

Primary Results of the CardioMEMS Heart Sensor Allows Monitoring of Pressure to Improve Outcomes in NYHA Class III Heart Failure Patients (CHAMPION) Trial

William T. Abraham, MD and Philip B. Adamson, MD
On behalf of the CHAMPION Trial Committees
and Study Group

The CHAMPION Trial was sponsored by CardioMEMS Inc. (Atlanta, Georgia, USA).
Drs. Abraham, Adamson, and other members of the CHAMPION Committees and Study Group
have received research grants and/or consulting fees from CardioMEMS.

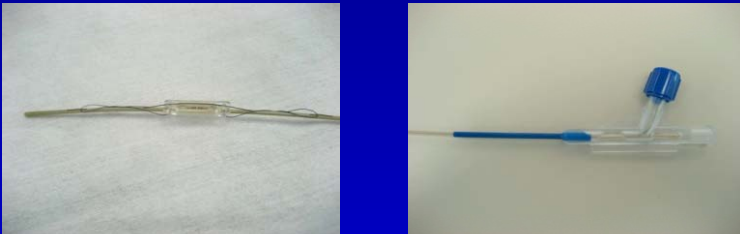
Background

- Despite current drug and device therapies, the rate of heart failure hospitalization remains unacceptably high*
 - > 1.1 million heart failure hospitalizations annually
 - > 20% readmission rate at 1 month
 - > \$18 billion in annual direct costs
- Current methods for monitoring heart failure patients have not adequately addressed this issue
- A new approach is needed to lower the rate of hospitalization in heart failure patients

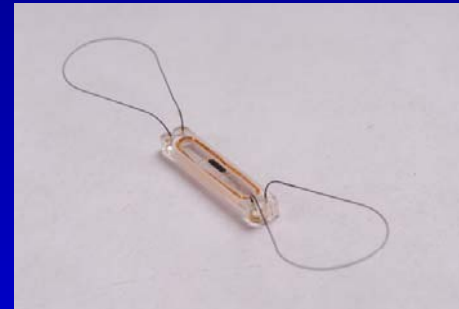
*U.S. Data: 2009 American Heart Association Heart Disease and Stroke Statistical Update

The Pulmonary Artery Pressure Measurement System*

Catheter-based delivery system



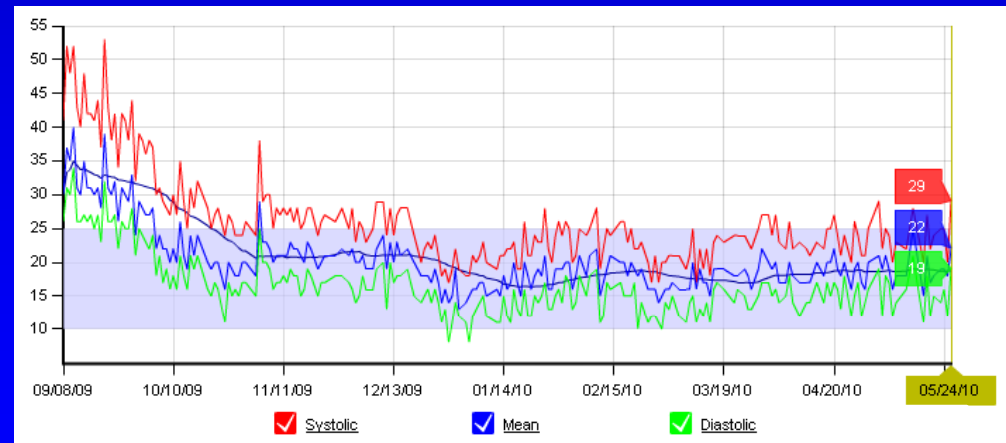
MEMS-based pressure sensor



Home electronics



PA Measurement database

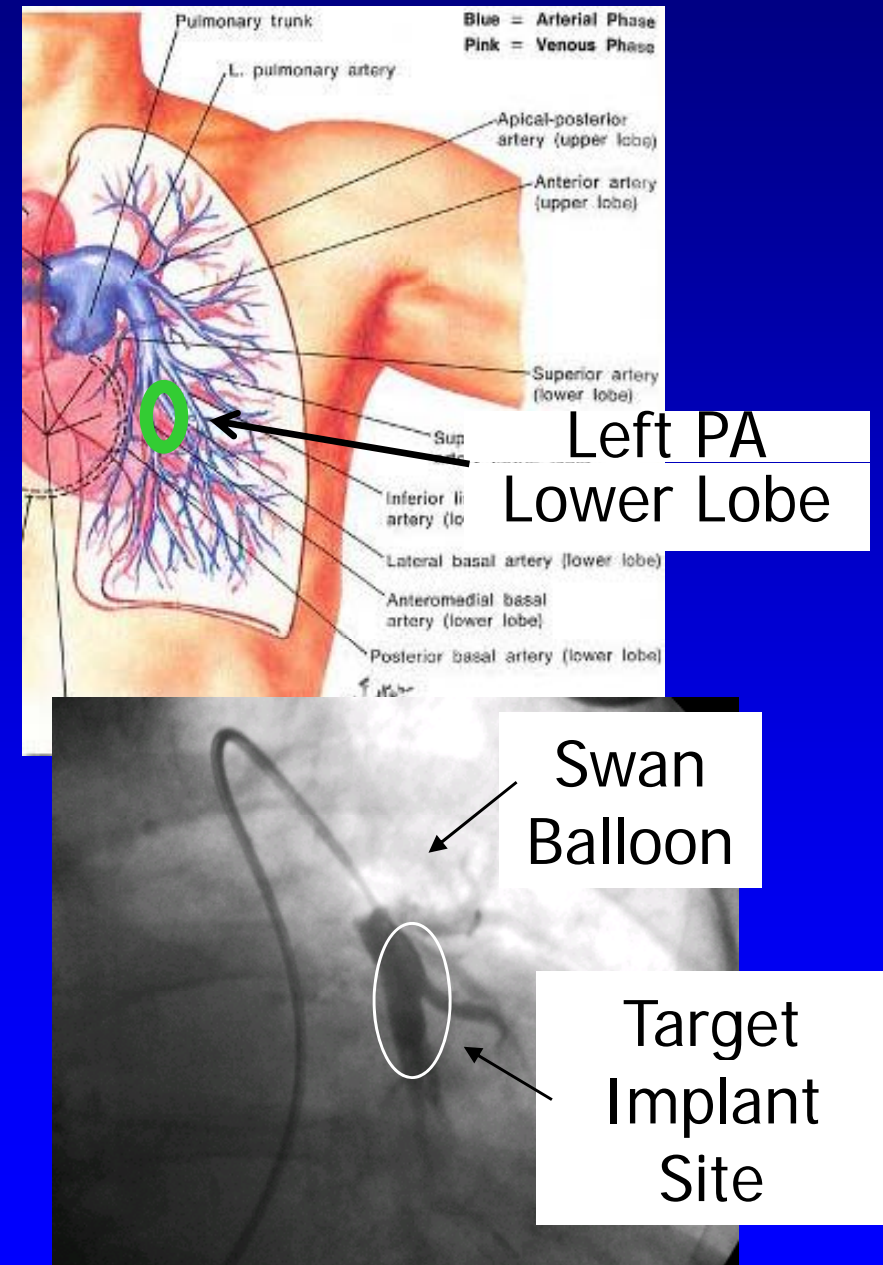


*CardioMEMS Inc., Atlanta, Georgia, USA

Caution – Investigational device. Limited by United States law to investigational use

Pulmonary Artery Sensor Implantation

- RHC with selective pulmonary angiogram
- Right or left PA branch, basal (lower) lobe, descending branch, pre-bifurcation
- Vessel Lumen ID: 10 mm (7-15mm)
- The Sensor and nitinol loops allow placement in the pulmonary artery in a distal location without injury to artery
- Clopidogrel/ASA combination 1 month post-implant or previous warfarin therapy



Objective/Hypothesis

- The objective of the study is to evaluate the safety and efficacy of the HF Pressure Measurement System in reducing heart failure (HF)-related hospitalizations in a subset of subjects suffering from HF
- Primary efficacy will be measured by comparing the rate of HF-related hospitalizations during the 6 months following implant in the TREATMENT group (standard of care HF management plus HF management based upon hemodynamic information obtained from the HF Pressure Management System) with that of the CONTROL group (standard of care HF management).

Study Design

- Prospective, multi-center, randomized (1:1), controlled single-blind clinical trial
 - Treatment group received traditional HF management guided by hemodynamic information from the sensor
 - Control group received traditional HF disease management
- 550 subjects enrolled at 63 sites in the U.S. between October 2007 and September 2009
- All subjects followed in their randomized single-blind study assignment until the last patient reached 6 months of follow-up

Hemodynamic Management Treatment Group

- Hemodynamic monitoring pressure target values:
 - Pulmonary artery systolic pressure 15 – 35 mmHg
 - Pulmonary artery diastolic pressure 8 – 20 mmHg
 - Pulmonary artery mean pressure 10 – 25 mmHg
- Target pressures were reached using neurohormonal, diuretic, and/or vasodilator therapies

Major Eligibility Criteria

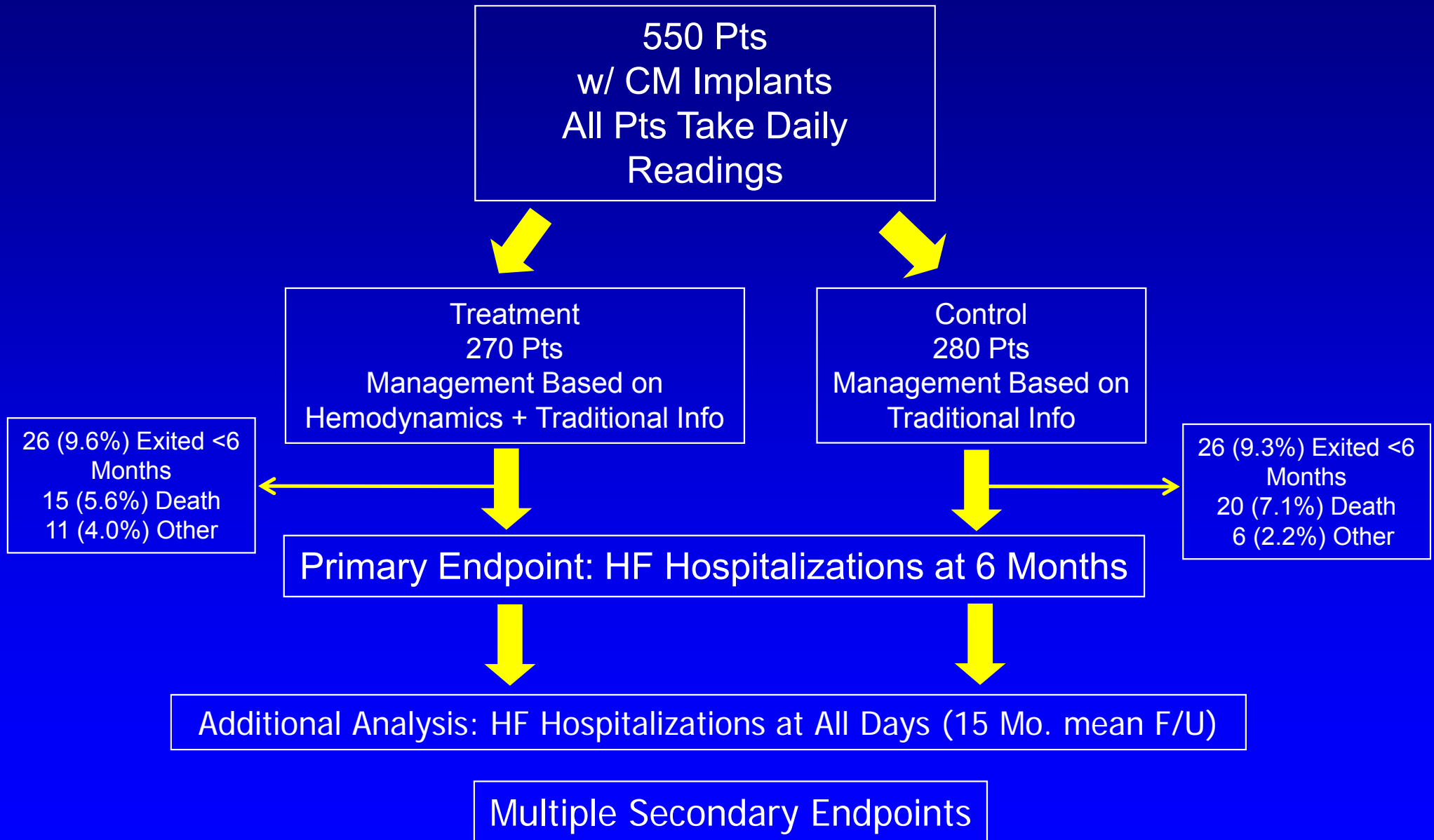
- NYHA Class III heart failure on optimal/stable drug and device therapy
- Hospitalized for heart failure within the past 12 months
- BMI $\leq 35^*$ and implanted PA branch diameter sized 7-15 mm
- No history of recurrent (> 1) PE or DVT
- No GFR < 25 ml/min if non-responsive to diuretic therapy or on chronic renal dialysis
- Not likely to undergo heart transplantation within 6 months
- No congenital heart disease or mechanical right heart valve(s)
- No coagulation disorders or hypersensitivity/allergy to aspirin, and/or clopidogrel

*If BMI > 35 and chest circumference within 53-64 inches, PA must be < 10 cm from skin on patient's back as confirmed by lateral angiogram during RHC

Endpoints

- Primary Safety Endpoint (at 6 months)
 - Freedom from device/system-related complications
 - Freedom from HF sensor failure
- Primary Efficacy Endpoint (at 6 months)
 - Rate of HF related hospitalizations
- Secondary Endpoints (at 6 months)
 - Change in pulmonary artery pressures
 - Proportion of subjects hospitalized for HF
 - Days alive out of the hospital
 - Quality of Life
- Ancillary Analysis
 - Rate of HF hospitalization over entire period of follow-up

Patient Disposition



Implant Characteristics

- Sensor implant time after RHC:
 - Mean 7 minutes
- PA pressures at time of Implant:
 - PA Systolic: 45 ± 15 mm Hg
 - PA Mean: 29 ± 10 mm Hg
 - PA Diastolic: 19 ± 8 mm Hg

Patient Demographics

	Treatment (n = 270)	Control (n = 280)	p-Value
Age (yrs), mean \pm SD	61 \pm 13	62 \pm 13	0.59
Gender (% female)	28	27	0.77
Race (% Caucasian)	73	73	0.92
Ejection Fraction (% \geq 40%)	22	20	0.55
CRT Device (%)	34	36	0.79
ICD Device (%)	62	66	0.38
Diuretic use (%)	94	95	0.85
ACE-I or ARB use (%)	78	81	0.40
Beta-blocker use (%)	84	86	0.55

CRT = cardiac resynchronization therapy; ICD = implantable cardioverter-defibrillator
 ACE-I = angiotensin-converting enzyme inhibitor; ARB = angiotensin receptor blocker.

Primary Safety Results

	Consented Not Enrolled (n=25)	Treatment (n=270)	Control (n=280)	All Patients	p-Value
Primary Safety Endpoint: Device/System Related Complications at 6 Months, # (%)	2(8)	3 (1.1)	3 (1.1)	8 (1.4)	<0.0001¹
Primary Safety Endpoint: Pressure Sensor Failures at 6 Months, # (%)	0 (0)	0 (0)	0 (0)	0 (0)	< 0.0001²

¹p-value from exact test of binomial proportions compared to 80% for All Patients

²p-value from exact test of binomial proportions compared to 90% for All Patients

Primary Efficacy Results

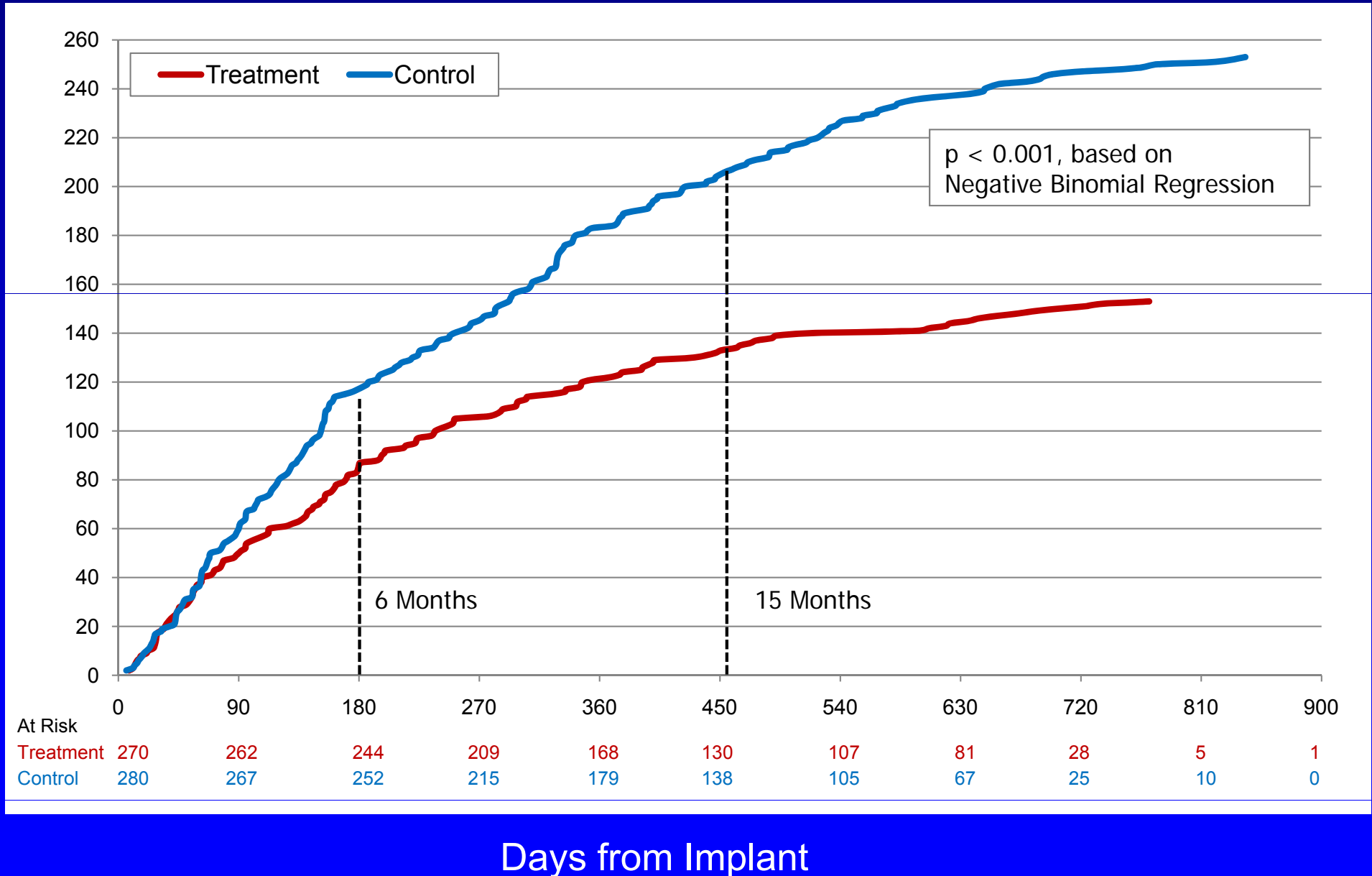
	Treatment (n=270)	Control (n=280)	Relative Risk Reduction	p-Value ¹	NNT
Primary Efficacy Endpoint: HF Hospitalizations Up To 6 Months, # (Rate)	83 (0.31)	120 (0.44)	30%	<0.001	8
Ancillary Analysis: Annualized HF Hospitalizations Over Entire Randomized F/U [Duration: 454±211 (1–931) Total: 249,656 days], # (Rate)	154 (0.45)	254 (0.73)	38%	<0.0001	4

¹p-value from negative binomial regression

NNT = Number Needed to Treat

Cumulative HF Hospitalizations Over Entire Randomized Follow-Up Period

Cumulative Number of HF Hospitalizations

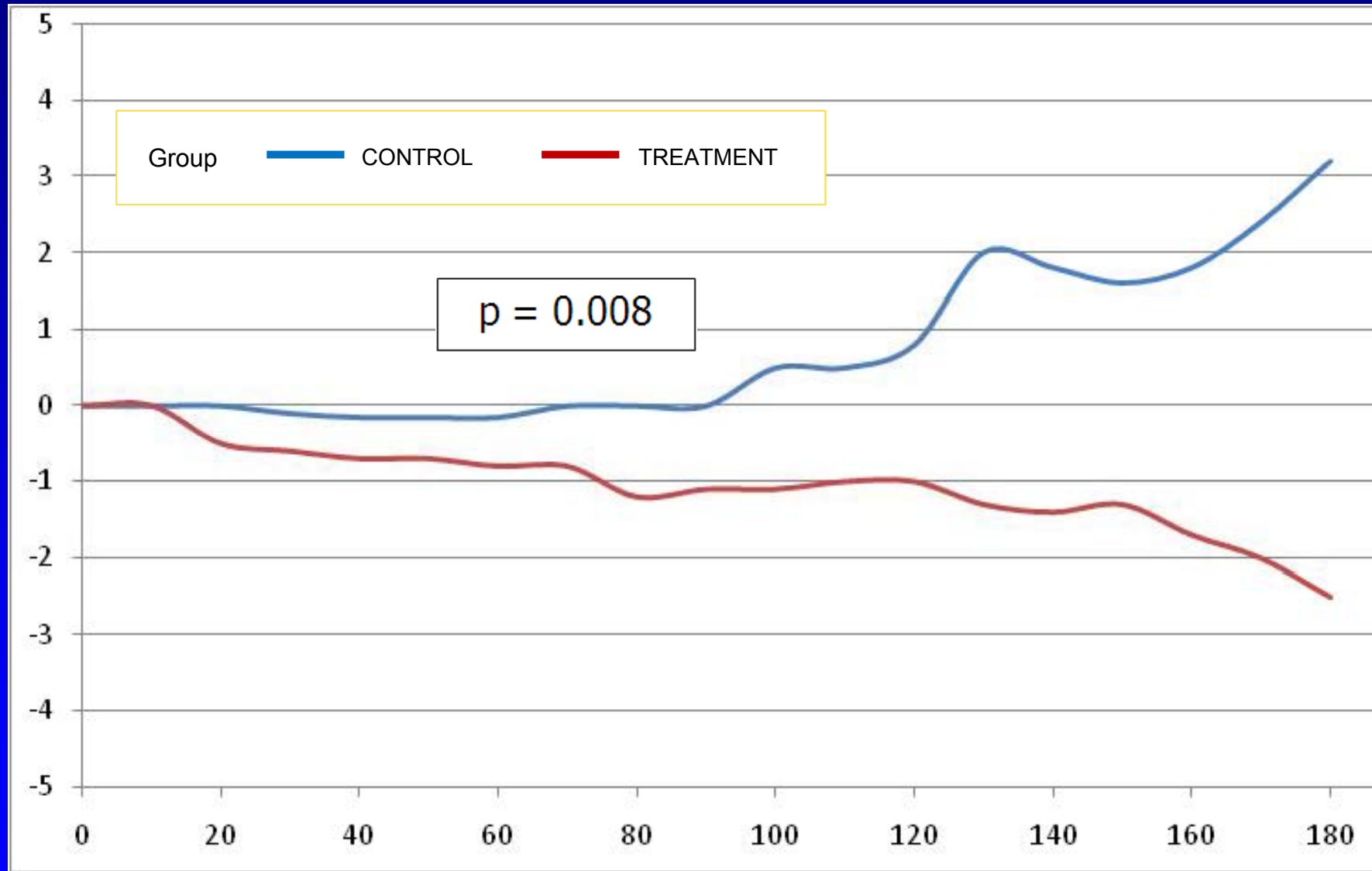


Secondary Efficacy Results

	Treatment (n=270)	Control (n=280)	p-Value
Change from Baseline in Mean Pulmonary Artery Pressure at 6 Months, mean AUC	-156	33	0.008
Subjects Hospitalized for Heart Failure at 6 Months, # (%)	54 (20)	80 (29)	0.022
Days Alive Outside Hospital at 6 Months, mean	177.1	175.9	0.022
Minnesota Living with Heart Failure Questionnaire at 6 Months, mean	45	51	0.024

AUC PA Mean Change from Baseline up to 6 Months

PA Mean AUC up to 6 Months



Days from Implant

Conclusions

- Heart failure management using the CardioMEMS pulmonary artery pressure monitoring system resulted in a significant reduction in HF hospitalizations:
 - 30% reduction in HF hospitalizations at 6 months
 - 38% reduction in annualized HF hospitalization rates for the entire randomized follow-up
 - Improvements in PAPs, proportion of patients hospitalized, days alive out of the hospital, and quality of life
- The CardioMEMS pulmonary artery pressure monitoring system represents a significant improvement in HF management for NYHA Class III HF patients

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