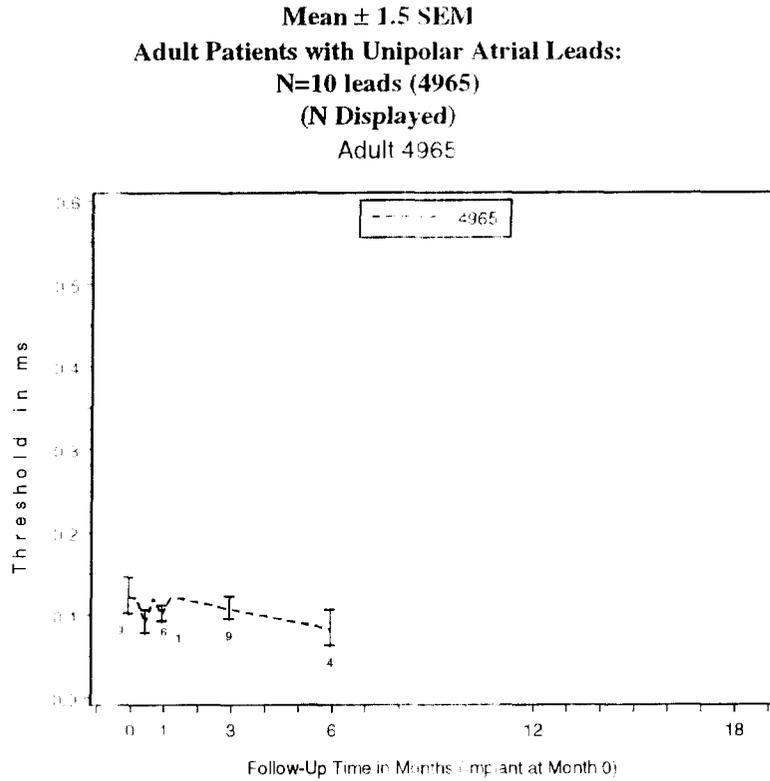
Event Type	Number Failed to 12 months	Survival at 12 months (Std. Error)
Lead Fracture (Fx)	0	100%
Lead Fx + Loss of Capture (LOC)	0	100%
Lead Fx + LOC + Exit Block + Elevated Thresholds	1	98% (2%)
Loss of Lead	1	98% (2%)

⁴ "Other" consists of intercostal lateral thoracotomy, anterior thoracotomy, and partial sternal split surgical approaches.

b. Electrical Data (Adult Cohort)

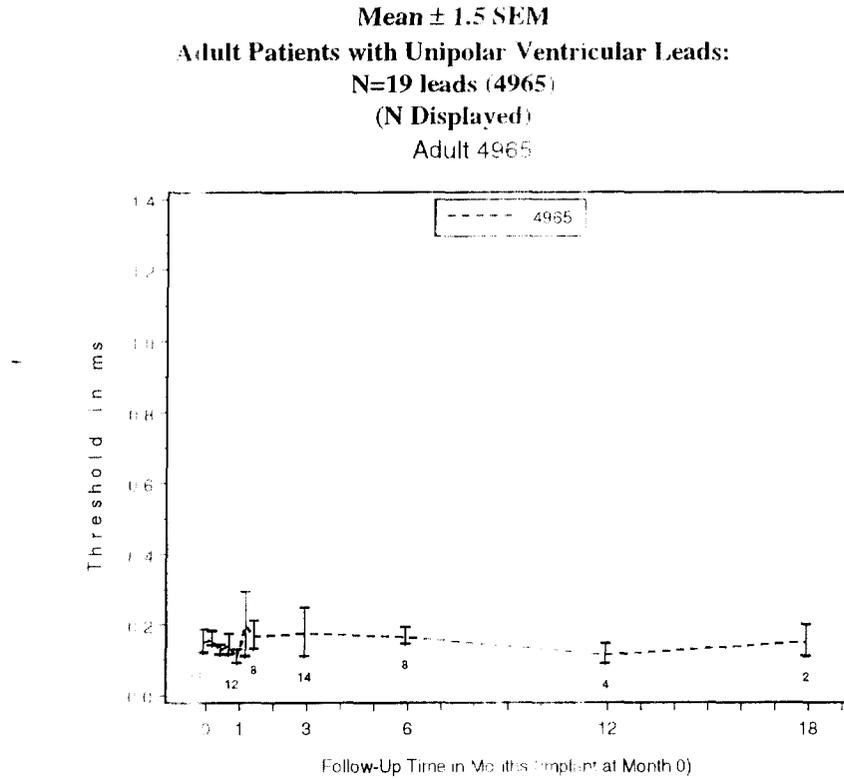
Pacing and sensing performance of the Model 4965 lead in adult patients is illustrated in Figure 9 through Figure 12.

Figure 9. Unipolar Atrial Pulse Width Thresholds at 2.5V



Unipolar Atrial Pulse Width Thresholds at 2.5V			
Follow-up	Model 4965		
	Mean (ms)	N	Standard Deviation
4 Weeks	0.10	6	0.02
3 Months	0.11	9	0.03
12 Months	---	0	---

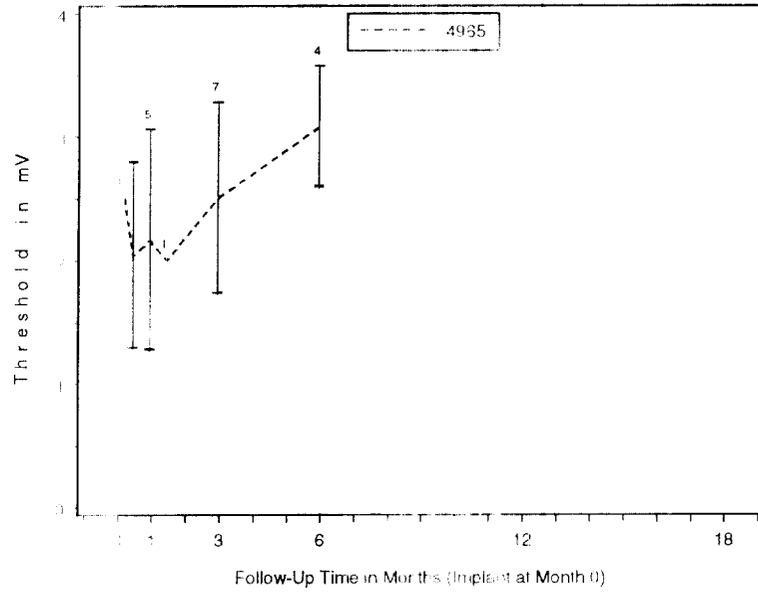
Figure 10. Unipolar Ventricular Pulse Width Thresholds at 2.5V



Unipolar Ventricular Pulse Width Thresholds at 2.5V			
Follow-up	Model 4965		
	Mean (ms)	N	Standard Deviation
4 Weeks	0.11	12	0.04
3 Months	0.17	14	0.17
12 Months	0.11	4	0.04

Figure 11. Unipolar Atrial Sensitivity Thresholds

Mean \pm 1.5 SEM
 Adult Patients with Unipolar Atrial Leads:
 N=10 leads (4965)
 (N Displayed)
 Adult 4965

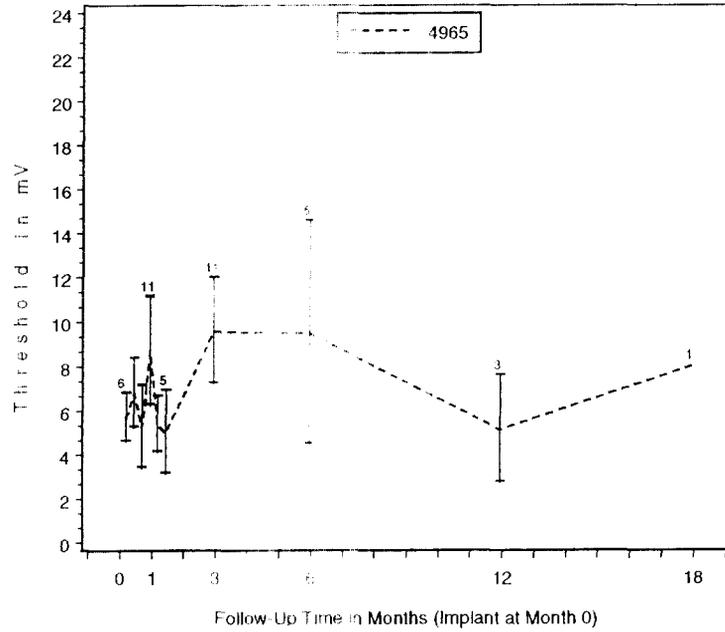


Adult Unipolar Atrial Sensitivity Thresholds			
Follow up	Model 4965		
	Mean (mV)	N	Standard Deviation
4 Weeks	2.16	5	1.32
3 Months	2.50	7	1.35
12 Months	---	0	---

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Figure 12. Unipolar Ventricular Sensitivity Thresholds

Mean ± 1.5 SEM
 Adult Patients with Unipolar Ventricular Leads:
 N=19 leads (4965)
 (N Displayed)
 Adult 4965



Adult Unipolar Ventricular Sensitivity Thresholds			
Follow-up	Model 4965		
	Mean (mV)	N	Standard Deviation
4 Weeks	8.67	11	5.38
3 Months	9.56	11	5.23
12 Months	5.13	3	2.80

9. Patient Deaths, Explants, Lead Abandonments, and Patients Lost to Follow-up

There were 48 patient deaths in the Model 4965 study. The deaths were attributed to the patients' illness, not to the function of the pacing lead. Sixty (60) leads were either explanted (30) or abandoned (30) during the study. Twenty-three (23) patients were lost to follow-up.

XI. Conclusions Drawn from the Studies

The results of the laboratory testing, animal testing, and human clinical study of the CapSure Epi Model 4965 lead demonstrate that it performs according to the design intent and is reasonably safe and effective for use.

In vitro (laboratory) studies included electrical, functional, and mechanical/ environmental testing. All requirements were satisfied and the devices performed according to specification. Animal testing conducted included an evaluation of the electrical performance of the device. Results demonstrated proper device operation. All of the tissue-contacting materials in the Model 4965 pacing lead have been previously tested for biocompatibility. All components and devices tested met all test requirements and performed within design specification.

The clinical evaluation of the Model 4965 lead has demonstrated that the lead is reasonably safe and effective. The Model 4965 lead had acceptable survival from loss of lead and stable, low stimulation thresholds in the acute and chronic phases following implantation.

XII. Panel Recommendations

The Circulatory System Devices Panel met on July 15, 1996, and unanimously recommended approval of the CapSure Epi Model 4965 pacing lead with conditions. The conditions included that additional adult data be collected under a post market surveillance study to validate device performance in adult patients. The following changes to the draft label were also suggested by the Panel: (1) all mention of the Model 4951 control lead and associated data should be removed since it was considered to be a poor historical control, (2) the fourth "potential complication" of the label (page 7) should be reworded, (3) Kaplan-Meier survival curves for the Model 4965 lead should be added, and (4) the number of adults treated with the study lead should be specified.

XIII. FDA Decision

FDA concurred with the recommendations of the Circulatory System Devices Panel and issued an approvable letter on August 28, 1996, with the condition that a study be conducted to collect safety and effectiveness data on fifty (50) adult patients who have been implanted with the CapSure Epi Model 4965 lead. Follow-up of these patients must continue for at least one year and results of this study should be submitted in annual postapproval reports.

The applicant submitted amendments to the PMA agreeing to the conditions of approval and providing the information recommended by the Panel and required by FDA.

A Good Manufacturing Practice (GMP) inspection was conducted and the facility was found to be in compliance with the GMP regulations (21 CFR Part 820).

XIV. Approval Specification

Instructions for Use: See the *Technical Manual*

Hazards to Health from Use of this Device: See Indications, Contraindications, Warnings, Precautions, and Adverse Events sections of the *Technical Manual*

Postapproval Requirements and Restrictions: See approval order

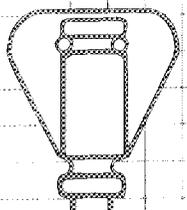


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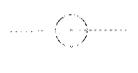
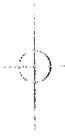
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Capsure Epi

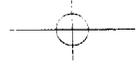
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Technical Manual



Inside Front Cover



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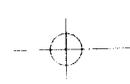
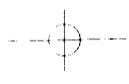
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TECHNICAL MANUAL

CAPSURE® EPI STEROID ELUTING, UNIPOLAR, EPICARDIAL LEAD

Model 4965

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



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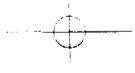


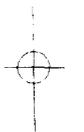
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DEVICE DESCRIPTION

The Medtronic® Model 4965 Capsure® Epi Steroid Eluting, Unipolar, Epicardial Lead is designed for pacing and sensing in either the atrium or the ventricle. Two leads may be used for bipolar pacing.

The porous electrode surface is platinum with platinum black and has been coated with the steroid dexamethasone sodium phosphate.

The electrode contains a maximum of 1.0 mg of dexamethasone sodium phosphate, a portion of which is in a silicone rubber binder. Upon exposure to body fluids, the steroid elutes from the electrode. Steroid suppresses the inflammatory response that is believed to cause threshold rises typically associated with implanted pacing electrodes.

The Model 4965's silicone suture pad is a triangular shape with two suture holes and grooves. The lead also features an MP35N nickel-alloy conductor, silicone rubber insulation, and a unipolar connector (IS-1 UN1).

IS-1 UN1 refers to an International Connector Standard (ISO) 5841:1992 (IEC) whereby pulse generators and leads so designated are assured of a basic mechanical fit.

Contents of Package

The lead and accessories are supplied sterile. Each package contains:

- 1 Model 4965 lead
- 1 tunneler
- 1 Model 5866-45 sizing sleeve
- 1 Lead end cap
- Product literature

INDICATIONS FOR USE

The Model 4965 lead is designed to be used with a pulse generator as part of a cardiac pacing system. The lead has application where implantable epicardial atrial or ventricular, single chamber or dual chamber pacing systems are indicated.

CONTRAINDICATIONS

The lead should not be used on a patient with a heavily infarcted or fibrotic myocardium. It is also contraindicated for the patient whose myocardium is suffused with fat. Do not use this device in patients for whom a single dose of 1.0 mg dexamethasone sodium phosphate may be contraindicated.

WARNINGS

An implanted lead forms a direct, low-resistance 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. The lead connector pin 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 acute lead system testing. Implantation procedure, and whenever arrhythmias are possible or intentionally induced during post-implant testing.

Inspecting the Package

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

Handling the Lead

Before implanting the lead, remove the tip protector. Leads should be handled with great care at all times. Any severe bending, kinking, stretching, or handling with surgical instruments may cause permanent damage to the lead. If the lead is damaged, do not implant. 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.

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-release device. For a listing of potentially adverse effects, refer to the dexamethasone sodium phosphate manufacturer prescribing information or the *Physician's 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.

Chronic Repositioning

Chronic repositioning or removal of the lead after it has been implanted in the patient is not recommended. If removal is unavoidable, return the lead to Medtronic.

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.

Repositioning the lead after it has been implanted may adversely affect a steroid lead's low-threshold performance. See additional cautions in the section titled "Directions for Use."

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 sterilize it with ethylene oxide as described below.

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

Use the tip protector during resterilization to prevent damage to the lead tip.

The process should not exceed temperatures of 55°C (130°F). Allow proper aeration of ethylene oxide residues prior to implantation. Use an 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.

Ensuring Product Integrity

ADVERSE EVENTS

The clinical investigation of the Model 4965 Pacing Lead studied 661 devices implanted in 381 patients for a total of 9681 cumulative device months of experience (3054 Atrial, 6627 Ventricular). Mean duration of implantation was 14.6 months (range 0 to 62 months). Forty eight (48) patients (12.6%) with Model 4965 pacing leads died during the course of the clinical study. None of the deaths were determined to be lead related. Lead related adverse events (AEs), including 43 complications (6.5% of leads) and 57 observations (8.6% of leads), were reported during the clinical investigation. The adverse events that occurred more than one time are summarized in Tables 1 and 2 on the following pages.

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Frequency of Adverse Events for Atrial Leads

Type of Adverse Event (AE)	# of Leads (n=224)	% of Leads [95% CI]	# of Patients (n=201)	% of Patients [95% CI]
Observations				
Muscle Stimulation	12	5.4% [2.4 - 8.3%]	12	6.0% [2.7 - 9.2%]
Undersensing	6	2.7% [0.6 - 4.8%]	6	3.0% [0.6 - 5.3%]
Oversensing	6	2.7% [0.6 - 4.8%]	6	3.0% [0.6 - 5.3%]
Elevated Thresholds	5	2.2% [1.0 - 5.2%]	5	2.5% [1.1 - 5.8%]
Total Observations ¹	29	12.9% [8.6 - 17.3%]	29	14.4% [9.6 - 19.3%]
Complications (Loss of Lead)				
Lead Fracture	5	2.2% [1.0 - 5.2%]	5	2.5% [1.1 - 5.8%]
Total Complications ²	5	2.2% [1.0 - 5.2%]	5	2.5% [1.1 - 5.8%]

¹Observations are adverse events which are corrected by non-invasive measures (e.g. reprogramming).
²Complications are adverse events that resulted in the loss of the lead function (e.g. unable to sense or unable to pace the heart).
 Table 1. Mean duration of implantation is 44 months (range 17 - 62 months).

Table 2. Mean duration of implantation is 14.6 months (range 0 - 67 months)

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

- Observations are adverse events that resulted in the loss of the lead function (e.g. unable to sense or unable to pace the heart)

Frequency of Adverse Events for Ventricular Leads			
Type of Adverse Event (AE)	# of Leads (n=437)	% of Leads [95% CI]	# of Patients (n=355)
			% of Patients [95% CI]
Observations			
Elevated Thresholds	10	2.3% [0.9 - 3.7%]	10
Undersensing	9	2.1% [0.7 - 3.4%]	9
Muscle Stimulation	7	1.6% [0.4 - 2.8%]	7
Overensing	2	0.5% [0.2 - 1.7%]	2
Total Observations¹	28	6.4% [4.1 - 8.7%]	28
Complications (Loss of Lead)			
Lead Fracture	20	4.6% [2.6 - 6.5%]	16
Exit Block	6	1.4% [0.3 - 2.5%]	5
Other Causes	5	1.1% [0.6 - 2.7%]	4
Elevated Pacing Thresholds	4	0.9% [0.4 - 2.4%]	4
Loss of Capture	-	0.7% [0.0 - 2.0%]	2
Total Complications²	38	8.7% [6.1 - 11.3%]	32
			9.0% [6.0 - 12.0%]
			0.8% [0.1 - 2.1%]
			1.1% [0.5 - 2.9%]
			1.1% [0.5 - 2.9%]
			1.4% [0.7 - 3.3%]
			4.5% [2.3 - 6.7%]
			7.9% [5.1 - 10.7%]

There are additional complications related to the use of epicardial leads that include, but are not limited to, the following:

- fibrillation
- heart wall damage
- cardiac tamponade
- muscle or nerve stimulation
- pericardial rub
- infection

In addition, the lead may not perform optimally in patients with thin-walled myocardiums.

Another complication, which has been referenced in the literature, is the potential for increased risk of inducing tachyarrhythmias when using two leads for bipolar pacing. This is thought to be due to the equal surface area of the anodal and cathodal electrodes. If pacing stimuli are observed to be falling on the T wave, it may help to unipolarize the system.

The potential complications listed above may occur at a higher rate with the use of these leads in pediatric patients.

Typical complications resulting in patient symptoms can often be resolved as outlined in the following chart.

Corrective Action	Symptom	to be Considered
Reposition the lead	Lead dislodgement	Intermittent or continuous loss of capture or sensing*
Replace the lead	Lead conductor fracture, or insulation failure	Intermittent or continuous loss of capture or sensing*
Adjust the pulse generator output, or replace or reposition the lead	Threshold elevation or exit block	Loss of capture*

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

CLINICAL STUDY

Summary

The Model 4965 lead was studied in 381 patients who received 661 leads for a total of 9681 device months experience. Six hundred (600) of these leads were implanted in 349 pediatric patients and 61 leads were implanted in 32 adult patients. Data were collected prospectively at 2 weeks and 1, 3, 6, 9 and 12 months post implant at 56 investigative centers. The median patient age for the pediatric population was 2.3 years (range 0 - 18.6 years) ; 57.3% of the pediatric patients were male. For the adult population, the median patient age was 34.3 years (range 19.2 - 79.6 years) ; 46.9% of the adult patients were male.

Primary Objectives

Primary Objective One: To demonstrate the safety of the Model 4965 lead by measuring Loss of Lead survival performance in four categories. The categories were loss of lead due to (1) Fracture (Fx), (2) Fracture (Fx) plus Loss of Capture (LOC) (3) Fx, LOC plus Elevated Thresholds (ET) and FxIt

† Data presented are from the pediatric cohort only

Block (EB) (4) Overall loss of lead (Fx, LOC, ET, EB plus "loss of sensing" and "other"). See Table 4.
Primary Objective Two: To demonstrate the effective acute and chronic pacing and sensing performance of the Model 4965 lead by measuring electrical threshold performance of the device.

Results: Patients in the study who received the Model 4965 device via a left thoracotomy surgical approach were found to have a statistically higher risk of lead fracture than those patients treated with other surgical approaches ($p < 0.01$). A comparison of surgical implant techniques for the effect on lead fractures is shown in Table 3.

Table 3: Cox Regression with surgical technique for effect on fracture of pediatric leads was used to calculate the risk associated with each type of surgical technique. No effect is noted by a confidence interval of the risk associated with each type

Implant Technique	Number Fractured/Total (%) [95% CI]	Risk Ratio [95% CI]
Median Sternotomy	2/250 (0.8%) [0.2 - 2.9%]	0.1 [0.03 - 0.6]
Subxyphoid	4/149 (2.7%) [1.1 - 6.8%]	0.6 [0.2 - 1.8]
Left Thoracotomy	17/157 (10.8%) [6.0 - 15.7%]	5.2 [2.2 - 12.3]
Subcostal	1/16 (6.3%) [1.5 - 30.3%]	2.9 [0.4 - 22.8]
Other	1/22 (4.5%) [1.1 - 22.9%]	0.5 [0.06 - 3.9]

The Model 4965 lead demonstrated acceptable survival at 12 months in the four identified categories:

Category	12 Month Survival
Coil Fractures	96.3%
Coil Fractures + Loss of Capture	95.5%
Coil Fractures + Loss of Capture + Elevated Thresholds + Exit Block	94.8%
Overall Loss of Lead	93.6%

Table 4. Loss of Lead Survival Performance in Pediatric Patients (n=594 leads).

Pacing and sensing thresholds were also found to be acceptable. Furthermore, the Model 4965 lead demonstrated no peaking phenomenon in the acute phase of implantation and had low, stable, chronic stimulation thresholds. The lead performance of the primary outcome study variables is represented graphically on the following pages. The electrical data are presented in Figures 1 through 4, followed by the Kaplan-Meier survival curves that display the safety performance of the Model 4965 lead in Figures 5 through 8.

Unipolar Atrial Pulse Width Thresholds at 2.5V in the Pediatric Cohort

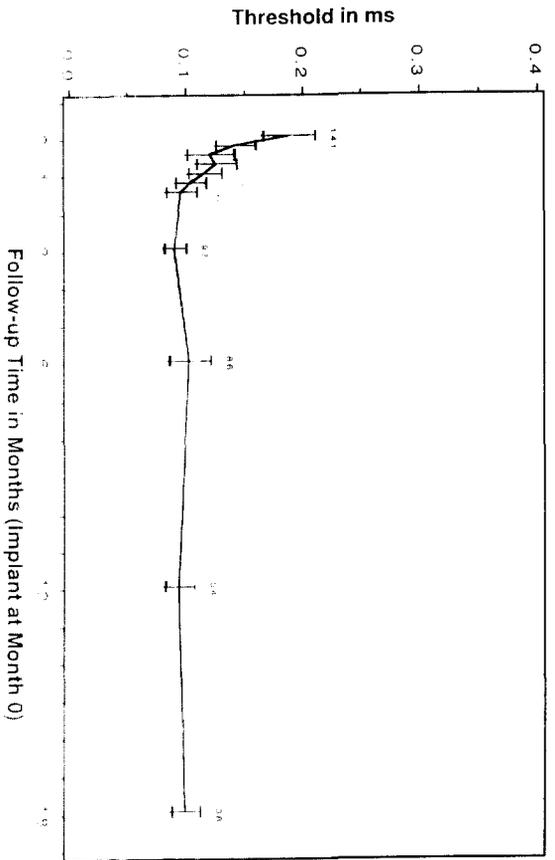


Figure 1. Unipolar Atrial Pulse Width Thresholds at 2.5 V. Mean \pm 1.5 Standard Error of the Mean (SE) are displayed at each data point. Pediatric patients with unipolar atrial leads: n-total=178.

Unipolar Ventricular Pulse Width Thresholds at 2.5V in the Pediatric Cohort

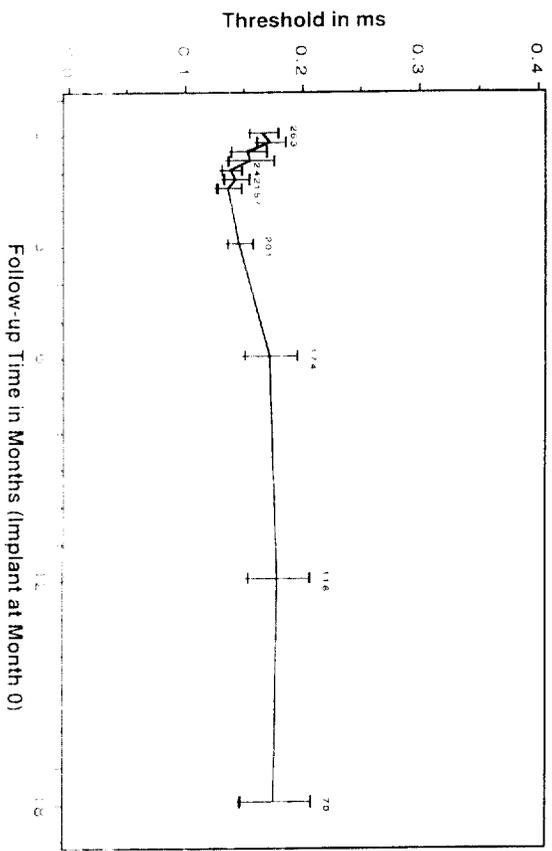


Figure 2. Unipolar Ventricular Pulse Width Thresholds at 2.5 V. Mean \pm 1.5 Standard Error of the Mean (SEM) n displayed at each data point. Pediatric patients with unipolar ventricular leads. n-total=320



Unipolar Atrial Sensitivity Thresholds in the Pediatric Cohort

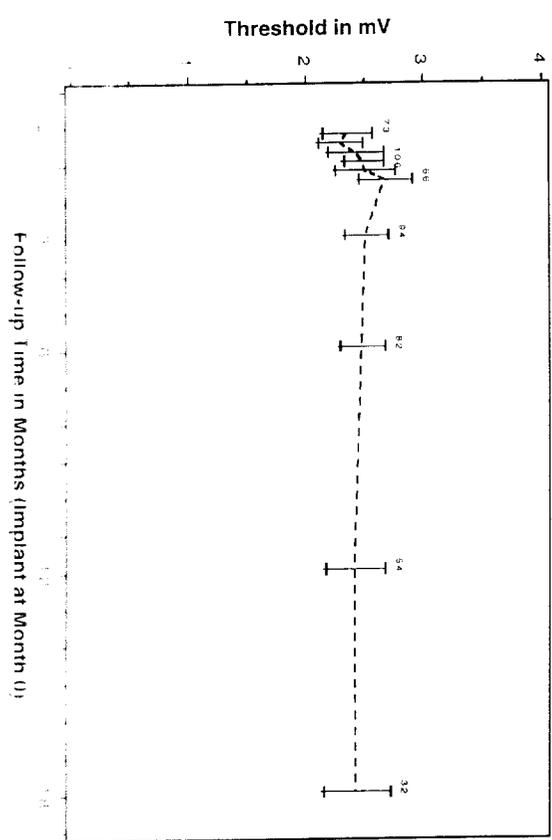


Figure 3 Unipolar Atrial Sensitivity Thresholds, Mean \pm 1.5 Standard Error of the Mean (SEM), as displayed in each data point. Pediatric patients with unipolar atrial leads, n-total=178.

Unipolar Ventricular Sensitivity Thresholds in the Pediatric Cohort

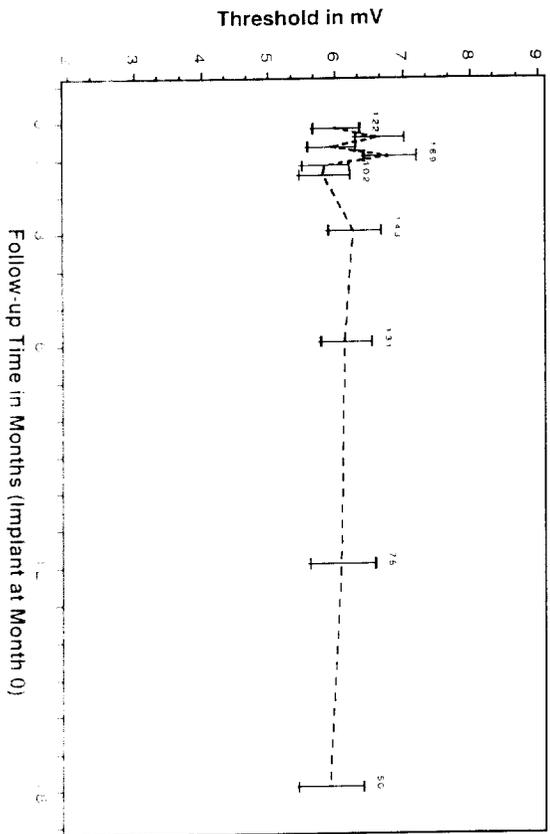


Figure 4. Unipolar Ventricular Sensitivity Thresholds. Mean \pm 1.5 Standard Error of the Mean (SEM). n displayed at each data point. Pediatric patients with unipolar ventricular leads. n-total=320.

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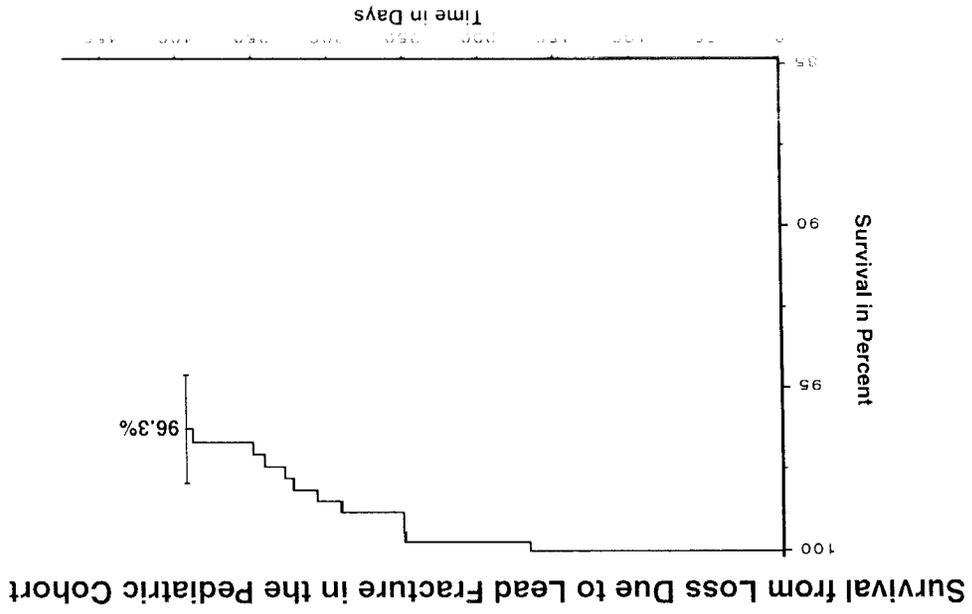


Figure 5 Kaplan-Meier Survival from Loss of Lead Due to Lead Fracture in the Pediatric Cohort, Rate \pm 1.5 Standard Error of the Mean (SEM), Eleven (11) failures in 594 leads, 233 leads at end-point, n=344 patients.

Survival from Loss Due to Lead Fracture and Loss of Capture in the Pediatric Cohort

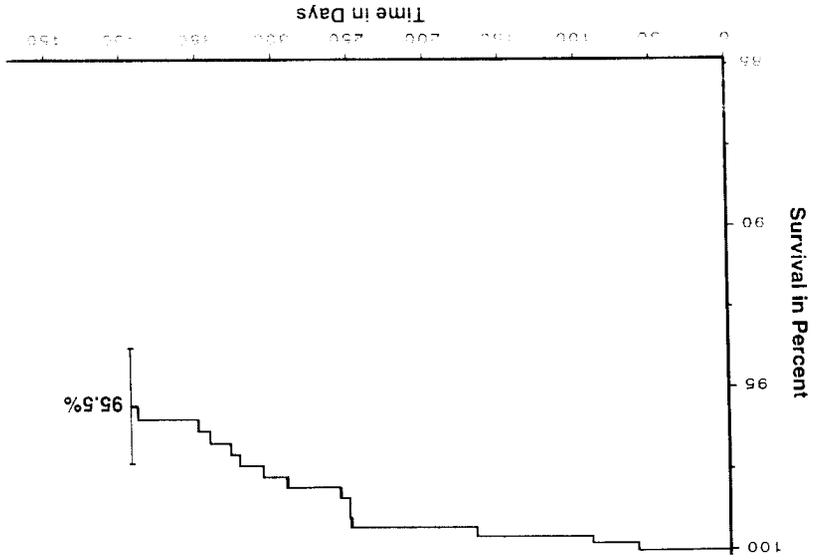


Figure 6. Kaplan-Meier Survival from Loss of Lead Due to Lead Fracture and Loss of Capture in the Pediatric Cohort. Note: The Standard Error of the Mean (SEM), Fourteen (14) failures in 594 leads, 233 leads at end-point, n=344 patients.

Survival from Loss Due to Lead Fracture, Loss of Capture, Exit Block, and Elevated Thresholds in the Pediatric Cohort

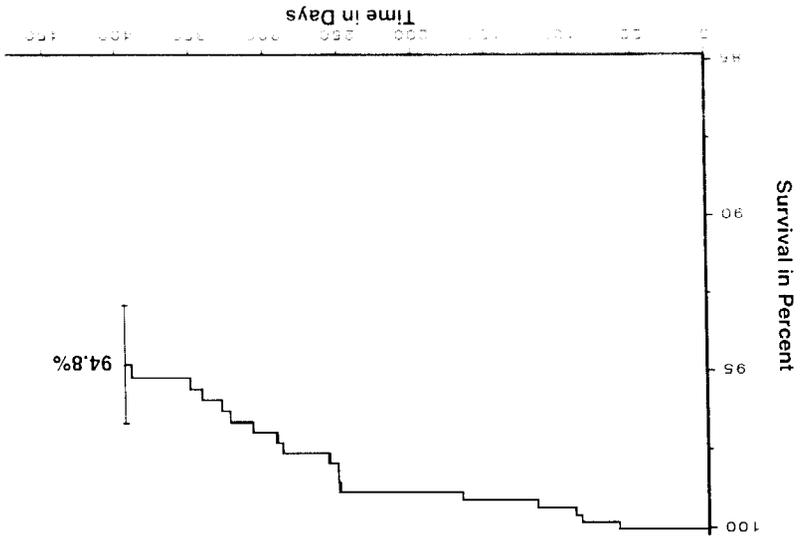


Figure 7 Kaplan-Meier Survival from Loss of Lead Due to Lead Fracture, Loss of Capture, Exit Block and Elevated Thresholds in the Pediatric Cohort (Rate +/- 1.5 Standard Error of the Mean (SEM). Seventeen (17) failures in 594 leads, 233 leads at end-point, n=344 patients)

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Survival from Overall Loss of Lead in the Pediatric Cohort

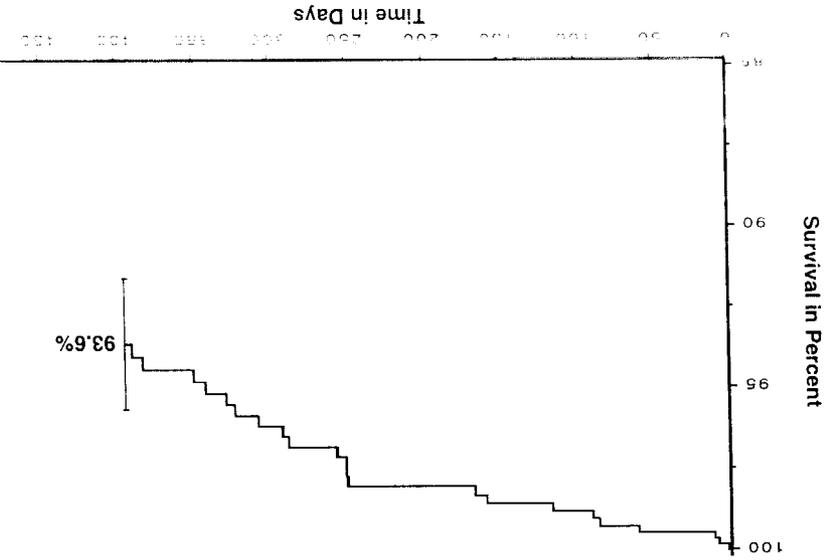


Figure 8 Kaplan-Meier Survival from Overall Loss of Lead in the Pediatric Cohort. Rate \pm 1.5 Standard Error of the Mean (SEM). Twenty-two (22) failures in 594 leads, 233 leads at end-point, n=344 patients.

DIRECTIONS FOR USE

Attaching the Electrode to the Epicardium

The attachment site should be an avascular area free of infarcts, fat, or fibrosis. If bipolar pacing is indicated, a separate electrode may be installed adjacent to the first with a minimum of 1.0 cm space between them (unless a different spacing is required for a particular pulse generator).*

A variety of surgical approaches can be used, including: subxiphoid, left thoracotomy, median sternotomy, transxiphoid, and transmediastinal (Figure 9); however, clinical trials have shown the techniques to have statistically different rates of success as shown in Table 3.

*Refer to the Adverse Events section of this manual.

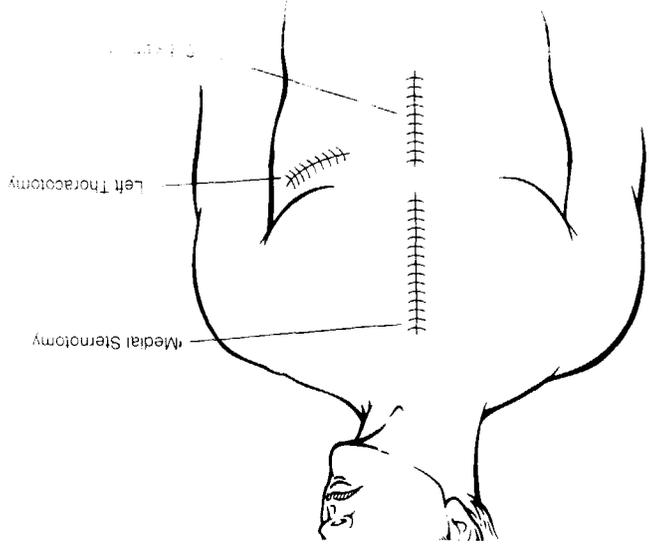


Figure 9. Surgical Approaches

The recommended techniques and guidelines are detailed following this paragraph.

Surgical technique for the subxiphoid approach:

1. Maximize exposure to the epicardial surface.

NOTE: Pericardial Sac should be tied back to maximize exposure to the myocardium.

2. Before implantation, the epicardial lead can be used as a mapping probe by resting the electrode against the epicardium. Stimulation thresholds and sensing signal amplitudes can be measured at various sites in order to locate a suitable attachment site (Figure 10). Each time the electrode touches the epicardium some steroid elutes. Therefore, when determining the best electrical placement for the electrode, move the electrode as

minimally as possible.

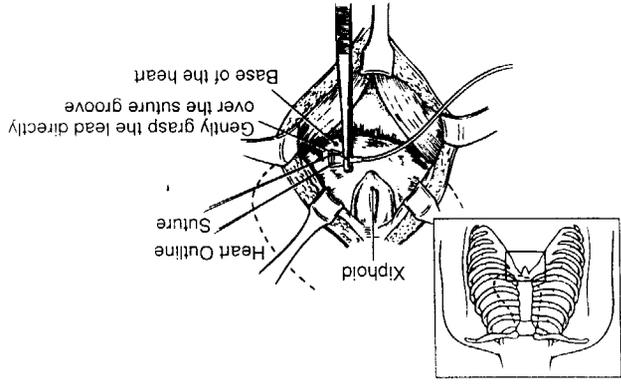


Figure 10. Exposing the epicardial surface and using the lead as a mapping probe.

3. Once an optimal electrode position is confirmed for either the atrium or ventricle, stable fixation through proper suturing of the electrode is critical for maintaining good chronic electrode performance. Suture holes are provided as guides and allow for a variety of suturing options (Figure 11).

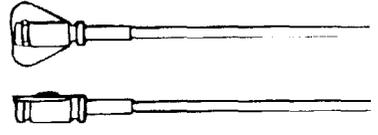


Figure 11. The Model 4965 suture pad has two suture holes for attachment to the epicardium. The top and side views of the electrode illustrate the suture holes and grooves that allow many suturing possibilities.

The recommended suturing technique is the double suture through the epicardium (Figure 12).

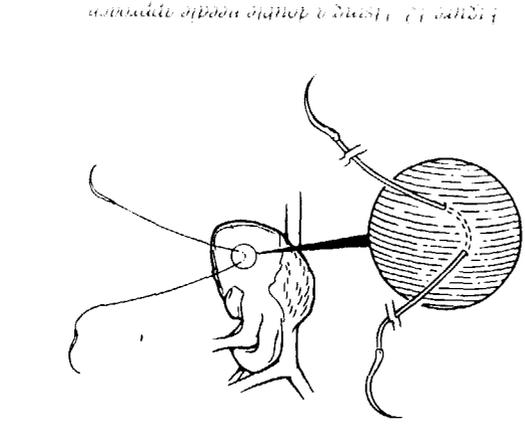


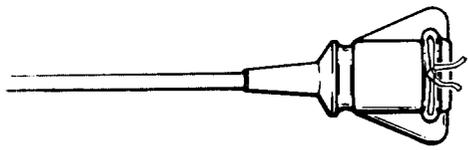
Figure 12. Using a double needle approach.

Insert both needles through the distal suture holes on the electrode head. Suture through the epicardium and tie (Figure 13).



Figure 13. Sutures through the epicardium and coronary artery. Proper suturing of the electrode is critical for maintaining good chronic electrical performance (Figure 14). Loosely attached electrodes might allow some movement, irritating the epicardium, and eventually resulting in elevated thresholds.

Recommended



Not Recommended

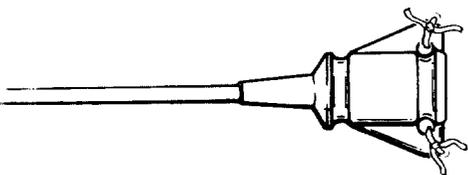


Figure 14. Proper suturing of the electrode.



To avoid causing trauma to tissue near the electrode, which may result in higher thresholds, suture the electrode perpendicular to the heart surface (Figure 15).



Figure 15. Acceptable electrode suturing.

NOTE: Suture should not pass under the electrode. To avoid buckling of the electrode, tie the suture securely, without placing undue tension on the lead (Figure 16).



Figure 16. Acceptable suture tying.

4. Suture through the proximal groove to assure a stable three point fixation (Figure 17).

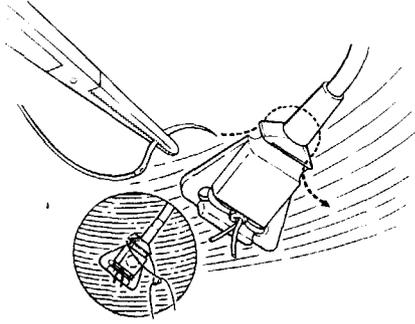


Figure 17. Suturing through the proximal groove.

5. Confirm the electrical measurements. See the next section titled "Taking Electrical Measurements."

Guidelines for a left thoracotomy approach:

1. Use the suturing technique described in the previous section, "Surgical technique for the subxiphoid approach."

- 2. Leave a moderate amount of the lead on both sides of the thoracic exit point to prevent stretching of the lead body (Figure 18).

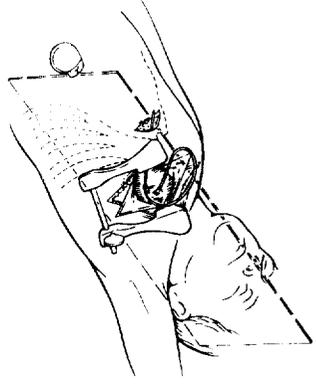


Figure 18. Using a left thoracotomy approach.

Leaving the lead body deep in the abdominal musculature, exit the thorax through the subxiphoid space. Exit the thorax at an angle, not parallel, to the midsagittal plane to reduce acute bending of the lead at the subcostal border. Tunneling the lead laterally or exiting the thorax near the subxiphoid area may reduce the potential for conductor coil fracture (Figure 19).

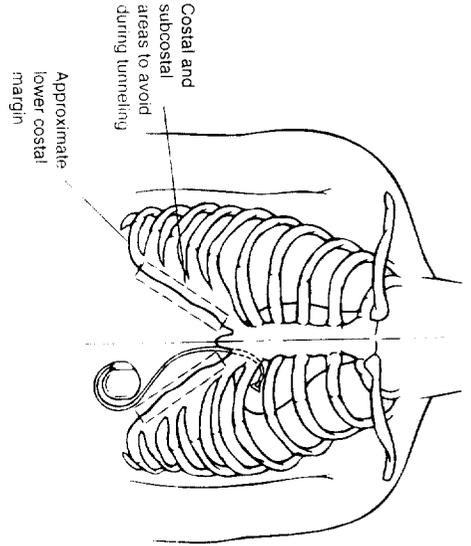


Figure 19. Tunneling the lead

Taking Electrical Measurements

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

Using an External Pulse Generator		Using a Pacing Systems Analyzer:	
Vent	Atrium	Vent	Atrium
Maximum acute stimulation thresholds*	1.5 V*	1.5 V*	1.5 V*
Minimum acute sensing amplitudes	3.0 mA	3.0 mA	3.0 mA

*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 to repeat the testing procedure.

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

AK

Connecting the Lead to the Pulse Generator

If a separate pocket is created for the pulse generator, the lead should be passed within muscle layers to the pocket while avoiding sharp angle bends to the lead body. Attach the connector end of the lead to the tunnel and pass the tunneler to the pocket incision. When removing the lead from the tunneler, hold the lead connector tightly near the pin and gently pull and twist off.

Connect the lead to the pulse generator according to the instructions in the pulse generator manual. Do not use excessive force to connect the lead.

The connector on the Model 4965 is a unipolar connector (IS-1 UNI). IS-1 Unipolar (UNI) and IS-1 Bipolar (BI) leads always have the label identification "IS-1 UNI" or "IS-1 BI" on the

connector.

The 5 mm sizing sleeve (Model 5866-45) included in the package allows the lead to be used with a Medtronic unipolar pulse generator having a 5/6 mm connector block.

If a sizing sleeve is attached and an IS-1 UNI connector is needed, grasp the strain relief area of the lead connector and gently pull the sleeve off (Figure 20).

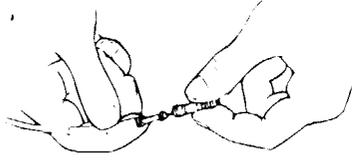


Figure 20. Adding or removing a sizing sleeve.

To add a sleeve to the lead connector, insert the lead connector into the sleeve until the lead pin is exposed approximately 5 mm. If a lubricant is needed, use sterile water only.

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 21).

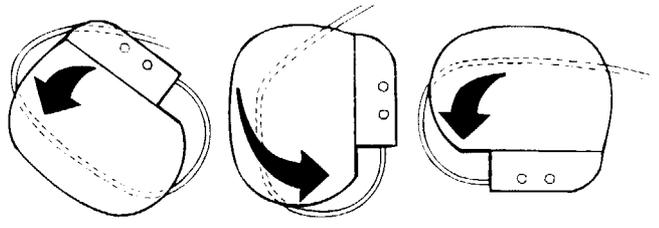


Figure 21. While rotating the pulse generator, loosely wrap the excess lead length and place it under the pulse generator.

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 22).
- Do NOT grip the lead or pulse generator with surgical instruments.

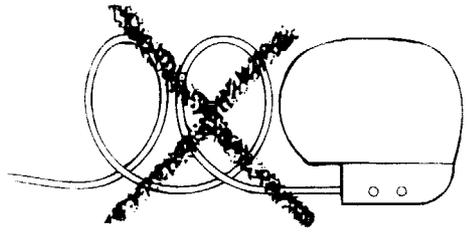


Figure 22. Do not coil the lead body.

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

Using a Lead End Cap

Use a lead end cap to seal off the connector pin (Figure 23) if the lead is being reserved for pacemaker connection at a future date, or if the lead has been abandoned, (i.e., any leads not explanted, but not connected to the pacemaker). Insert the end cap over the lead connector pin so that the sealing rings on the lead are fully covered. Only sterile water may be used to facilitate this application. No adhesives are necessary. Tie a non-absorbable, synthetic ligature in the end cap's groove.

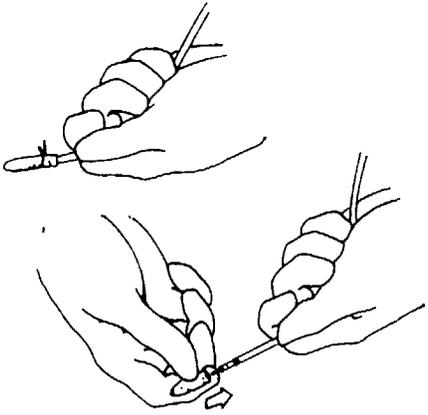


Figure 23. Using the lead end cap.

CAUTION: Do not secure the ligature so tightly that it damages the end cap and the lead.

The end cap can be removed at a later date without damaging the lead.

DETAILED DEVICE DESCRIPTION

Specifications (Nominal)

PARAMETER	MODEL 4965	PARAMETER	MODEL 4965
Type	Unipolar	Electrode Surface Area	14.0 mm ²
Chamber	Ventricle or Atrium	Unipolar Resistance	38 ohms (50 cm)
Fixation	Sutures	Steroid	Dexamethasone Sodium Phosphate
Length	15-110 cm	Amount of Steroid	1.0 mg maximum
Connector	IS-1 UNI	Steroid Binder	Silicone Rubber
Materials	Conductor: MP35N Insulator: Silicone Rubber with SilaCure [®] treatment Electrode: Platinum Alloy		
Tip Electrode Configuration	Platinized, Porous, Steroid Plating,		

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.

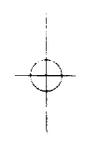
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