



Bolton Medical

**RELAY**<sup>®</sup> THORACIC STENT-GRAFT  
with **plus**<sup>1</sup> Delivery System

2844-1735, Rev B.

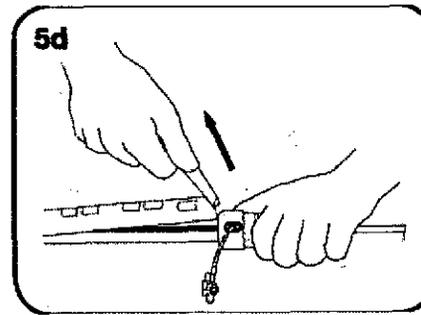
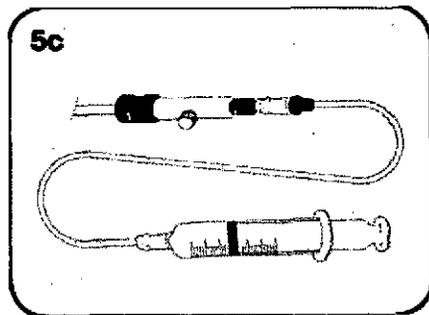
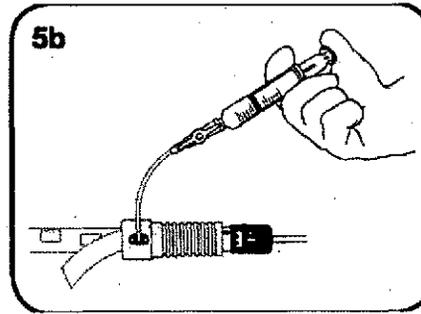
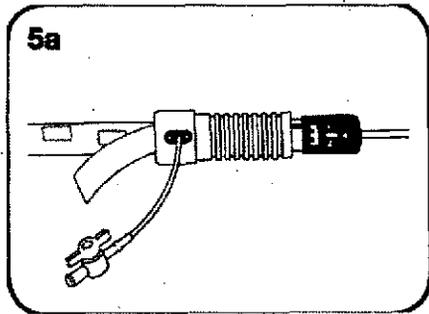
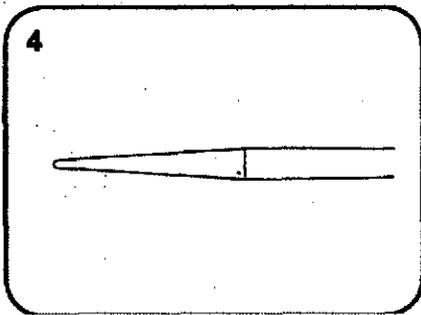
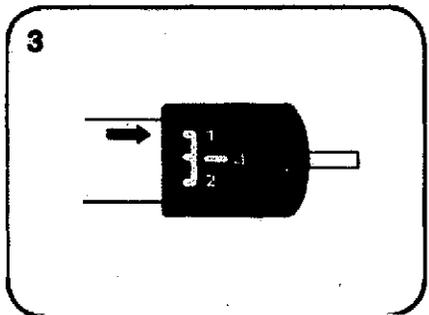
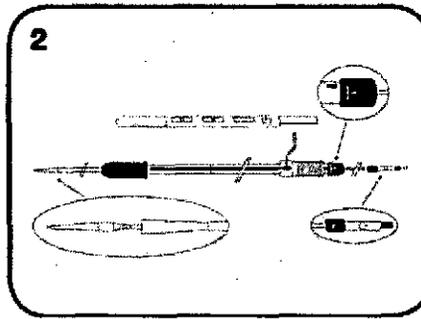
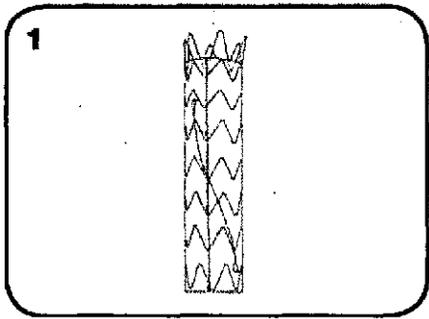
# RELAY<sup>®</sup> THORACIC STENT-GRAFT

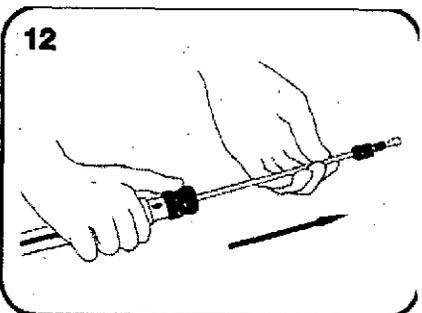
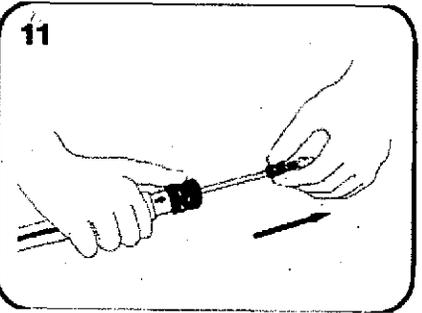
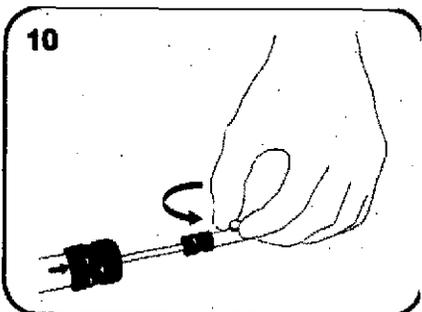
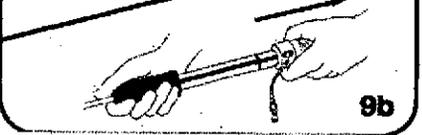
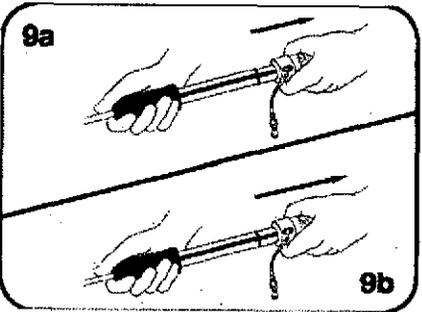
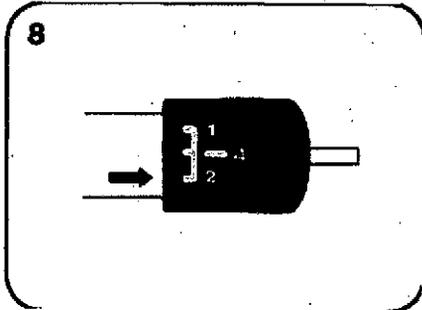
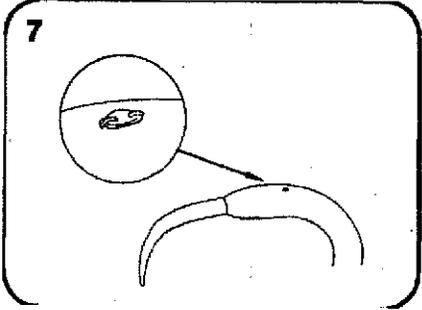
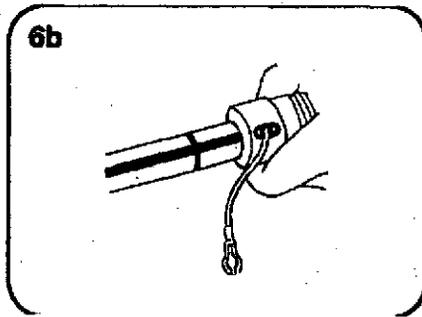
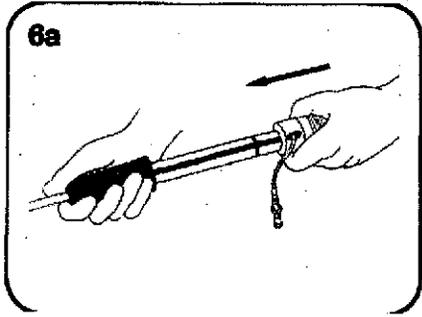
with **plus** Delivery System

<b>STERILE</b>	<b>R</b>
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## Instructions for Use (IFU)

- Caution: Federal (USA) law restricts this device for sale by or on the order of a physician.
- Review the guidance in this Instructions for Use before attempting to use the Relay<sup>®</sup> Thoracic Stent-Graft with Plus Delivery System
- This device is supplied **STERILE** for single use only. Do not attempt to re-sterilize.
- Do not use the device if it is visibly damaged or if it appears that the sterile packaging is compromised.





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**RELAY**<sup>®</sup> THORACIC STENT-GRAFT  
with **PLUS**<sup>™</sup> Delivery System

2844-1735, Rev B

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Symbols and Definitions

	Consult Instructions For Use	<b>REF</b>	Model/Catalogue Number
	Do Not Reuse	<b>LOT</b>	Lot Number
	Do Not Resterilize		Do Not Use If Package Is Damaged
<b>STERILE R</b>	Sterilized by Irradiation		Use By
	Manufacturer		MR Conditional
	Date of Manufacture	<b>RxOnly</b>	Caution: Federal (USA) law restricts this device for sale by or on the order of a physician
	Storage Temperature		

# Relay<sup>®</sup> Thoracic Stent-Graft with Plus Delivery System

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## 1 DEVICE DESCRIPTION

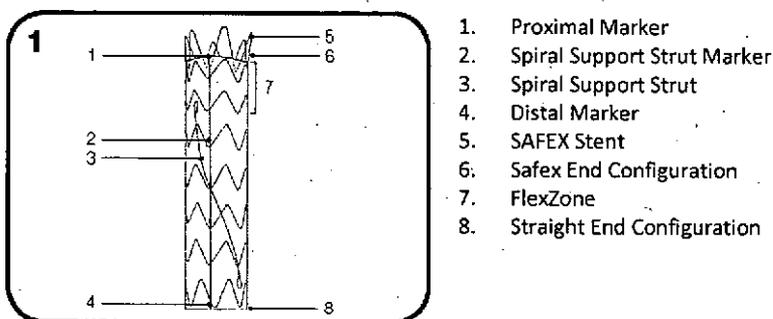
The Relay® Thoracic Stent-Graft with Plus Delivery System is an endovascular device intended to treat fusiform aneurysms and saccular aneurysms/penetrating atherosclerotic ulcers in the descending thoracic aorta. The Relay® device, once placed in the aorta, provides an alternative conduit for blood flow while excluding the lesion. The system consists of an implantable stent-graft and delivery system.

### 1.1 STENT-GRAFT

The Relay® Stent-Graft is comprised of self-expanding nitinol stents sutured to polyester graft fabric. The stent scaffold is a series of serpentine springs stacked in a tubular configuration. These stents are spaced along the length of the graft fabric. Longitudinal support for the stent-graft is provided by a curved nitinol wire called Spiral Support Strut. Additionally, radiopaque markers are placed on the stent-graft to aid visualization and accurate placement.

One proximal end configuration is available. The SAFEX end configuration (*Fig 1*) consists of uncovered, sinusoidal nitinol wires of varying heights, circumferentially projecting above the fabric end of the graft. These uncovered wires, when in position, expand to the vessel wall anchoring the device in place and aid in creating a seal zone oriented to the vasculature. Secondly, this design is placed across vessels maintaining patency, i.e. left subclavian/ left common carotid arteries, and increasing the landing zone area.

One distal configuration is available. The STRAIGHT end configuration (*Fig 1*) consists of fabric covering the nitinol springs evenly about the circumference of the stent-graft. This configuration is present distally on all Stent-Grafts.



1. Proximal Marker
2. Spiral Support Strut Marker
3. Spiral Support Strut
4. Distal Marker
5. SAFEX Stent
6. Safex End Configuration
7. FlexZone
8. Straight End Configuration

All stent-grafts have platinum/iridium radiopaque marker bands (*Fig 1*) which indicate the fabric edge and will also serve as guides for positioning the spiral support strut.

The Relay® stent-graft does not contain any natural rubber latex; however, during the manufacturing process, it may have incidental contact with latex. **Table 1** lists the Relay® Thoracic Stent-Graft materials.

**Table 1: Relay® Thoracic Stent-Graft Materials**

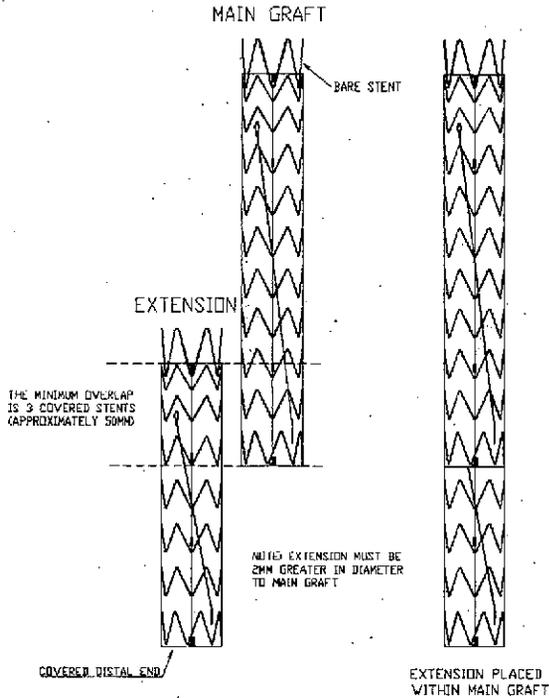
Component	Material
Stents	Nitinol Wire
Spiral Support Strut	Nitinol Wire
Graft Fabric	Polyester
Suture	PTFE-impregnated polyester

Radiopaque markers

Platinum-iridium wire

Figure 1a shows the how Relay® stent-grafts are combined.

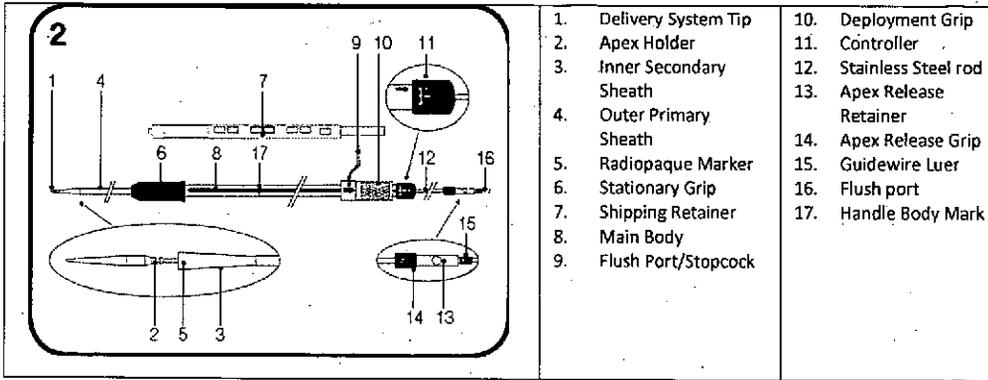
Figure 1a: Combination of Relay® Stent-Grafts



## 1.2 DELIVERY SYSTEM

The Plus Delivery System consists of a series of coaxially-arranged sheaths and catheters, along with a tubular handle control system. The tapered tip and introducer sheath have a lubricious hydrophilic coating. The delivery system is provided in outer diameters ranging from 22 to 26 French, depending on the corresponding stent-graft diameter, with a working length of 90 cm. It is single-use and disposable.

The delivery mechanism consists of two stages. The first stage consists of a hydrophilically-coated introducer (Outer Primary Sheath), which is used to advance and track over a guidewire. It is compatible with a 0.035 in. (0.89 mm) guidewire. The tip of the Outer Primary Sheath contains a preformed curve. Within the first stage is the second stage. The second stage is a flexible sheath (Inner Secondary Sheath) in which the stent-graft is compressed. The flexibility of the second stage permits tracking through tortuous and curved portions of the thoracic aorta. The stent-graft is self-expandable and the delivery system is withdrawn after deployment.



## 2 INDICATIONS FOR USE

The Relay Thoracic Stent-Graft with Plus Delivery System is indicated for the endovascular repair of fusiform aneurysms and saccular aneurysms/penetrating atherosclerotic ulcers in the descending thoracic aorta in patients having appropriate anatomy, including

- Iliac or femoral access vessel morphology that is compatible with vascular access techniques, devices and/or accessories
- Non-aneurysmal aortic neck diameter in the range of 19 – 42 mm
- Non-aneurysmal proximal aortic neck length between 15 and 25 mm and non-aneurysmal distal aortic neck length between 25 and 30 mm, depending on the diameter stent-graft required

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## 3 CONTRAINDICATIONS

The Relay Thoracic Stent-Graft with Plus Delivery System is contraindicated in the following clinical scenarios:

- Patients who have a condition that threatens to infect the graft
- Patients who are sensitive to, or have known allergies to, the device materials (Refer to Table 1)

Consideration should also be given to the information presented in Section 7, Patient Selection and Treatment.

**CAUTION:** Read all instructions carefully. Failure to properly follow the instructions, warnings, and precautions may lead to serious consequences or injury to the patient.

#### 4.1 General

- Always have a qualified surgery team available during implantation or reintervention procedures in the event that conversion to open surgical repair is necessary.
- The Relay® Thoracic Stent-Graft should only be used by physicians and teams trained in vascular interventional techniques and in the use of this device. Specific training expectations are described in **Section 10.1, Physician Training Requirements**.

#### 4.2 Patient and Device Selection

- The Relay® Thoracic Stent-Graft is not recommended in patients unable to undergo, or who will not be compliant with, the necessary pre-operative and post-operative imaging and implantation studies as described in **Section 12, Follow-up Imaging Recommendations**.
- The Relay® Thoracic Stent-Graft is not recommended for patients who cannot tolerate contrast agents necessary for intra-operative and post-operative follow-up imaging.
- The Relay® Thoracic Stent-Graft is not recommended for patients whose weight or size would compromise or prevent the necessary imaging requirements.
- Preoperative planning for access and placement should be performed prior to the procedure. See **Section 10.2, Recommended Device Sizing**. Key anatomic features that may adversely impact successful exclusion of the lesion include tortuosity, short landing zone(s), and thrombus or calcium formation at the implantation sites. In the presence of anatomical limitations, a longer landing zone and additional stent grafts may be required to obtain adequate sealing and fixation.
- As part of prudent preoperative case planning, an inventory of device lengths and diameters necessary to complete the procedure should be available to the physician.
- The use of the Relay® Thoracic Stent-Graft requires the administration of radiographic agents. These may present increased risk of post-operative renal failure for patients with pre-existing renal insufficiency.
- Improper patient selection may lead to poor performance of the Relay® Thoracic Stent-Graft.
- The safety and effectiveness of the Relay® Thoracic Stent-Graft has not been evaluated in the following patient populations:
  - Patients who require placement of the covered proximal end of the stent-graft proximal to the left common carotid
  - Patients with access vessels that, in the judgment of the physician, cannot accommodate the Plus Delivery System. (Iliac conduits may be used to permit safe introduction of the delivery system.)
  - Patients with symptomatic or ruptured aneurysms
  - Patients with known or suspected connective tissue disorders (e.g., Marfan's or Ehlers-Danlos Syndromes)
  - Patients with previously-placed stents, stent-grafts or surgical grafts in the targeted area of treatment
  - Patients for whom a concomitant surgical or endovascular repair of an infrarenal abdominal aortic aneurysm is planned
  - Patients who have known allergy or hypersensitivity to anticoagulants or contrast media and are unable to tolerate pretreatment

- Patients with prohibitive calcification, occlusive disease, tortuosity, or circumferential thrombus in the intended fixation sites
  - Female patients who are pregnant or lactating
  - Patients less than 18 years of age
  - Patients with acute or chronic dissection
  - Patients with transections or traumatic aortic injuries
  - Patients with intramural hematoma
  - Patients with mycotic aneurysms
  - Patients with pseudoaneurysms
  - Patients with systemic infection (e.g., sepsis)
  - Patients with increasing tapered proximal necks with  $\geq 3$  mm increase in diameter from proximal fixation site to the aneurysm
  - Patients with decreasing tapered distal necks with  $\geq 3$  mm increase in diameter from distal fixation site to the aneurysm
  - Patients with aneurysm or distal thoracic aortic neck angles that preclude advancement of the introduction system and device
- The long-term safety and performance of endovascular grafts has not yet been established. All patients should be advised that endovascular treatment requires life-long, regular follow-up to assess their health and the performance of their endovascular graft. Patients with specific clinical findings (e.g., endoleaks, enlarging lesions, or changes in the structure or position of the endovascular graft) should receive enhanced follow-up. Specific follow-up guidelines are described in **Section 12, Follow-up Imaging Recommendations**.
  - Strict adherence to the sizing guidelines in **Section 10.2, Recommended Device Sizing** is expected. Sizing outside these guidelines could result in endoleak, migration, stent-graft separation, infolding, or device damage.
  - Conversion to open surgical repair or other intervention after the initial implantation procedure should be considered for patients who experience enlarging lesions or endoleak. Increases in lesion size or persistent endoleak can be a predictor of lesion rupture.
  - The minimum recommended amount of overlap between devices is three overlapping covered stents (approximately 50 mm). Less than this amount of overlap may result in endoleak (with or without component separation). Device lengths should be selected accordingly.
  - Refer to **Section 10.2, Recommended Device Sizing** for the proximal and distal aortic landing zone lengths recommended for stent-graft diameters. Seal zones outside these recommendations could result in migration, endoleak, or other complications.
  - Failure to have non-contrast CT imaging may inhibit the assessment of iliac or aortic calcification, which may preclude access and/or effective fixation and seal.
  - Pre-procedure imaging reconstruction thicknesses  $>3$  mm may lead to inadequate device sizing or impair the ability to detect focal stenoses from CT.
  - Clinical experience indicates that contrast-enhanced spiral computed tomographic angiography (CTA) with 3-D reconstruction is the strongly recommended imaging modality to accurately assess patient anatomy prior to treatment with the Relay<sup>®</sup> Thoracic Stent-Graft. If contrast-enhanced spiral CTA with 3-D reconstruction is not available, the patient should be referred to a facility with these capabilities.
  - Clinicians recommend positioning of the image intensifier (C-arm) so that it is perpendicular to the aneurysm neck, typically 45-75 degrees left anterior oblique (LAO) for the arch.

### 4.3 Implant Procedure

(Refer also to **Section 11, Implantation Procedure**)

- A seal zone less than recommended in **Section 10.2, Recommended Device Sizing** could increase the risk of endoleak or migration of the stent-graft. Migration may also be caused by deployment of the proximal stent into a thrombus-filled or severely angled vessel wall.
- When manipulating catheters, wires and sheaths within the thoracic aorta, use caution as this activity can cause rupture or dislodge fragments of thrombus or plaque which may lead to proximal/distal embolization.
- Do not bend or kink the delivery system as it may cause damage to not only the delivery system but also the Relay® Thoracic Stent-Graft.
- Stop advancing the guidewire or delivery system if resistance is encountered. Assess the source of the resistance before proceeding to avoid vessel or catheter damage.
- Wire fractures are more likely to occur in conditions with an excessively oversized stent-graft, flexion, kinking, or bending of cardiac or respiratory cycles. Fractures of the spiral support strut are more likely to occur if the strut is deployed along the inner radius of curvature. Wire fractures may have clinical consequences including endoleak, migration, or tissue damage.
- Oversize the aortic portion of the stent graft per the sizing guidelines in **Section 10.2, Recommended Device Sizing**.
- Care should be taken when using the device in areas of stenosis, thrombosis, or calcified and tortuous vessels. This may lead to dislodgement of material during positioning or lead to inadequate exclusion or vessel damage after placement.
- Do not advance the Relay® Thoracic Stent-Graft System once it has opposed the vessel wall. Inadvertent partial deployment or migration of the Relay® Thoracic Stent-Graft may require surgical removal.
- The proximal end of the covered Relay® Thoracic Stent Graft should not be placed beyond the origin of the left common carotid artery.
- Ensure that the Relay® devices are placed in a landing zone consists of healthy tissue. Healthy tissue is non-aneurysmal and is without evidence of circumferential thrombus, intramural hematoma, dissection, or ulceration. Failure to place the stent-graft in healthy tissue could lead to inadequate exclusion or vessel damage, including perforation.
- Endoleaks detected at the conclusion of the procedure and not corrected should be carefully monitored after implantation.
- Except in medically-indicated circumstances, do not deploy the Relay® Thoracic Stent-Graft in a location that will occlude arteries necessary to supply blood flow to organs or extremities as this may impair circulation to cerebral and upper-limb circulation and collateral circulation to the spinal cord. Coverage of the left subclavian artery (LSA) is at the discretion of the physician as is monitoring of blood flow at the level of the vertebral or cerebral arteries and the retrograde blood flow at the LSA.
- If occlusion of the left subclavian artery ostium is required to obtain adequate neck length for fixation and sealing, transposition or bypass of the left subclavian artery may be warranted.
- Inaccurate placement and/or incomplete sealing of the Relay® Thoracic Stent-Graft within the vessel may result in increased risk of endoleak, migration, or inadvertent occlusion of the left subclavian, left common carotid, and/or celiac arteries. Surgical intervention may be required.

- Always use fluoroscopy for guidance, delivery, and observation of the Relay® Thoracic Stent-Graft within the vasculature.
- Care should be taken to minimize the amount of contrast medium used during the procedure, especially in patients with pre-procedure renal insufficiency. Preventative methods of treatment to decrease renal compromise (e.g., adequate hydration) should be considered.
- Care should be taken to ensure air is purged from the system.
- Maintain guidewire position during delivery system insertion.
- Failure to promptly deploy the stent-graft may cause an elevation in blood pressure and may result in distal migration of the stent-graft during deployment.
- Do not attempt to re-sheath the graft after partial or complete deployment.
- Deploying the device in a portion of the aorta with a different diameter than planned when selecting the graft size may potentially result in inadequate sizing and therefore migration, endoleak, aneurysm growth, or increased risk of thrombosis.
- Institutional practices should be observed regarding systemic anticoagulation. Alternate anticoagulation should be used when heparin is contraindicated.
- Anatomy and graft position may change during the withdrawal of the delivery system and/or guidewire; therefore, constant monitoring of the graft position is important. Use angiography as necessary.
- If balloon modeling is desired, use a compliant balloon equal in size to the largest diameter stent-graft used. Balloon inflation should not exceed 1 atm. Inflate the balloon inside the covered portion of the stent-graft. Failure to do so could lead to aortic rupture, atherosclerotic plaque embolization, or other complications.
- Do not use power/pressure injections through the Plus delivery system
- Use caution when treating patients where tracking through a previously placed endovascular or surgical prosthesis is required.

#### 4.4 Imaging Guidelines and Post-operative Follow-up

After endovascular graft placement, patients should be regularly monitored for endoleaks, lesion growth, or changes in the structure or position of the endovascular graft. At a minimum, annual imaging is required. Refer to **Section 12** for follow-up guidance.

#### 4.5 Magnetic Resonance Imaging



Non-clinical testing demonstrated that the Relay® Stent-Graft is MR Conditional. A patient with this device can be scanned safely, immediately after placement under the conditions specified in **Section 12, Follow-up Imaging Recommendations**.

## 5 ADVERSE EVENTS

Adverse events, clinical incidents, or complaints involving the Relay® device should be reported to Bolton Medical, Inc. To report an incident in the United States, contact 1-855-726-5866 (1-855-7BOLTON). In the event of surgical removal or postmortem examination, please contact Bolton Medical for guidance on removal and disposal of implant.

### Expected Adverse Events

Access Failure	Dysphagia	Reaction to Anesthesia
Adynamic Ileus	Edema (e.g., leg, foot)	Reaction / Pain at Catheter Insertion Site
Allergic Reaction (to contrast, antiplatelet therapy, stent-graft materials)	Embolism (with transient or permanent ischemia or infarction)	Renal Complications (failure, insufficiency, contrast toxicity)
Amputation	Endoleak	Reoperation
Anaphylaxis	Excessive / Inappropriate Radiation Exposure	Seizure
Anesthetic Complications	Extrusion / Erosion	Seroma
Aneurysm Expansion	Fever / Localized Inflammation	Shock
Aneurysm / Lesion Rupture	Fistulas (aorto-bronchial, aorto-enteric, aorto-esophageal, arteriovenous, lymph)	Stent-Graft Dilatation / Rupture
Angina	Gastrointestinal Complications (bleeding, diarrhea, nausea, vomiting)	Stent-Graft Failure
Bleeding Complications (hemorrhage, hematoma, coagulopathy, procedural bleeding, post-procedural bleeding)	Genitourinary Complications (urinary incontinence, hematuria)	Stent-Graft Infection
Blindness	Hepatic Failure	Stent-Graft Migration
Bowel Ischemia	Impotence	Stent-Graft Misplacement
Bowel Necrosis	Incision Site Complications	Stent-Graft Tearing/Wear
Bowel Obstruction	Infection/Sepsis (including wound infection)	Stent-Graft Twisting/Kinking
Cardiac events (arrhythmia, tachyarrhythmia, cardiac tamponade, myocardial infarction, congestive heart failure, hypertension, hypotension, tachycardia, bradycardia)	Intramural Hematoma	Suture Fracture
Catheter Breakage	Ischemia (spinal cord, perfusion pathways, peripheral, limb, vascular)	Tissue Necrosis
Cerebral Vascular Accident – CVA (stroke)	Lymphocele	Transient Ischemic Attack
Change In Mental Status	Neuropathy (e.g., femoral)	Vascular Access Complications
Claudication (buttock, lower limb)	Pain (e.g., intercostals pain, general pain, etc.)	Vascular Spasm/Trauma
Compartment Syndrome	Paralysis/Paraplegia/Paresthesia/Paraparesis/Spinal Neurological Deficit	Vessel Damage/Trauma/Rupture
Contrast Toxicity	Perforation (vessel / device)	Vessel Dissection
Conversion To Open Repair	Peripheral Nerve Injury	Vessel (arterial or venous) or Device (Stent-Graft) Occlusion/Thrombosis
Death	Post Implantation Syndrome	Vessel or Stent-Graft Stenosis
Deployment Difficulties/Failures	Pseudoaneurysm	Wire Form Fractures
Device Dehiscence	Pulmonary Complications (atelectasis respiratory failure, respiratory depression, pneumonia, pulmonary edema, pulmonary embolism)	Wound Dehiscence
Device Insertion Or Removal Difficulty	Radiation Overexposure or Reaction	Wound Healing Complications

The clinical evidence supporting the safety and effectiveness of the Relay® Thoracic Stent-Graft with Plus Delivery System included data from a multi-center pivotal study across the United States, data from a multi-center feasibility study conducted across the United States, and data from a Continued Access arm of the pivotal trial. The purpose of the Relay® Phase II clinical study was to demonstrate the safe and effective use of the Relay® Thoracic Stent-Graft with Plus Delivery System for the treatment of fusiform aneurysms and saccular aneurysms/penetrating ulcers of the descending thoracic aorta in subjects who were candidates for endovascular repair. The other studies provide supplementary clinical data on the overall performance of the device.

#### 6.1 Relay® Phase II: Relay® Thoracic Stent-Graft with Plus Delivery System Pivotal Study

The Relay® Thoracic Stent-Graft study was a multicenter, non-blinded, nonrandomized study in subjects with TAAs and PAUs. The study included 120 subjects treated with the Relay® Thoracic Stent-Graft and 60 surgical control subjects. The study included 29 investigational sites, 27 of which enrolled subjects. The surgical control cohort was a combination of prospectively and retrospectively treated subjects. The subjects were enrolled if they met all of the inclusion criteria and none of the exclusion criteria. The same inclusion/exclusion criteria applied to both the endovascular and surgical cohorts, except that subjects in the surgical cohort did not have to meet the anatomical criteria required for placement of the Relay® device.

This study was designed to evaluate the safety and effectiveness of the Relay® Thoracic Stent-Graft in subjects with a diagnosed thoracic aortic aneurysm or penetrating atherosclerotic ulcer compared with subjects who underwent open surgical repair for the same pathologies. The primary effectiveness analysis evaluated the proportion of Relay subjects remaining free of major device-related adverse events following endovascular repair through 1 year. Major device-related adverse events were endoleak (Types I, III and IV), stent migration (> 10mm as compared to the 1 month visit), lumen occlusion, aneurysm rupture, and deployment failure/conversion to surgical repair. The proportion of subjects who were free from major device-related AEs at 1 year post-procedure was compared against a performance goal of 0.80 using a 1-sided z-test (normal approximation to the binomial) at an alpha level of 0.025. Rejection of the null hypothesis would provide evidence that this performance goal (proportion-free greater than 0.80) was met.

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The primary safety analysis compared the distribution of Relay® and surgical control subjects experiencing at least 1 major adverse event (MAE) within 1 year post-procedure. MAEs included aneurysm-related mortality, stroke, paralysis/paraplegia, myocardial infarction, procedural bleeding, respiratory failure, renal failure, and wound healing complications. The null hypothesis was that the probability of subjects experiencing at least 1 major adverse event within 1 year is equivalent between both treatments using a two-sided alpha level of 0.05. Rejection of the null hypothesis would provide evidence that the probability of experiencing at least 1 major adverse event is not the same between the two treatments.

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Secondary effectiveness objectives included assessment of major device-related adverse events occurring at timeframes other than 1 year. Similarly, secondary safety objectives included an assessment of the incidence of major adverse events at timeframes other than 1 year for both the Relay® and the surgical control cohorts. Secondary objectives also included a comparison of clinical utility measurements between the Relay® and surgical control cohorts. In addition to covariate analysis, propensity score analysis was

used to assess comparability of the groups. The control group was analyzed to justify the use of both retrospectively and prospectively enrolled patients.

The sample size for the Relay® cohort was driven by the primary effectiveness analysis. Accounting for an expected 10% loss to follow-up, 120 subjects were expected to yield 80% power for a one-sided z-test (normal approximation to the binomial) at an alpha level of 0.025 against an alternative of 0.80. The sample size for the surgical control group was based on the primary safety analysis. Assuming withdrawal and loss to follow-up of 20%, approximately 60 subjects were required for the surgical control cohort in order to provide 90% power at a two-sided alpha level of 0.05, to detect a difference in the distribution of major adverse events if the one-year event probabilities are 0.25 in the Relay® cohort and 0.50 in the surgical control cohort.

Pre-procedure baseline data, including CT scan and X-ray were gathered for each subject and post-procedure assessments were obtained prior to hospital discharge and at 1-month, 6-month, and 1-year post-implantation follow-up visits, with annual assessments to 5 years.

Patient imaging was analyzed by an independent Core Laboratory. Serious adverse events were adjudicated by an independent Clinical Events Committee (CEC) and safety was monitored by a Data Safety Monitoring Board (DSMB).

During the course of the study, two changes were implemented. The delivery system was modified from the original system to the Plus Delivery System. Additionally, penetrating atherosclerotic ulcers (PAUs) were added as one of the types of lesions treatable as part of the study protocol. Two subgroup analyses were performed for subjects who were treated with the Relay® Stent-Graft. One analysis compared the 2 delivery systems (original delivery system versus Plus system) and the second analysis compared the lesion types (fusiform aneurysms vs. saccular aneurysms and PAUs).

#### **6.1.1 Suitability of the Control Group for the Primary Safety Objective**

Safety data for the Relay® cohort was compared to a cohort of surgical control subjects treated at trial institutions within the past 10 years of site initiation. The surgical control cohort was a combination of prospectively- and retrospectively-treated subjects. In order to minimize selection bias, similar inclusion/exclusion criteria applied to both the endovascular and surgical cohorts. Subjects in the surgical control cohort did not have to meet the anatomical criteria required for placement of the Relay® device. In addition, enrollment of surgical subjects at the same sites that were enrolling endovascular subjects was encouraged to minimize differences in subject care between the two groups. In addition to covariate analysis, propensity score analysis was used to assess comparability of the groups. The control group was analyzed to justify the use of both retrospectively- and prospectively-enrolled patients.

#### **6.1.2 Subject Accountability and Follow-up**

Detailed subject accountability data, including imaging data are presented in Table 2. Access failures/delivery system complications were encountered in four cases. Three subjects did not receive the Relay® stent-graft as a result of these complications. The implantation procedure was successfully re-attempted for one subject.

Table 2 Compliance Imaging and Follow-up (Core Lab Reported)

Visit Interval <sup>a</sup>	Eligible for Follow-Up <sup>b</sup>	Subjects with <sup>c</sup> n (%)			Adequate Imaging to Assess Parameter n (%)				Events Occurring Before Next Interval <sup>d</sup> n (%)					
		Data for Visit	CT Scan	X-Ray	Size <sup>e</sup>	Endo-leak <sup>f</sup>	Mi-gration <sup>g</sup>	Fracture <sup>h</sup>	Death	Technical Failure <sup>i</sup>	Con-version	Lost to Follow-Up	With-drawn Early	Not Due for Next Visit <sup>j</sup>
Operative (Day 0 – 15)	120	120 (100)	NA	NA	NA	NA	NA	NA	3 (2.5)	3 (2.5)	0	3 (2.5)	0	0
Events between operative and 1 month visit														
1 Month (Day 16 – 151)	114	108 (94.7)	107 (93.9)	100 (87.7)	NA	97 (85.1)	NA	97 (85.1)						
Events between 1 month and 6 month visit									7 (6.1)	0	1 (0.9)	0	0	0
6 Month (Day 152 – 336)	106	97 (91.5)	94 (88.7)	90 (84.9)	92 (86.8)	85 (80.2)	89 (84.0)	89 (84.0)						
Events between 6 month and 1 year visit									7 (6.6)	0	0	0	2 (1.9)	0
1 Year (Day 337 – 673)	97	89 (91.8)	89 (91.8)	86 (88.7)	86 (88.7)	81 (84) <sup>h</sup>	87 (89.7)	83 (85.6)						
									Totals	17	3	1	3	2
									Deaths after conversion	0				
									Total Deaths	17				

NA= Not Applicable.

- <sup>a</sup> Visit intervals took into account the follow-up visit windows. The visit windows were ±2 weeks for 30 days, ±4 weeks for 6 months and 1 year, and ±8 weeks for 2 to 5 years. 1 year visit window is 337 - 393
- <sup>b</sup> Eligible for follow-up if subject reached the start of the visit window and was not a technical failure, was not lost to follow-up, did not die, did not withdraw early, or did not convert to open repair. Eligible for follow-up included any subject who reached the start of the visit window, but who had not reached the end of the visit window.
- <sup>c</sup> Percentages are calculated based on the number of subjects eligible for follow-up. Data for visit information is site-reported. CT scan and x-ray reflect images received for evaluation by the core laboratory.
- <sup>d</sup> Size increase, endoleak, and migration were assessed by CT Scan (core lab-reported data).
- <sup>e</sup> Fracture was assessed by x-ray (core lab-reported data).
- <sup>f</sup> Subjects for whom the procedure was attempted but aborted and who did not receive a Relay® Stent-Graft at a later additional procedure.
- <sup>g</sup> Not due for next visit if subject had not reached the start of the visit window. Subjects who died, had a technical failure, converted to open repair, were lost to follow-up, withdrew early, or were not due for a previous visit are not counted.
- <sup>h</sup> Considers re-examined imaging

## 6.2 Study Demographics and Baseline Medical History

Tables 3 and 4 provide demographic and medical history information for the Relay® and surgical control cohorts. Overall, demographics and baseline characteristics were similar between the treatment groups, for age, gender, race, medical history, weight, and height. Covariate and propensity score analyses supported the appropriateness of comparisons between study groups.

**Table 3 Demographics: Age, Gender, and Race**

	Relay® Thoracic Stent-Graft Repair	Surgical Repair	p-value <sup>a</sup>
<b>Age (years)<sup>b</sup></b>			0.093
n	120	60	
Mean (SD)	72.8 (11.02)	70.0 (9.17)	
Median	74.0	71.0	
Min, Max	28, 91	35, 84	
<b>Age categories (years)</b>			0.648
18 to 64	19/120 (15.8%)	12/60 (20.0%)	
65 to 74	45/120 (37.5%)	24/60 (40.0%)	
≥75	56/120 (46.7%)	24/60 (40.0%)	
<b>Gender</b>			0.056
Male	62/120 (51.7%)	40/60 (66.7%)	
Female	58/120 (48.3%)	20/60 (33.3%)	
<b>Race</b>			0.165
White	106/120 (88.3%)	50/60 (83.3%)	
Black	6/120 (5.0%)	6/60 (10.0%)	
Asian	0/120	2/60 (3.3%)	
Hispanic	5/120 (4.2%)	1/60 (1.7%)	
Other	3/120 (2.5%)	1/60 (1.7%)	

Notes: Percentages and summary statistics are based on the number of subjects in each treatment group with data available.

<sup>a</sup> Comparison using a 2-sample t test for continuous data or a chi-square test for categorical data.

<sup>b</sup> Age = (date of procedure minus date of birth plus 1)/365.25.

**Table 4 Demographics: Medical History/Risk Factors**

	Relay® Thoracic Stent-Graft Repair	Surgical Repair	p-value <sup>a</sup>
<b>Medical history/Risk factors</b>			
– History of peripheral vascular disease	30/120 (25.0%)	15/60 (25.0%)	>0.999
– Documented coronary artery disease	57/120 (47.5%)	31/60 (51.7%)	0.598
– Documented chronic obstructive pulmonary disease	40/120 (33.3%)	20/60 (33.3%)	>0.999
– History of neurologic disease	30/120 (25.0%)	8/60 (13.3%)	0.071
– History of diabetes mellitus	24/120 (20.0%)	13/60 (21.7%)	0.794
– Hypertension and/or treatment for hypertension	106/120 (88.3%)	54/60 (90.0%)	0.737
– Hypercholesterolemia	90/120 (75.0%)	37/60 (61.7%)	0.064
– History of smoking	94/120 (78.3%)	47/58 (81.0%)	0.677
– History of impaired renal function	27/120 (22.5%)	9/60 (15.0%)	0.236
– Subject currently taking any antiplatelet or anticoagulant medications	73/120 (60.8%)	29/57 (50.9%)	0.210
– History of limb ischemia	8/120 (6.7%)	7/59 (11.9%)	0.238
– History of gastrointestinal complications	60/120 (50.0%)	27/60 (45.0%)	0.527
– History of other relevant medical history and/or clinical status	103/120 (85.8%)	49/60 (81.7%)	0.467
– History of vascular/endovascular intervention	54/120 (45.0%)	22/60 (36.7%)	0.286
<b>Weight (lbs)</b>			0.169
N	120	52	
Mean (SD)	167.75 (41.457)	176.72 (33.050)	
Median	166.30	179.00	
Min, Max	65.6, 289.0	105.8, 244.6	
<b>Height (in)</b>			0.326
N	120	48	
Mean (SD)	65.80 (4.310)	66.51 (3.930)	
Median	65.00	66.00	
Min, Max	56.0, 76.0	58.0, 74.0	

Notes: Percentages and summary statistics are based on the number of subjects in each treatment group with data available.

<sup>a</sup> Comparison using a 2-sample t test for continuous data or a chi-square test for categorical data.

### 6.3 Baseline Aneurysm Data

Tables 5 through 7 show the baseline aneurysm and vessel measurements for the Relay® and surgical control cohorts. Table 5 shows the types of lesions treated in each study cohort. A total of 86 (71.7%) subjects had fusiform aneurysms in the descending thoracic

aorta, while 34 subjects (28.3%) had saccular aneurysms or penetrating ulcers in the descending thoracic aorta. Tables 6 and 7 show anatomical measurements for the endovascular and surgical cohorts. Table 6 shows the results for all subjects in each cohort, regardless of lesion type. Table 7 shows that the diameter reported by the sites was similar for the subjects in the 2 treatment groups, with the majority of the subjects having an aneurysm diameter between 50 mm and 70 mm (70.8% Relay®, 68.2% surgical). When isolating Relay® subjects with saccular aneurysms/PAUs, the majority had lesion diameters between 40 mm and 70 mm.

**Table 5 Demographics: Lesion Type - Relay® and Surgical**

Lesion type	Relay Thoracic Stent-Graft Repair	Surgical Repair	p-value <sup>a</sup>
<b>Fusiform Aneurysms</b>	86/120 (71.7%)	54/60 (28.3%)	0.011
– Descending thoracic fusiform aneurysm, 5 cm in diameter or greater	83/120 (69.2%)	50/60 (83.3%)	
– Descending thoracic aneurysm is 4 cm or more in diameter that has increased in size by 0.5 cm in the last 6 months	3/120 (2.5%)	2/60 (3.3%)	
– Descending thoracic aneurysm with a maximum diameter of aneurysm exceeds 2 times the diameter of the non-aneurysmal, adjacent aorta	0/120	2/60 (3.3%)	
<b>Saccular Aneurysm or Penetrating Atherosclerotic Ulcers (PAU)</b>	34/120 (28.3%)	6/60 (10.0%)	
<b>Fusiform Aneurysm Average Maximum Diameter</b>	6.22 cm	5.72 cm	
<b>Saccular Aneurysm/PAU Average Maximum Diameter</b>	4.84 cm	5.91 cm	

Notes: Percentages and summary statistics are based on the number of subjects in each treatment group with data available.

<sup>a</sup> Comparison using a 2-sample t test for continuous data or a chi-square test for categorical data.

**Table 6 Demographics: Baseline Vessel Dimensions**

	Relay® Thoracic Stent-Graft Repair	Surgical Repair	p-value <sup>a</sup>
<b>Length of proximal neck (mm)</b>			0.590
n	120	13	
Mean (SD)	53.1 (35.40)	47.5 (35.26)	
Median	42.5	33.0	
Min, Max	15, 185	10, 126	
<b>Length of lesion (mm)</b>			0.034
n	120	15	
Mean (SD)	107.5 (60.84)	143.7 (69.61)	
Median	100.0	130.0	
Min, Max	12, 273	7, 260	
<b>Length of distal neck (mm)</b>			<0.001
n	120	14	
Mean (SD)	57.3 (41.85)	31.1 (20.34)	
Median	40.0	30.0	
Min, Max	20, 208	7, 90	
<b>Length from lesion to celiac (mm)</b>			0.019
n	119	14	
Mean (SD)	97.5 (57.83)	59.4 (48.14)	
Median	86.0	50.5	
Min, Max	20, 263	7, 175	
<b>Total treatment length (mm)</b>			0.177
n	120	14	
Mean (SD)	191.7 (68.78)	217.9 (64.77)	
Median	200.0	211.5	
Min, Max	70, 350	110, 311	
<b>Diameter of proximal neck (mm)</b>			0.214
n	120	20	
Mean (SD)	32.2 (4.70)	34.1 (6.46)	
Median	32.0	34.5	
Min, Max	21, 42	22, 43	
<b>Diameter of lesion (mm)</b>			0.734
n	120	44	
Mean (SD)	58.3 (13.77)	57.4 (16.54)	
Median	60.0	60.5	
Min, Max	5, 98	5, 80	
<b>Diameter of distal neck (mm)</b>			0.033
n	119	22	
Mean (SD)	31.2 (5.25)	36.0 (9.73)	
Median	31.0	34.0	
Min, Max	19, 42	20, 60	
<b>Diameter of access artery (mm)</b>		N/A	N/A
n	118		
Mean (SD)	9.3 (2.43)		
Median	9.0		
Min, Max	5, 26		
<b>Right iliac access site minimum diameter (mm)</b>		N/A	N/A
n	116		
Mean (SD)	9.9 (2.57)		

**Table 6 Demographics: Baseline Vessel Dimensions**

	Relay® Thoracic Stent-Graft Repair	Surgical Repair	p-value <sup>a</sup>
Median	9.0		
Min, Max	6, 22		
<b>Left iliac access site minimum diameter (mm)</b>		N/A	N/A
n	114		
Mean (SD)	9.5 (2.18)		
Median	9.0		
Min, Max	5, 16		
<b>Right femoral access site minimum diameter (mm)</b>		N/A	N/A
n	115		
Mean (SD)	8.9 (1.87)		
Median	9.0		
Min, Max	5, 14		
<b>Left femoral access site minimum diameter (mm)</b>		N/A	N/A
n	114		
Mean (SD)	8.6 (1.91)		
Median	9.0		
Min, Max	0, 13		
<b>Calcification in access artery</b>		N/A	N/A
None	35/120 (29.2%)		
Mild	57/120 (47.5%)		
Moderate	24/120 (20.0%)		
Severe	4/120 (3.3%)		
<b>Tortuosity of access artery</b>		N/A	N/A
None	16/120 (13.3%)		
Mild	81/120 (67.5%)		
Moderate	19/120 (15.8%)		
Severe	4/120 (3.3%)		

Notes: Percentages and summary statistics are based on the number of subjects in each treatment group with data available.

<sup>a</sup> Comparison using a 2-sample t test for continuous data or a chi-square test for categorical data.

**Table 6 Demographics: Baseline Vessel Dimensions**

	Relay® Thoracic Stent-Graft Repair	Surgical Repair	p-value <sup>a</sup>
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**Table 7 Demographics: Baseline Maximum Lesion Diameters - Relay® and Surgical**

Diameter (mm)	Relay® Thoracic Stent-Graft (fusiform TAA) (%)	Relay® Thoracic Stent-Graft (Saccular TAA and PAU) (%)	Relay® Thoracic Stent-Graft (all lesion types) (%)	Surgical Control Group (%)
5 to < 10	0	2/34 (5.9%)	2/120 (1.7%)	3/44 (6.8%)
10 to < 20	0	1/34 (2.9%)	1/120 (0.8%)	0
20 to < 30	0	1/34 (2.9%)	1/120 (0.8%)	0
30 to < 40	0	6/34 (17.6%)	6/120 (5.0%)	1/44 (2.3%)
40 to < 50	1/86 (1.2%)	7/34 (20.6%)	8/120 (6.7%)	1/44 (2.3%)
50 to < 60	33/86 (38.4%)	6/34 (17.6%)	39/120 (32.5%)	14/44 (31.8%)
60 to < 70	38/86 (44.2%)	8/34 (23.5%)	46/120 (38.3%)	16/44 (36.4%)
70 to < 80	10/86 (11.6%)	3/34 (8.8%)	13/120 (10.8%)	7/44 (15.9%)
80 to < 90	2/86 (2.3%)	0	2/120 (1.7%)	2/44 (4.5%)
90 to < 100	2/86 (2.3%)	0	2/120 (1.7%)	0
100 to < 110	0	0	0	0
110 to < 120	0	0	0	0
120 and greater	0	0	0	0
Lesion Diameter < 50 mm	1/86 (1.2%)	17/34 (50%)	18/120 (15%)	5/44 (11.4%)
Lesion Diameter ≥ 50 mm	85/86 (98.8%)	17/34 (50%)	102/120 (85%)	39/44 (88.6%)

Note: Percentages are based on the number of subjects in each treatment group with data available.

**6.4 Devices Implanted**

One hundred sixteen (116) subjects received the Relay® device during the initial implant procedure. The majority of the subjects had 1 (48.3%) or 2 (38.8%) Relay® device(s) implanted during the initial procedure, as shown in Table 8. None of the subjects had more than 4 Relay® device implants during the initial procedure. A total of 192 Relay® devices were implanted during the initial procedures for an average of 1.7 devices per subject. The number of Relay® devices implanted by size is shown in Table 9.

**Table 8 Number of Relay® Devices Implanted During the Initial Procedure**

Number of Relay® Devices Implanted	Relay® Thoracic Stent-Graft (N = 116)
1	56/116 (48.3%)
2	45/116 (38.8%)
3	13/116 (11.2%)
4	2/116 (1.7%)
5	0/116

Note: The Effectiveness sample includes All Enrolled subjects who underwent implantation of the Relay® device. Percentages were based on the number of subjects in the Effectiveness sample who had at least 1 device implanted in the initial procedure.

**Table 9 Diameter of Relay® Devices Implanted During the Initial Procedure**

Relay® Stent-Graft Diameter (Proximal/Distal, mm)	Number of Devices
	% (m/n)
28/24	1/192 (0.5%)
28/28	4/192 (2.1%)
30/26	1/192 (0.5%)
30/30	7/192 (3.6%)
32/28	6/192 (3.1%)
32/32	19/192 (9.9%)
34/30	9/192 (4.7%)
34/34	13/192 (6.8%)
36/32	10/192 (5.2%)
36/36	20/192 (10.4%)
38/34	3/192 (1.6%)
38/38	18/192 (9.4%)
40/36	17/192 (8.8%)
40/40	12/192 (6.3%)
42/38	11/192 (5.7%)
42/42	15/192 (7.8%)
44/40	5/192 (2.6%)
44/44	10/192 (5.2%)
46/42	3/192 (1.6%)
46/46	9/192 (4.7%)

Note: m is the number of devices of the identified size; n is the total number of devices implanted at the initial procedure.

## 6.5 Acute Procedural Data

Acute procedural data (Treatment Assessments) are presented in **Table 10**. The Relay<sup>®</sup> Thoracic Stent-Graft was successfully implanted in 116 of 120 subjects (96.7%). For the majority of subjects (70/119, 58.8%) access was achieved via the native right femoral artery. In 20% of the cases, the left subclavian artery was completely covered by the fabric portion of the device, and it was partially covered in 12.2% of cases. Although the Relay<sup>®</sup> device does not require balloon expansion, balloons were used in 37 cases (37/120, 30.8%). The lesion was excluded in 92.5% of the subjects during the initial implantation. The completion angiogram for 5 subjects (4.2%) demonstrated an endoleak.

Physicians rated the performance of the device during implantation. Of the 116 subjects who were successfully implanted with the Relay<sup>®</sup> Stent-Graft during the initial procedure, no fractures or lumen occlusions were detected at the time of implant. There were also no reports of poor deployment accuracy. Kinking and twisting was reported at the time of deployment for 1 subject, although there was no corresponding report of lumen occlusion. Due to difficulties with vessel access and proper device positioning, 4 of the 120 procedures (3.3%) were aborted. Implantation was successfully re-attempted for 1 of these 4 subjects.

**Table 10 Acute Procedure Detail /Treatment Assessments – Relay® Cohort**

	Relay® Subjects N = 120
<b>Total Relay® implanted (Successful delivery/deployment)<sup>a</sup></b>	116/120 (96.7%)
<b>Final procedure result</b>	
- Excluded lesion	111/120 (92.5%)
- Endoleak: not excluded during the procedure	5/120 (4.2%)
- Conversion from endovascular to open repair	0/120
- Procedure attempted, but aborted	4/120 (3.3%)
<b>Evaluation of Relay® system</b>	
- Stent-graft deployed <sup>b</sup>	116/116 (100%)
- Accurate deployment <sup>b</sup>	116/116 (100%)
- Deployment without stent-graft kinking or twisting <sup>b</sup>	115/116 (99.1%)
- Stent-graft patent <sup>b</sup>	116/116 (100%)
- Stent-graft integral (e.g., no fractures) <sup>b</sup>	116/116 (100%)
<b>Anesthesia<sup>c</sup></b>	
- Local	4/120 (3.3%)
- Regional / Epidural	20/120 (16.7%)
- General	100/120 (83.3%)
<b>Spinal Protection</b>	74/120 (61.7%)
<b>Vascular access</b>	
- Native right femoral artery	70/119 (58.8%)
- Native left femoral artery	16/119 (13.4%)
- Native right iliac artery	5/119 (4.2%)
- Native left iliac artery	2/119 (1.7%)
- Conduit, left iliac artery	11/119 (9.2%)
- Conduit, right iliac artery	15/119 (12.6%)
<b>Left Subclavian Artery (LSA) Revascularization</b>	
- Transposition	16/120 (13.3%)
- Carotid-LSA Bypass	None reported
<b>Coverage of the Left Subclavian Artery (LSA)<sup>d</sup></b>	
- Complete	23/115 (20%)
- Partial	14/115 (12.2%)
- None	78/115 (67.8%)

Percentages are based on the number of subjects in each treatment group with data available, unless noted. All treatment assessments are based on the initial procedure.

- a One subject received the device during a secondary attempt
- b Responses entered only for those cases in which a stent-graft was implanted.
- c Multiple types of anesthesia may be used on a single subject
- d Based on core laboratory assessment

## 6.6 Clinical Utility Measures

Table 11 shows the clinical utility measures for the Relay® and surgical control cohorts.

**Table 11 Summary of Clinical Utility Measures**

Clinical Utility Measures		Relay Thoracic Stent-Graft Repair (N = 120)	Surgical Repair N = 60
Duration of procedure time (hours)	n	119	56
	Mean (SD)	2.39 (1.235)	4.59 (2.275)
	Median	1.98	3.92
	Min, Max	0.1, 6.2	1.4, 14.1
Estimated volume of blood loss (cc)	n	118	30
	Mean (SD)	228.5 (394.47)	2025.0 (1982.26)
	Median	150.0	1300.0
	Min, Max	0, 4000	0, 7000
Transfusion required <sup>a</sup>	Yes	10/119 (8.4%)	50/59 (84.7%)
	No	109/119 (91.6%)	9/59 (15.3%)
Time in intensive care unit (hours)	n	114	42
	Mean (SD)	58.221 (52.2587)	190.777 (190.0883)
	Median	46.660	123.375
	Min, Max	0.00, 256.70	24.00, 745.25
Duration of hospital stay (days)	n	114	56
	Mean (SD)	5.47 (4.206)	13.24 (9.626)
	Median	5.00	9.15
	Min, Max	1.0, 30.0	3.0, 45.0

Notes: Percentages and summary statistics are based on the number of subjects in each treatment group with data available. Clinical utilities are based on initial procedure.

<sup>a</sup> A subject counted as 'Yes' if she/he was given any blood product. Blood products included packed red blood cells, fresh frozen plasma, platelets, and other products. A subject may have been given more than 1 type of blood product.

## 6.7 Safety Data

### 6.7.1 Primary Safety Endpoint

The primary safety endpoint was the distribution of Relay® and surgical control subjects experiencing at least 1 major adverse event (aneurysm-related mortality, stroke, paralysis/paraplegia, myocardial infarction, procedural bleeding, respiratory failure, renal failure, and wound healing complications) within 1 year post-procedure. These events were considered by definition to be serious in nature.

Of the 120 subjects who were treated with the Relay® device, 32 subjects (26.7%) experienced a major adverse event within 1 year post-procedure compared with 30 (50.0%) of the 60 subjects who underwent surgical repair. Kaplan-Meier analysis, using both a log rank test (Table 12) and a normal approximation with variance estimated by Greenwood's formula, indicated that

the distribution of major adverse events in the surgical control cohort was greater than in the Relay® device cohort ( $p < 0.001$  and  $p = 0.002$ , respectively). The time to the first major adverse event is graphically presented in **Diagram 1**. Sensitivity analyses were performed on the primary safety endpoint using an unadjusted Cox proportional hazards model to calculate the hazard ratio, the 95% CI, and the p-value for treatment effect. The calculated hazard ratio of 0.43 (Relay®:surgical) showed a statistically significant difference between the 2 treatment methods ( $p = 0.001$ ) with the results in favor of the Relay® device (hazard ratio  $< 1$ ). Thus, superiority of the Relay® device treatment relative to the surgical arm was shown. The primary safety and sensitivity analyses show the primary safety objective was achieved.

**Table 12 Kaplan-Meier: First Major Adverse Event Within 1 Year**

	Relay® Thoracic Stent-Graft (N = 120)	Surgical Repair (N = 60)	p-value <sup>a</sup>
Major adverse event <sup>b,c</sup>	32/120 (26.7%)	30/60 (50.0%)	
Censored (subjects without observed events) <sup>b,d</sup>	88/120 (73.3%)	30/60 (50.0%)	
Kaplan-Meier estimated probability of (upper limit of the one-sided 97.5% CI <sup>e</sup> ) of major adverse event within 1 year	0.27 (0.361)	0.51 (0.650)	$< 0.001$

Notes: The Safety sample includes All Enrolled subjects who underwent implantation of the Relay® device or surgical repair. If the initial procedure resulted in an implant failure of the Relay® Stent-Graft and a Relay® Stent-Graft was implanted during a second procedure, the time to event is based on the initial procedure date if the adverse event occurred before the second procedure date; otherwise, time to event is based on the second procedure date.

<sup>a</sup> p-value from Log Rank test.

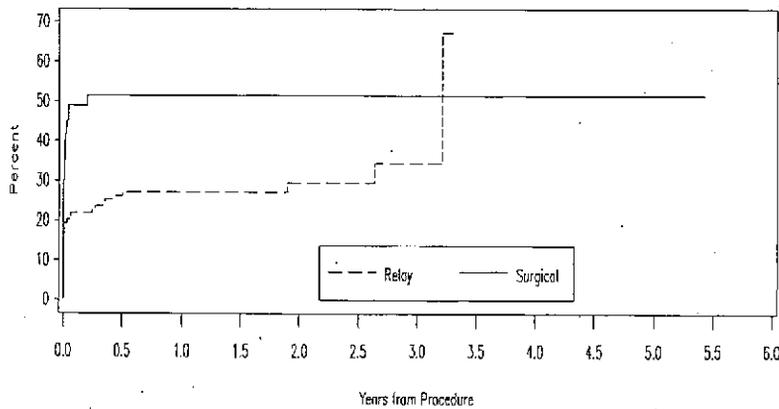
<sup>b</sup> Percentages are based on the number of subjects in each treatment group.

<sup>c</sup> Adjudicated by the CEC. In the event that the CEC determines an event could never be adjudicated, it will be assumed that the site investigator's report is accurate and it is used in place of an adjudication.

<sup>d</sup> Subjects without observed events were censored at the last follow-up (up to 1 year).

<sup>e</sup> Using Greenwood. The upper limit of the one-sided 97.5% CI was constructed using Greenwood's variance (loglog transformation). An upper limit of the one-sided 97.5% CI was also constructed using Peto's method which produced similar results with respect to the primary safety analysis.

**Diagram 1 Time to First Major Adverse Event**



Notes: The Safety Sample includes All Enrolled subjects who underwent implantation of the Relay® device or surgical repair. If the initial procedure resulted in an implant failure of the Relay® Stent-Graft and a Relay® Stent-Graft was implanted during a secondary procedure, the time to event is based on the initial procedure date if the event occurred before the second procedure date; otherwise, time to event is based on the second procedure date.

**Aneurysm-Related Mortality**

Aneurysm-related mortality was a component of the primary safety endpoint. The protocol definition of aneurysm-related mortality was any death due to a rupture, death prior to 30 days or hospital discharge from primary procedure, or death less than 30 days or prior to hospital discharge for a secondary procedure designed to treat the original aneurysm. Excluded are aneurysms in other anatomic segments other than the segment treated with the Relay® stent-graft. There were 8 deaths considered aneurysm-related in the Relay® cohort, 7 of which occurred within 30 days. The death that occurred beyond 30 days involved a subject who suffered a contained rupture of an untreated aneurysm. Within 30 days of placing a second Relay® device to treat the contained rupture, the subject died. In the surgical control cohort, there were 6 aneurysm-related deaths, all of which occurred within 30 days of the surgical procedure.

Kaplan Meier analysis of freedom from aneurysm-related mortality within 1 year is presented in Table 13. Freedom from aneurysm-related mortality and time to aneurysm-related mortality are graphically presented in Diagrams 2 and 3, respectively.

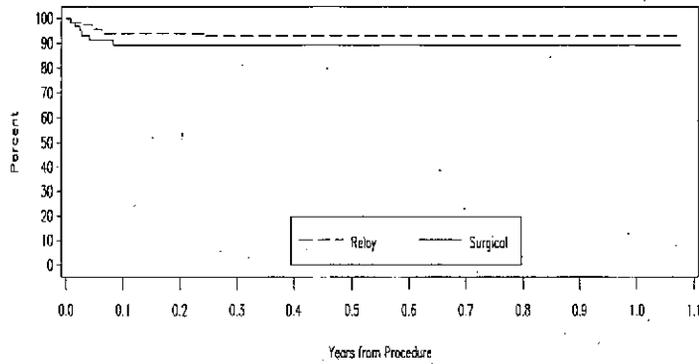
**Table 13 Kaplan-Meier: Freedom From Aneurysm-Related Mortality Within 1 Year**

	Relay Thoracic Stent-Graft (N = 120)	Surgical Repair (N = 60)
Aneurysm-related mortality <sup>a, b</sup>	8/120 (6.7%)	6/60 (10.0%)
Censored (subjects without observed events) <sup>a, c</sup>	112/120 (93.3%)	54/60 (90.0%)
Kaplan-Meier estimated probability (95% two-sided CI <sup>d</sup> ) of freedom from aneurysm-related mortality within 1 year	0.93 (0.87, 0.97)	0.89 (0.78, 0.95)

Notes: The Safety sample includes All Enrolled subjects who underwent implantation of the Relay® device or surgical repair. If the initial procedure resulted in an implant failure of the Relay® Stent-Graft and a Relay® Stent-Graft was implanted during a second procedure, the time to event is based on the initial procedure date if the adverse event occurred before the second procedure date; otherwise, time to event is based on the second procedure date.

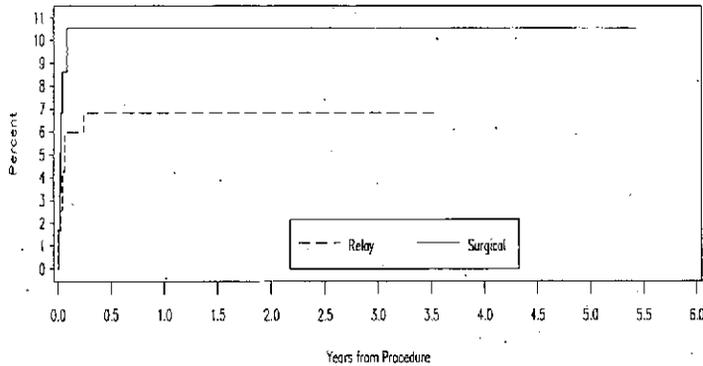
- <sup>a</sup> Percentages are based on the number of subjects in each treatment group.
- <sup>b</sup> Adjudicated by the CEC. In the event that the CEC determines an event could never be adjudicated, it will be assumed that the site investigator's report is accurate and it is used in place of an adjudication.
- <sup>c</sup> Subjects without observed events were censored at the last follow-up (up to 1 year).
- <sup>d</sup> Using Greenwood's variance (loglog transformation). The lower limit of the two-sided 95% CI is equivalent to the lower limit of the one-sided 97.5% CI.

**Diagram 2 Freedom from Aneurysm-Related Mortality**



Notes: The Safety Sample includes all enrolled subjects who underwent implantation of the Relay® device or surgical repair. If the initial procedure resulted in an implant failure of the Relay® Stent-Graft and a Relay® Stent-Graft was implanted during a secondary procedure, the time to event is based on the initial procedure date if the event occurred before the second procedure date, otherwise time to event is based on the second procedure date.

**Diagram 3 Time to Aneurysm Related Mortality**



Notes: The Safety Sample includes all enrolled subjects who underwent implantation of the Relay® device or surgical repair. If the initial procedure resulted in an implant failure of the Relay® Stent-Graft and a Relay® Stent-Graft was implanted during a secondary procedure, the time to event is based on the initial procedure date if the event occurred before the second procedure date, otherwise time to event is based on the second procedure date.

Time to event is calculated as 1 minus freedom from event (Kaplan-Meier estimate).

### 6.7.2 Secondary Safety Endpoints

The secondary safety endpoint included evaluation of the major adverse device events at timepoints other than 1 year. In addition, an evaluation of all-cause mortality was conducted as part of the secondary endpoint. Although not a secondary endpoint per the study protocol, information on serious adverse events and their relationship to the study device and procedure was collected.

#### Major Adverse Events (including All-Cause Mortality)

Table 14 summarizes the number of subjects in the Relay® and surgical control cohorts who experienced major adverse events (MAEs). All data were CEC adjudicated. The percentage of subjects experiencing one or more MAE was higher in the surgical control cohort than in the Relay® cohort (50% vs. 26.7%). The results of an unadjusted Cox proportional hazards analysis of all MAEs post-procedure was conducted. The hazard ratio was 0.49.

Stroke (10.8%) accounted for the greatest number of MAEs in the Relay® cohort compared with 6.7% in the surgical cohort. Based on adjudicated data, fewer aneurysm-related deaths were reported in the Relay® cohort (6.7%) than in the surgical cohort (10.0%). As noted previously, within 30 days of the initial implantation procedure, there were seven deaths in the Relay® cohort. None of these deaths was due to aneurysm rupture. Causes of death included sepsis/bowel perforation, bowel ischemia, respiratory failure, hemorrhagic stroke, pneumonia, cardiopulmonary arrest, and combination respiratory failure/acute renal failure, stroke.

**Table 15** presents the Kaplan Meier Analysis of Freedom from All-Cause Mortality through the end of the 1-year visit window (Day 393). There were 17 deaths (14.2%) in the Relay® cohort and 10 deaths (16.7%) in the surgical control cohort. Freedom from all-cause mortality and time to all death following implantation through the end of the 1-year visit window are graphically presented in **Diagrams 4** and **5**, respectively. An unadjusted Cox proportional hazards analysis of the all-cause mortality was conducted. The hazard ratio was 0.75.

Deaths occurring after the end of the 1-year visit window and before the start of the 2-year follow-up window (Day 674) were also captured. **Table 14** presents the full 1-year visit interval which extends from Day 337 to Day 673. In addition, **Table 14** presents the cumulative number of deaths from implantation through the end of the 1 year visit interval (Day 673). Cumulatively, there were 23 deaths (19.2%) in the Relay® cohort. Seventeen (17) occurred by Day 393 (1-year visit window) and another 6 occurred between Day 394 and 673. For the surgical control cohort, there were a total of 18 deaths (30%), 10 by Day 393 and another 8 between 394 and Day 673.

Table 14 Mortality and Major Adverse Events (MAEs) -- Relay and Surgical

	Operative 515 Days		30-Day Visit 16-151 Days		6-Month Visit 152-336 Days		1-Year Visit 337-673 Days		530 Days		Overall (cumulative through 1 year interval)	
	Relay <sup>a</sup> (N = 120)	Surgical (N = 60)	Relay <sup>a</sup> (N = 114)	Surgical (N = 51)	Relay <sup>a</sup> (N = 107)	Surgical (N = 35)	Relay <sup>a</sup> (N = 97)	Surgical (N = 33)	Relay <sup>a</sup> (N = 120)	Surgical (N = 60)	Relay <sup>a</sup> (N = 120)	Surgical (N = 60)
Mortality (all causes) <sup>b</sup>	3 (2.5%)	5 (8.3%)	7 (6.1%)	5 (9.8%)	7 (6.5%)	0	6 (6.2%)	1 (3.0%)	77 (5.8%)	6 (10.0%)	23 (19.2%)	18 (30.0%)
One or more MAE	24 (20%)	29 (48.3%)	6 (5.3%)	1 (2.0%)	2 (1.9%)	0	0	0	26 (21.7%)	29 (48.3%)	32 (26.7%)	30 (50%)
- Stroke	6 (5.0%)	4 (6.7%)	3 (2.6%)	0	2 (1.9%)	0	0	0	6 (5.0%)	4 (6.7%)	10 (9.2%) <sup>b</sup>	4 (6.7%)
- Paralysis/paraplegia <sup>c</sup>	2 (1.7%)	2 (3.3%)	0	0	1 (0.9%)	0	0	0	2 (1.7%)	2 (3.3%)	3 (2.5%)	2 (3.3%)
- Myocardial infarction	2 (1.7%)	1 (1.7%)	0	0	0	0	0	0	2 (1.7%)	1 (1.7%)	2 (1.7%)	1 (1.7%)
- Procedural bleeding	8 (6.7%)	17 (28.8%)	0	0	0	0	0	0	8 (6.7%)	17 (28.3%)	8 (6.7%)	17 (28.8%)
- Respiratory failure	5 (4.2%)	11 (18.3%)	2 (1.8%)	0	1 (0.9%)	0	0	0	7 (5.8%)	11 (18.3%)	8 (6.7%)	11 (18.3%)
- Renal failure	2 (1.7%)	3 (5.0%)	0	0	1 (0.9%)	0	0	0	2 (1.7%)	3 (5.0%)	3 (2.5%)	3 (5.0%)
- Wound healing complications	6 (5.0%)	3 (5.0%)	1 (0.9%)	5 (9.8%)	1 (0.9%)	0	0	0	7 (5.8%)	4 (6.7%)	8 (6.7%)	7 (11.7%)
- Aneurysm-related mortality <sup>d</sup>	3 (2.5%)	5 (8.3%)	5 (4.4%)	1 (2.0%)	0	0	0	0	7 (5.8%)	6 (10.0%)	8 (6.7%)	6 (10.0%)

Notes: The Safety sample includes All Enrolled subjects who underwent implantation of the Relay<sup>®</sup> device or surgical repair. Mortality and major adverse events were adjudicated by the CEC. At each level of summarization, a subject is counted once if the subject reported 1 or more events. Percentages are based on the number of subjects in the Safety sample who have sufficient follow-up. A subject has sufficient follow-up if the date of last follow-up minus procedure date is greater than or equal to the start of the time period. Percentages for the overall time period are based on all subjects in the Safety sample. If the initial procedure resulted in an implant failure of the Relay<sup>®</sup> Stent-Graft and a Relay<sup>®</sup> Stent-Graft was implanted during a second procedure, the time periods are based on the initial procedure date if the adverse event occurred before the second procedure date; otherwise, time periods are based on the second procedure date. In the event that the CEC determines an event can never be adjudicated, it is assumed that the site investigator's report is accurate and it is used in place of adjudication.

<sup>a</sup> While all-cause mortality is presented, the safety endpoint is aneurysm-related mortality.

<sup>b</sup> One subject experienced a stroke in two separate intervals, but is not counted twice in the cumulative interval.

<sup>c</sup> Paraparesis was not one of the events tracked as a major adverse event. Paraparesis was reported in one Relay<sup>®</sup> subject 2 days post-implant, and it resolved with medication. Paraparesis was also reported in one surgical subject 2 days post-op when the lumbar drain was stopped. This event also resolved.

**Table 15 Kaplan-Meier: Freedom From All-Cause Mortality Within 1 Year**

	Relay Thoracic Stent-Graft (N = 120)	Surgical Repair (N = 60)
Mortality (All-cause) <sup>a</sup>	17/120 (14.2%)	10/60 (16.7%)
Censored (subjects without observed events) <sup>b</sup>	103/120 (85.8%)	50/60 (83.3%)
Kaplan-Meier estimated probability (95% two-sided CI <sup>c</sup> ) of freedom from all-cause mortality within 1 year	0.85 (0.78, 0.91)	0.81 (0.67, 0.89)

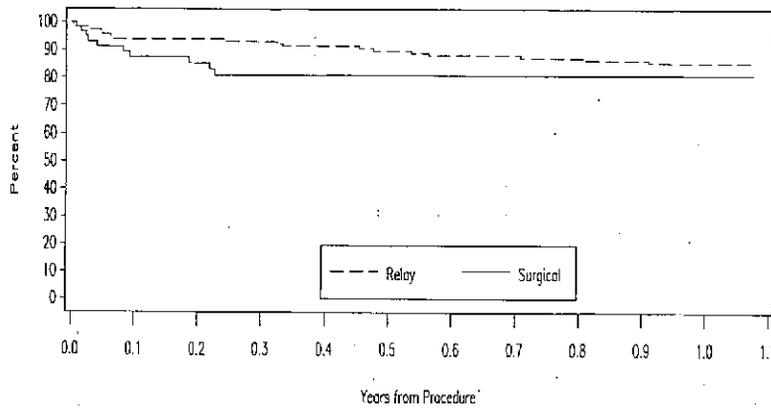
Notes: The Safety sample includes All Enrolled subjects who underwent implantation of the Relay® device or surgical repair. If the initial procedure resulted in an implant failure of the Relay® Stent-Graft and a Relay® Stent-Graft was implanted during a second procedure, the time to event is based on the initial procedure date if the adverse event occurred before the second procedure date; otherwise, time to event is based on the second procedure date.

<sup>a</sup> Percentages are based on the number of subjects in each treatment group.

<sup>b</sup> Subjects without observed events were censored at the last follow-up (up to 1 year).

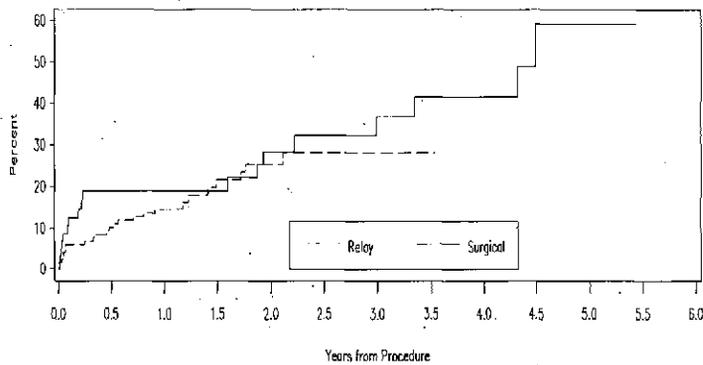
<sup>c</sup> Using Greenwood's variance (loglog transformation). The lower limit of the two-sided 95% CI is equivalent to the lower limit of the one-sided 97.5% CI.

**Diagram 4: Freedom from All-Cause Mortality**



Notes: The Safety Sample includes all enrolled subjects who underwent implantation of the Relay® device or surgical repair. If the initial procedure resulted in an implant failure of the Relay® Stent-Graft and a Relay® Stent-Graft was implanted during a secondary procedure, the time to event is based on the initial procedure date if the event occurred before the second procedure date, otherwise time to event is based on the second procedure date

**Diagram 5 Time to Mortality (All Cause)**



Notes: The Safety Sample includes all enrolled subjects who underwent implantation of the Relay® device or surgical repair. If the initial procedure resulted in an implant failure of the Relay® Stent-Graft and a Relay® Stent-Graft was implanted during a secondary procedure, the time to event is based on the initial procedure date if the event occurred before the second procedure date, otherwise time to event is based on the second procedure date.

Time to event is calculated as 1 minus freedom from event (Kaplan-Meier estimate).

## 6.8 Effectiveness Data

### 6.8.1 Primary Effectiveness Endpoint

The primary effectiveness endpoint was freedom from major device-related adverse events [endoleak (Types I, III and IV), stent migration (> 10mm as compared to the 1 month visit), lumen occlusion, aneurysm rupture, and deployment failure/conversion to surgical repair] at 1 year post-procedure. The results of this study are summarized in Table 16. The primary effectiveness analysis was evaluated in three ways. The initial analysis considered the entire cohort of 120 subjects. The second analysis considered 99 subjects who achieved the 1-year visit and/or had some 1-year follow-up information. Specifically, as noted in Table 2, only 97 subjects were eligible for a 1-year visit, but 99 subjects were evaluated as part of the primary effectiveness endpoint since two subjects who experienced major device-related adverse events died prior to 1-year and were included in the total analyzed. Finally, as noted in Table 2 not all subjects had 1-year imaging evaluated by the core laboratory. Therefore, an alternate analysis considering only those subjects with complete imaging was also conducted.

When the primary effectiveness endpoint is evaluated for the entire cohort of 120 subjects who were implanted with the Relay® stent-graft, 116 (97%) were free of major device-related events out to 1 year. When the primary effectiveness analysis was conducted including only 99 subjects with some follow-up information at 1 year, the freedom from major device-related adverse events at 1 year is 96%. In both analyses (120 subjects and 99 subjects), the lower limit of one-sided 97.5% confidence interval was greater than 0.90. The results of the one-sided z-test rejected the null hypothesis, providing evidence that the performance goal of greater than 0.80 proportion-free of major device-related adverse events within 1 year was met. A Kaplan-Meier analysis resulted in a 96% probability (lower limit of the one-sided 97.5% confidence interval of 0.902) of remaining free from major device-related events at the 1-year follow-up visit (Table 17). Time to first major device related adverse events is graphically presented in Diagram 6. Tipping point

analyses performed to evaluate the impact of non-evaluable subjects demonstrated that the effectiveness analyses conducted were robust.

It should be noted that since only 89 subjects had imaging for the 1-year visit evaluated by the core laboratory, additional 1-year data were obtained to allow for the inclusion of 99 patients in the primary effectiveness analysis. These data consisted of a combination of site-reported data and imaging data obtained after the 1-year interval. Use of the later imaging provided a conservative estimate of the device effectiveness, as any events identified at a later follow-up time were considered to have been present at 1 year and because it is unlikely that an event would have been present at 1 year with spontaneous resolution before the later follow-up. As further support, an alternate effectiveness analysis considering only those subjects with interpretable CTs at 1 year showed that study endpoints were still met. Specifically, the alternative analysis was performed on 70 event-free subjects with 1-year CTs that were interpretable for both endoleak and migration plus 4 subjects with major device-related adverse events. This analysis yielded a proportion of 0.95 and a lower confidence limit of 0.89. Since the lower limit of the confidence interval was greater than 0.80, the effectiveness endpoint remained satisfied.

**Table 16 Freedom From Major Device-Related Adverse Events at 1 Year**

<b>Subjects Free From Major Device-Related Adverse Events at 1 Year Post-Procedure<sup>a</sup></b>	<b>Relay<sup>®</sup> Thoracic Stent-Graft (N = 120)</b>
Proportion free from event for all subjects who underwent implantation of the Relay <sup>®</sup> device <sup>b</sup>	116/120 (0.97)
— Lower limit of 97.5% 1-sided confidence interval <sup>c</sup>	0.93
Proportion free from event excluding subjects with less than 1 year of follow-up <sup>d</sup>	95/99 (0.96)
— Lower limit of 97.5% 1-sided confidence interval <sup>e</sup>	0.92

Note: The Effectiveness sample includes All Enrolled subjects who underwent implantation of the Relay<sup>®</sup> device.

<sup>a</sup> Adjudicated by the CEC and as identified by the Core Laboratory as a major device-related adverse event.

<sup>b</sup> Calculated for subjects in the Effectiveness sample.

<sup>c</sup> Test failed if the lower limit of the 1-sided confidence interval was less than or equal to 0.80.

<sup>d</sup> Excluding subjects in the Effectiveness sample with less than 1 year (minus 1 month to account for the visit window) of follow-up without major device-related adverse event.

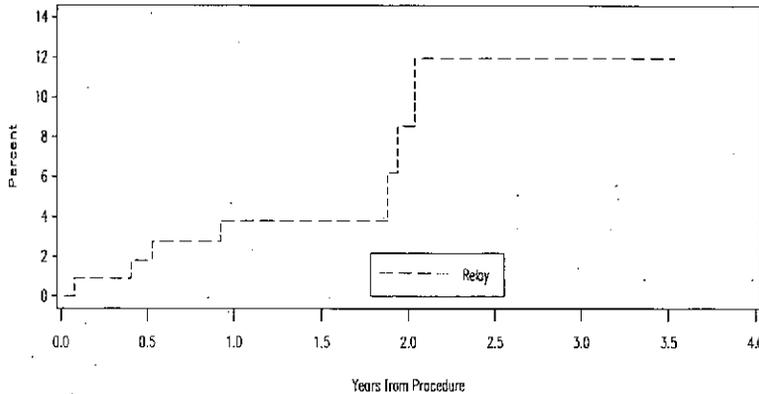
**Table 17 Kaplan-Meier: First Major Device-Related Event Within 1 Year**

	Relay® Thoracic Stent-Graft (N=120)
Major device-related adverse event <sup>a, b</sup>	4/120 (3.3%)
Censored (subjects without observed events) <sup>a, c</sup>	116/120 (96.7%)
Kaplan-Meier estimated probability (lower limit of the one-sided 97.5% CI <sup>d</sup> ) of free from major device-related adverse event at 1 year	0.96 (0.902)

Notes: The Effectiveness sample includes All Enrolled subjects who underwent implantation of the Relay® device. If the initial procedure resulted in an implant failure of the Relay® Stent-Graft and a Relay® Stent-Graft was implanted during a second procedure, the time to event is based on the initial procedure date if the adverse event occurred before the second procedure date; otherwise, time to event is based on the second procedure date.

- <sup>a</sup> Percentages were based on the number of subjects in the Effectiveness sample.
- <sup>b</sup> Adjudicated by the Clinical Events Committee and as identified by the Core Laboratory.
- <sup>c</sup> Subjects without observed events were censored at the last follow-up (up to 1 year).
- <sup>d</sup> Using Greenwood. The one-sided 97.5% CI was constructed using Greenwood's variance (loglog transformation). A one-sided CI was also constructed using Peto's method which produced similar results with respect to the primary effectiveness analysis.

**Diagram 6: Time to First Major Device-Related Adverse Event**



Notes: Effectiveness sample includes all enrolled subjects who underwent implantation of the Relay® device. If the initial procedure resulted in an implant failure of the Relay® Stent-Graft and a Relay® Stent-Graft was implanted during a second procedure, the time to event is based on the initial procedure date if the event occurred before the second procedure date, otherwise time to event is based on the second procedure date. The increase between 1.5 and 2.0 years represents n = 1.

**6.8.2 Secondary Effectiveness Endpoints**

The secondary effectiveness analyses included an evaluation of major device-related AEs [endoleak (excluding Type II), stent migration (migration ≥ 10 mm as compared to the 1-month visit), lumen occlusion, aneurysm rupture, conversion to surgery] at times other than 1 year. Other secondary effectiveness endpoints included lesion measurement changes from the 1-month visit as compared with the 6-month and 1-year visits, device integrity failures, and vascular access complications.

### **Major Device-Related Adverse Events**

**Table 18** combines the major device-related adverse events as reported by the Core Laboratory with the major device-related adverse events as adjudicated by the CEC. As noted, there have been no treated aneurysm ruptures. One subject has been converted to surgery. The etiology was noted to be due to esophageal erosion into the aorta well below the placement of the Relay® device. On this basis, the CEC concluded that the event was not device-related and should not be considered part of the primary endpoint.

Table 18 Major Device-Related Events

	Operative 5-15 Days		30-Day Visit (full window) 16-151 Days		6-Month Visit 152-336 Days		1-Year Visit 337-673 Days		≤ 30 Days		Overall (cumulative through 1 year interval)	
	Core Lab	CEC	Core Lab	CEC	Core Lab	CEC	Core Lab	CEC	Core Lab	CEC	Core Lab	CEC
Any major adverse device-related event	0/107	0/120	2/107 (1.9%)	0/114	2/95 (2.1%)	0/107	2/87 (2.3%)	0/97	1/107 (0.9%)	0/120	6/107 (5.6%)	0/120
Any endoleak	0/103	NA	1/103 (1.0%)	NA	0/90	NA	1/80 (1.3%)	NA	1/103 (1.0%)	NA	2/103 (1.9%)	NA
- Type I	0/103	NA	1/103 (1.0%)	NA	0/90	NA	1/80 (1.3%)	NA	1/103 (1.0%)	NA	2/103 (1.9%)	NA
- Type III	0/103	NA	0/103	NA	0/90	NA	0/80	NA	0/103	NA	0/103	NA
- Type IV	0/103	NA	0/103	NA	0/90	NA	0/80	NA	0/103	NA	0/107	NA
Stent migration	0/107	NA	1/107 (0.9%)	NA	2/95 (2.1%)	NA	2/86 (2.3%)	NA	0/107	NA	3/107 (2.8%)*	NA
Lumen occlusion	0/104	0/120	0/104	0/114	0/91	0/107	0/80	0/97	0/104	0/120	0/104	0/120
Treated aneurysm rupture	NA	0/120	NA	0/114	NA	0/107	NA	0/97	NA	0/120	NA	0/120
Conversion to surgery / deployment failure	NA	0/120	NA	0/114	NA	0/107	NA	0/97	NA	0/120	NA	0/120

CEC: Clinical Events Committee; NA= Not Applicable.

Notes: The Effectiveness sample includes All Enrolled subjects who underwent implantation of the Relay® device. Major device-related adverse events were reported by Core Laboratory. Site-reported events were adjudicated by the CEC. At each level of summarization, a subject was counted once if the subject reported 1 or more events. Percentages are based on the number of subjects in the Effectiveness sample who have sufficient follow-up. A subject has sufficient follow-up if the date of last follow-up minus the procedure date is greater than or equal to the start of the time period. Percentages for the Overall time period are based on all subjects in the Effectiveness sample. Sufficient follow-up is calculated separately for site-reported and Core Laboratory data. Sufficient follow-up for Core Laboratory data is based only on follow-up computed tomography (CT) scans or x-ray. If the initial procedure resulted in an implant failure of the Relay® Stent-Graft and a Relay® Stent-Graft was implanted during a second procedure, the time periods are based on the initial procedure date if the adverse event occurred before the second procedure date; otherwise, time periods are based on the second procedure date.

\*In total, 3 subjects experienced migration within 1 year; migration may be reported at more than one interval for some subjects.

### Lesion Size Changes

A summary of the changes in maximum lesion diameter ( $\geq 10$  mm) from the 1-month post-procedure visit compared with the lesion length at the 6-months and 1-year visits is presented in **Table 19**. Lesion enlargement was detected in a total of 3 study subjects. Enlargement was detected in 1 of these subjects at the 6-month and 1-year visits. The subject's lesion increased a total of 20.8 mm from the time of procedure through the 1-year visit and was associated with both migration and Type I endoleak. Intervention was proposed for this subject, but at the time of datalock, none had been performed. The lesion enlargement detected in the other 2 subjects was not associated with device migration or Type I, III, or IV endoleak.

**Table 19 Lesion Diameter Changes in Relay® Cohort - Core Laboratory-Reported**

6-month visit	
Increase ( $\geq 10$ mm)	1/92 (1.1%)
Decrease ( $\geq 10$ mm)	9/92 (9.8%)
No change	82/92 (89.1%)
1-year visit	
Increase ( $\geq 10$ mm)	3/86 (3.5%)
Decrease ( $\geq 10$ mm)	20/86 (23.3%)
No change	63/86 (73.3%)

### Vascular Access Complications

Vascular access complications were evaluated by the sites and the CEC. Applicable complications included iliac artery injury, femoral artery injury, pseudoaneurysm formation, and access difficulties. The overall incidence of vascular access complications as adjudicated by the CEC was 9.2% (11/120). The majority of these complications were iliac artery injuries (5.8%, 7/120). There were 3 reports of femoral artery injury (2.5%) and 1 incidence of pseudoaneurysm (0.8%, 1/120).

### Device Integrity Failures (Wireform Fractures)

Wireform fractures have been detected in two subjects. The fractures were in the longitudinal support system of the graft and in both cases, investigation revealed that the fractures were due to the placement of the device (either completely or partially) along the inferior curvature of the aorta versus the superior curvature as described in the implantation instructions. Both fractures were detected at the 1-year follow-up interval by the Core Laboratory. Both subjects have been followed regularly as part of the protocol requirements. One of the subjects has achieved the 3-year follow-up with no reports of additional fracture, endoleak, migration, lumen occlusion or other adverse findings. The other subject has achieved the 2-year follow-up visit. The core lab has detected a Type II endoleak, but there is no finding of Type I/III endoleak, migration, or lumen occlusion.

### Secondary Interventions

During the course of follow-up, 3 subjects required secondary intervention. Two subjects received additional stent-grafts to treat endoleaks at days 126 and 430 post-procedure, respectively. One subject was converted to open surgical repair 91 days post-procedure due to a graft infection secondary to an aorto-esophageal fistula.

Finally, the re-attempted procedure for the subject described previously was documented as a secondary intervention to distinguish it from the initial aborted attempt.

## 6.10 Subgroup Analyses

Two subgroup analyses were performed for subjects who were treated with the Relay® Stent-Graft. One analysis compared the 2 delivery systems (original delivery system versus Plus system) and the second analysis compared the lesion types (fusiform aneurysms versus saccular aneurysms and PAUs).

### 6.10.1 Delivery System Subgroups

A comparison of the delivery and deployment in procedures involving the Plus delivery system versus those involving the original delivery system was conducted. The subgroup analysis included summaries of the number of subjects who completed and discontinued the study by delivery system used. Demographics, baseline medical history, aneurysm diameter, and clinical utilities were also summarized. Comparisons of treatment assessments, requirements for additional treatments, and final procedure results were made using the chi-square test for categorical data for subjects treated with the original delivery system and the Plus delivery system.

Subjects treated with the original Relay® delivery system and subjects treated with the Plus delivery system were compared (chi-square test) to demonstrate that the following do not differ based on the delivery system used, thus allowing the subjects to be pooled for the evaluation of the primary effectiveness endpoint:

- evaluation of the delivery system
- overall rate of vascular access complications ( $\leq 30$  days)
- rate of access failures
- rate of deployment system difficulties

Twenty-five (25) of the 120 subjects in the study received treatment with the Plus system. The subjects in the 2 subgroups were similar in age, gender, and race. The subjects in both delivery system subgroups responded similarly during the implantation process. Comparison of the 2 treatment systems using the chi-square test did not show any statistically significant differences between the subjects treated with the 2 delivery systems with respect to major device-related adverse events. The 2 delivery system subgroups were similar in clinical utility measures except for the number of subjects requiring transfusions (Relay® 9.6%; Relay® Plus 4.0%), estimated blood loss (Relay® 248.8 cc; Relay® Plus 152.8 cc), and procedures performed during implant (Relay® had 11 procedures and Relay® Plus had none). The differences may be due to the small number of subjects treated with the Relay® Plus system at the time the data were generated.

Overall, the comparison of the subjects treated with the original Relay® delivery system and the subjects treated with the Plus delivery system showed that the 2 subgroups were similar and that it was appropriate to pool the results for the evaluation of effectiveness and safety.

### 6.10.2 Lesion Types

A subgroup analysis compared Relay® subjects based on lesion type, grouping saccular aneurysms with penetrating ulcers and comparing them to the subjects with fusiform thoracic aneurysms. As described for the delivery system subgroup analysis, demographics and baseline medical information were summarized. Additionally, CT scan and x-ray data were summarized as reported by both the sites and the Core Laboratory.

Primary and secondary effectiveness endpoints were compared including freedom from major device-related adverse events (AEs) at 1-year post-procedure (chi-square test); major device-related AEs as reported by the sites, as reported by the Core Laboratory, and as adjudicated by the CEC (chi-square test); time to first major device-related AE (log rank test); and individual components of major device-related AEs (chi-square test). Changes in maximum lesion diameter from 1-month post-procedure were also summarized for the lesion type subgroups. Additionally, the primary and selected secondary safety endpoints were compared. A Kaplan-Meier analysis of time to first major adverse event (MAE) within 1-year post procedure is presented as well as summaries of mortality and the components of MAEs. Fisher's exact test was utilized in place of chi-square test where appropriate.

Subjects with saccular aneurysms in the descending thoracic aorta were grouped with the subjects with penetrating atherosclerotic ulcers (PAU group) and compared to those with fusiform aneurysms (non-PAU group). Of the 120 Relay® subjects enrolled in the study, 34 were categorized as PAU and 86 were non-PAU. A greater number of subjects in the PAU group were in the 18 to 64 year-old category (non-PAU, 8.1%; PAU, 35.3%) with fewer subjects in the ≥75 year-old category (non-PAU, 52.3%; PAU, 32.4%). The mean total treatment length of the vessel was greater in the non-PAU subjects than in the PAU subjects (non-PAU, 218.7 mm; PAU, 123.5 mm) as was the length of the lesion (non-PAU, 129.0 mm; PAU, 53.0 mm). The length from the lesion to the celiac artery was greater in the PAU subjects than in the non-PAU subjects (non-PAU, 87.0 mm; PAU, 125.1 mm). A greater number of subjects in the PAU group had aneurysm diameters less than 50 mm.

Overall, the comparison of the subjects with PAU and non-PAU lesions showed that the 2 groups were similar and that it was appropriate to pool the results for the evaluation of effectiveness and safety.

### 6.10.3 Gender

The Relay® cohort accrued a total of 58 (48.3%) female and 62 (51.7%) male subjects. The prevalence of fusiform TAA was 72.4% (42/58) in the female population, 71% (44/62) in males, and 71.7% (86/120) in both groups combined. The prevalence of saccular TAA/penetrating ulcer was 27.6% (16/58) in the female population, 29% (18/62) in males, and 28.3% (34/120) in both groups combined. These data indicate that the distribution of fusiform TAA and saccular TAA/penetrating ulcers were comparable between the male and female subjects.

The primary safety endpoint was the distribution of Relay® and surgical control subjects experiencing at least 1 major adverse event (aneurysm-related mortality, stroke, paralysis/paraplegia, myocardial infarction, procedural bleeding, respiratory failure, renal failure, and wound healing complications) within 1 year post-procedure. The primary effectiveness endpoint was freedom from major device-related adverse events [endoleak (Types I, III and IV), stent migration (> 10mm as compared to the 1 month visit), lumen occlusion, aneurysm rupture, and deployment failure/conversion to surgical repair] at 1 year post-procedure. Fifty-eight (58) female and 62 male subjects were evaluable for the primary safety and effectiveness endpoints.

The occurrence of major adverse events was 25.9% among the female subjects and 27.4% among the male subjects. Table 20 shows the Analysis of Major Adverse Event by Gender. Both the Kaplan Meier estimated probability of major adverse event and Kaplan Meier estimated probability of freedom from major adverse events are presented. Probabilities are similar for both males and females, indicating similar safety outcomes for both genders. Freedom from major adverse events is graphically presented in Diagram 7.

**Table 20 Kaplan-Meier: Analysis of Major Adverse Events Within 1 Year by Gender**

	Females (N = 58)	Males (N = 62)
Major Adverse Event <sup>a,b</sup>	15/58 (25.9%)	17/62 (27.4%)
Censored (subjects with observed events) <sup>a,c</sup>	43/58 (74.1%)	45/62 (72.6%)
Kaplan-Meier estimated probability (95% two-sided CI) of major adverse event within 1 year <sup>d</sup>	0.26 (0.40, 0.17)	0.27 (0.40, 0.18)
Kaplan-Meier estimated probability (95% two-sided CI) of freedom from major adverse event within 1 year	0.74 (0.60, 0.83)	0.73 (0.60, 0.82)

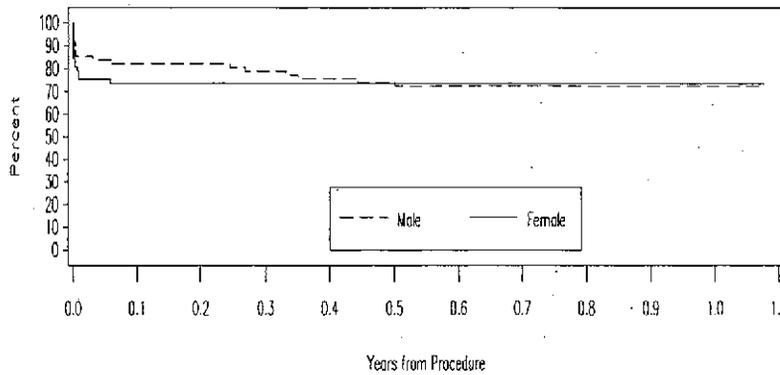
Notes: The Safety sample includes All Enrolled subjects who underwent implantation of the Relay® device or surgical repair. If the initial procedure resulted in an implant failure of the Relay® Stent-Graft and a Relay® Stent-Graft was implanted during a second procedure, the time to event is based on the initial procedure date if the adverse event occurred before the second procedure date; otherwise, time to event is based on the second procedure date.

<sup>a</sup> Percentages are based on the number of subjects in each treatment group.

<sup>b</sup> Adjudicated by the CEC. In the event that the CEC determines an event could never be adjudicated, it will be assumed that the site investigator's report is accurate and it is used in place of an adjudication.

<sup>c</sup> Subjects without observed events were censored at the last follow-up (up to 1 year).

**Diagram 7 Freedom from Major Adverse Events within 1 Year by Gender**



Of the 120 subjects who underwent implantation of the Relay® Stent-Graft, 56 females (97%) and 60 males (97%) were free of device-related events through the 1-year follow-up visit. When the subjects with less than 1-year follow-up were excluded from the analysis, 96% of both female and male subjects were free of device-related events at the 1-year follow-up visit. These findings indicate similar effectiveness outcomes for males and females. **Table 21** and **Diagram 8** show the Freedom from Major Device-Related Events by Gender.

**Table 21 Kaplan-Meier: Freedom from Major Device-Related Event Within 1 Year by Gender**

	Females (N = 58)	Males (N = 62)
Subjects free from major device-related adverse events at 1 year post-procedure <sup>a</sup>		
Proportion free from event <sup>b</sup>	56/58 (0.97)	60/62 (0.97)
Lower limit of 97.5% one-sided CI <sup>c</sup>	0.92	0.92
Proportion free from event <sup>d</sup>	46/48 (0.96)	49/51 (0.96)
Lower limit of 97.5% one-sided CI <sup>c</sup>	0.90	0.91

Notes: The Effectiveness sample includes All Enrolled subjects who underwent implantation of the Relay® device.

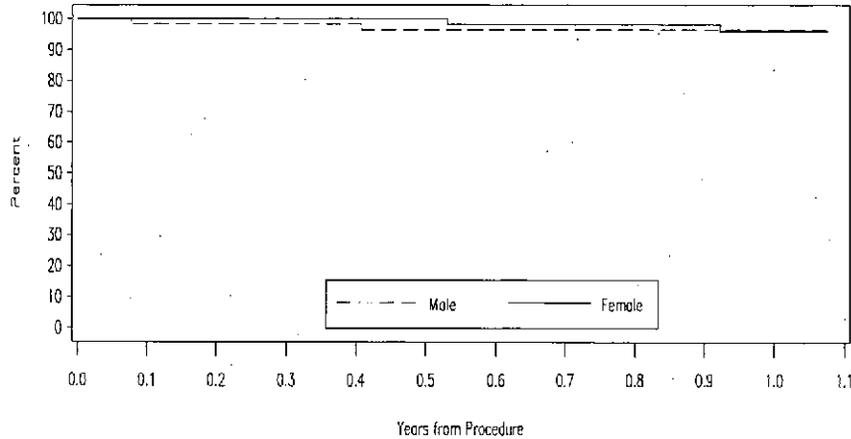
<sup>a</sup> Adjudicated by the Clinical Events Committee (CEC) and as identified by the Core Laboratory as a major device-related adverse event.

<sup>b</sup> Calculated for subjects in the Effectiveness sample.

<sup>c</sup> Test fails if the lower limit of the one-sided confidence interval is less than or equal to 0.80

<sup>d</sup> Excluding subjects in the Effectiveness sample with less than one year (minus one month to account for the visit window) of follow-up without major device-related adverse event.

**Diagram 8 Freedom from Major Device-Related Adverse Events by Gender**



Female and male subjects had similar mortality rates (12.1% and 16.1%, respectively). A Kaplan-Meier analysis of all-cause mortality is presented in Table 22 and Diagram 9.

**Table 22 Kaplan-Meier: Freedom From All-Cause Mortality Within 1 Year by Gender**

	Females (N = 58)	Males (N = 62)
Mortality (All-cause) <sup>a</sup>	7/58 (12.1%)	10/62 (16.1%)
Censored (subjects without observed events) <sup>a,b</sup>	51/58 (87.9%)	52/62 (83.9%)
Kaplan-Meier estimated probability (95% two-sided CI) of freedom from mortality (all-cause) at 1 year	0.87 (0.75, 0.94)	0.84 (0.72, 0.91)

Notes: The Safety sample includes All Enrolled subjects who underwent implantation of the Relay® device or surgical repair. If the initial procedure resulted in an implant failure of the Relay® Stent-Graft and a Relay® Stent-Graft was implanted during a second procedure, the time to event is based on the initial procedure date if the adverse event occurred before the second procedure date; otherwise, time to event is based on the second procedure date.

<sup>a</sup> Percentages are based on the number of subjects in each treatment group.

<sup>b</sup> Subjects without observed events were censored at the last follow-up (up to 1 year).

**Diagram 9 Freedom from All-Cause Mortality by Gender**



Table 23 presents individual rates of safety and effectiveness endpoints as well as other measures by gender. Events within 1 year represent the cumulative number of events between Day 0 and Day 393 (the end of the 1-year visit window).

Table 23: Endpoints Within 30 Days and 1 Year<sup>a</sup> by Gender

Safety				
	≤30 Days		Within 1 year	
	Females	Males	Females	Males
<b>Primary Safety:</b> Occurrence of one or more major adverse event within 1 year			25.9% (15/58)	27.4% (17/62)
<b>Secondary Endpoints</b>				
Mortality (all causes)	5.2% (3/58)	6.5% (4/62)	12.1% (7/58)	16.1% (10/62)
Major Adverse Events (one or more MAE)	25.9% (15/58)	9.7% (11/62)	25.9% (15/58)	27.4% (17/62)
– Stroke	6.9% (4/58)	3.2% (2/62)	6.9% (4/58) <sup>b</sup>	9.7% (6/62)
– Paralysis/paraplegia	1.7% (1/58)	1.6% (1/62)	1.7% (1/58)	3.2% (2/62)
– Myocardial infarction	0% (0/58)	3.2% (2/62)	0% (0/58)	3.2% (2/62)
– Procedural bleeding	8.6% (5/58)	4.8% (3/62)	8.6% (5/58)	5.2% (3/62)
– Respiratory failure	6.9% (4/58)	4.8% (3/62)	6.9% (4/58)	6.5% (4/62)
– Renal failure	3.4% (2/58)	0% (0/62)	3.4% (2/58)	1.6% (1/62)
– Wound healing complications	8.6% (5/58)	3.2% (2/62)	8.6% (5/58)	5.2% (3/62)
– Aneurysm-related mortality	5.2% (3/58)	6.5% (4/62)	5.2% (3/58)	8.1% (5/62)
Effectiveness				
	≤ 30 Days		Within 1 year	
	Females	Males	Females	Males
<b>Primary Effectiveness:</b> Freedom from major device-related adverse events within 1 year			97% (56/58)	97% (60/62)
<b>Secondary Endpoints and other Measures</b>				
Successful delivery and deployment at initial procedure	93.1% (54/58) <sup>c</sup>	100% (62/62)		
Patent graft at initial implant	100% (54/54) <sup>d</sup>	100% (62/62)		
Any major adverse device-related event	0% (0/58)	1.6% (1/62)	3.4% (2/58)	3.2% (2/62)
Any endoleak	0% (0/58)	1.6% (1/62)	1.7% (1/58)	1.6% (1/62)
– Type I	0% (0/58)	1.6% (1/62)	1.7% (1/58)	1.6% (1/62)
– Type III	0% (0/58)	0% (0/62)	0% (0/58)	0% (0/62)
– Type IV	0% (0/58)	0% (0/62)	0% (0/58)	0% (0/62)
Stent migration	0% (0/58)	0% (0/62)	3.4% (2/58)	1.6% (1/62)
Lumen occlusion / Loss of patency	0% (0/58)	0% (0/62)	0% (0/58)	0% (0/62)
Treated aneurysm rupture	0% (0/58)	0% (0/62)	0% (0/58)	0% (0/62)
Conversion to surgery / deployment failure <sup>e</sup>	0% (0/58)	0% (0/62)	0% (0/58)	0% (0/62)
Secondary endovascular procedures due to endoleak after discharge	0% (0/58)	0% (0/62)		
Secondary endovascular procedures due to endoleak after 30 days			1.7% (1/58)	0% (0/62) <sup>f</sup>

<sup>a</sup>Within 1 year Includes events from Day 0 through Day 393 (end of the 1 year visit window)

<sup>b</sup>One female experienced two strokes within one year but is only counted once in the total rate.

<sup>c</sup>Four aborted cases at initial implant; one successfully implanted during second attempt

<sup>d</sup>Includes only those subjects who received the graft during the initial attempt

<sup>e</sup>One subject was converted to open repair 91 days post-procedure due to a graft infection secondary to an aorto-esophageal fistula. The etiology was noted to be due to esophageal erosion into the aorta well below the placement of the Relay<sup>®</sup> device. On this basis, the CEC concluded that the event was not device-related and should not be considered part of the primary endpoint.

<sup>f</sup>One male subject underwent secondary intervention for endoleak but not until 430 days post-implant.

A set of *post hoc* analyses was conducted to assess the similarity by gender within the Relay<sup>®</sup> treatment for the primary safety endpoint, primary effectiveness endpoint, and all-cause mortality. The results suggest that the overall results of this study can be generalized to both genders.

- The primary safety analysis (Kaplan-Meier) was conducted for each gender (Table 20). The direct comparison (using a log-rank test) between the Kaplan-Meier results for each gender are similar. The result is further supported by the direct comparison (using a Chi-square test) of the observed gender-based point estimates.
- The primary effectiveness endpoint analysis was conducted for each gender (Table 21). The direct comparison (using a Fisher's Exact test) between the gender-based point estimates showed similarity between genders. Comparable results were also seen when excluding subjects without events and follow-up less than 1 year (sensitivity to the effectiveness endpoint).
- The direct comparison (using a Chi-square test) between gender-based point estimates for freedom from all-cause mortality within 1 year post-procedure (Table 22) showed similarity between genders.

In summary, women were reasonably represented in the Relay<sup>®</sup> study. The analyses showed that there may be some differences in the expected event rates for women as compared to men (higher major adverse event rate within 30 days), but the overall incidence of major adverse events within one year was comparable between males and females as was the incidence of typical endovascular events.

#### 6.11 Summary of Other Clinical Studies

Several other sources of data served to support the safety and effectiveness of the Relay<sup>®</sup> Thoracic Stent-Graft. These sources of data include longer-term data from the pivotal Relay<sup>®</sup> Phase II trial, the Relay<sup>®</sup> Phase I feasibility trial, and the ongoing continued access study.

##### 6.11.1 Long-Term Results of Pivotal Relay<sup>®</sup> Study

The Phase II pivotal study protocol required that subjects in the Relay<sup>®</sup> cohort be followed through five years. Data will be collected for any subjects remaining in the study up to 5 years. Patient compliance and follow-up from the beginning of the study through 3 years is provided in Table 24. Of the subjects who reached the beginning of the 2- and 3-year follow-up intervals, approximately half had returned by the time the analysis was prepared. Tables 25 and 26 present major adverse events and major device-related events for subjects at 2 and 3 years post-implant. The only major adverse event reported has been stroke. Major device-related events have been reported in a limited number of subjects. These data continue to support the 1-year conclusions of safety and effectiveness.

**Table 24 Relay® Phase II Compliance Imaging and Follow-up Through 3 years (Core Lab Reported)**

Visit Interval <sup>a</sup>	Eligible for Follow-Up <sup>b</sup>	Subjects with <sup>c</sup>			Adequate Imaging to Assess Parameter <sup>c</sup>				Events Occurring Before Next Interval <sup>c</sup>						
		Data for Visit	CT Scan	X-Ray	Size <sup>d</sup>	Endo-leak <sup>d</sup>	MI-gration <sup>d</sup>	Fracture <sup>e</sup>	Death	Technical Failure <sup>f</sup>	Con-version	Lost to Follow-Up	With-drawn Early	Not Due for Next Visit <sup>g</sup>	
Operative (Day 0 – 15)	120	120 (100)	NA	NA	NA	NA	NA	NA							
Events between operative and 1 month visit									3 (2.5)	3 (2.5)	0	3 (2.5)	0	0	
1 Month (Day 16 – 151)	114	108 (94.7)	107 (93.9)	100 (87.7)	NA	97 (85.1)	NA	97 (85.1)							
Events between 1 month and 6 month visit									7 (6.1)	0	1 (0.9)	0	0	0	
6 Month (Day 152 – 336)	106	97 (91.5)	94 (88.7)	90 (84.9)	92 (86.8)	85 (80.2)	89 (84.0)	89 (84.0)							
Events between 6 month and 1 year visit									7 (6.6)	0	0	0	2 (1.9)	0	
1 Year (Day 337 – 673)	97	89 (91.8)	89 (91.8)	86 (88.7)	86 (88.7)	81 (84) <sup>h</sup>	87 (89.7)	83 (85.6)							
Events between 1 year and 2 year visit									6 (6.2)	0	0	0	1 (1.0)	31 (32.0)	
2 year (Day 674 to Day 1038)	62 <sup>h</sup>	34 (57.6)	33 (55.9)	33 (55.9)	32 (54.2)	33 (53%) <sup>h</sup>	36 (58%) <sup>h</sup>	33 (55.9)							
Events between 2 year and 3 year visit									1 (1.7)	0	0	1 (1.7)	3 (5.1)	24 (40.7)	
3 year (Day 1039 to Day 1403)	30	12 (40.0)	11 (36.7)	11 (36.7)	10 (33.3)	10 (33.3)	10 (33.3)	11 (36.7)							
<b>Totals</b>									<b>24</b>	<b>3</b>	<b>1</b>	<b>4</b>	<b>6</b>		
<b>Deaths after conversion</b>									<b>0</b>						
<b>Total Deaths</b>									<b>24</b>						

NA= Not Applicable.

- <sup>a</sup> Visit Intervals took into account the follow-up visit windows. The visit windows were ±2 weeks for 30 days, ±4 weeks for 6 months and 1 year, and ±5 weeks for 2 to 5 years. 1 year visit window is 337 - 393
- <sup>b</sup> Eligible for follow-up if subject reached the start of the visit window and was not a technical failure, was not lost to follow-up, did not die, did not withdraw early, or did not convert to open repair. Eligible for follow-up included any subject who reached the start of the visit window, but who had not reached the end of the visit window.
- <sup>c</sup> Percentages are calculated based on the number of subjects eligible for follow-up. Data for visit information is site-reported. CT scan and x-ray reflect images received for evaluation by the core laboratory.
- <sup>d</sup> Size increase, endoleak, and migration were assessed by CT Scan (core lab-reported data).
- <sup>e</sup> Fracture was assessed by x-ray (core lab-reported data).
- <sup>f</sup> Subjects for whom the procedure was attempted but aborted and who did not receive a Relay® Stent-Graft at a later additional procedure.
- <sup>g</sup> Not due for next visit if subject had not reached the start of the visit window. Subjects who died, had a technical failure, converted to open repair, were lost to follow-up, withdrew early, or were not due for a previous visit are not counted.
- <sup>h</sup> Considers information examined as part of application review.

**Table 25: Major Adverse Events Beyond 1 Year – CEC-Adjudicated**

Event	2-year (Day 674-1038)	3-year (Day 1039 – 1403)
Mortality (all causes)	1/40 (2.5%)	0/15
One or more MAE	2/40 (5.0%)	1/15 (6.7%)
– Stroke	2/40 (5.0%)	1/15 (6.7%)
– Paralysis/paraplegia	0/40	0/15
– Myocardial infarction	0/40	0/15
– Procedural bleeding	0/40	0/15
– Respiratory failure	0/40	0/15
– Renal failure	0/40	0/15
– Wound healing complications	0/40	0/15
– Aneurysm-related mortality	0/40	0/15

NA = Not applicable

Notes: The Safety sample includes All Enrolled subjects who underwent implantation of the Relay® device or surgical repair. Mortality and major adverse events were adjudicated by the CEC. At each level of summarization, a subject is counted once if the subject reported 1 or more events. Percentages are based on the number of subjects in the Safety sample who have sufficient follow-up. A subject has sufficient follow-up if the date of last follow-up minus procedure date is greater than or equal to the start of the time period. Percentages for the overall time period are based on all subjects in the Safety sample. If the initial procedure resulted in an implant failure of the Relay® Stent-Graft and a Relay® Stent-Graft was implanted during a second procedure, the time periods are based on the initial procedure date if the adverse event occurred before the second procedure date; otherwise, time periods are based on the second procedure date. In the event that the CEC determines an event can never be adjudicated, it is assumed that the site investigator's report is accurate and it is used in place of adjudication.

**Table 26: Major Device-Related Events Beyond 1 Year – Core Lab and Site-Reported**

Event	2-Year Visit		3-Year Visit	
	Core Lab-Reported	Site-Reported	Core Lab-Reported	Site-Reported
Any endoleak	1/32 (3.1%)	0/40	1/10 (10.0%)	0/15
– Type I	0/32	0/40	1/10 (10.0%)	0/15
– Type III	1/32 (3.1%)	0/40	0/10	0/15
– Type IV	0/32	0/40	0/10	0/15
Stent migration	2/33 (6.1%)	0/40	1/10 (10.0%)	0/15
Lumen Occlusion	0/32	0/40	0/10	
Aneurysm Rupture	NA	0/40	NA	0/15
Deployment	NA	0/40	NA	0/15
Failure/Conversion to Surgery				
Lesion Size Increase	1/32 (3.1%)	2/32 (6.3%)	1/10 (10%)	1/12 (8.3%)
Fracture	1/33 (3.0%)	0/40	1/11 (9.1%)	0/15

NA = Not applicable

Notes: The Effectiveness sample includes All Enrolled subjects who underwent implantation of the Relay® device. Major device-related adverse events were reported by Core Laboratory. Site-reported events were adjudicated by the CEC. At each level of summarization, a subject was counted once if the subject reported 1 or more events. Percentages are based on the number of subjects in the Effectiveness sample who have sufficient follow-up. A subject has sufficient follow-up if the date of last follow-up minus the procedure date is greater than or equal to the start of the time period. Percentages for the Overall time period are based on all subjects in the Effectiveness sample. Sufficient follow-up is calculated separately for site-reported and Core Laboratory data. Sufficient follow-up for Core Laboratory data is based only on follow-up computed tomography (CT) scans or x-ray. If the initial procedure resulted in an implant failure of the Relay® Stent-Graft and a Relay® Stent-Graft was implanted during a second procedure, the time periods are based on the initial procedure date if the adverse event occurred before the second procedure date; otherwise, time periods are based on the second procedure date.

**6.11.2 Relay® Phase I Feasibility**

Bolton Medical, Inc. conducted a 30-subject Relay® Phase I study using the Relay® stent-graft. The goal of the Phase I study was to evaluate the safety and preliminary performance of the Relay® Thoracic Stent-Graft in subjects with thoracic aortic pathologies.

#### 6.11.2.1 Subject Population and Subject Accountability (Relay® Phase I)

The inclusion / exclusion criteria in the Relay® Phase I study protocol required subjects to have diagnosed thoracic aortic aneurysm (TAA) or penetrating atherosclerotic ulcer. Eligible subjects had to be 18 years of age or older. Additionally, subjects had to be considered intermediate risk for traditional thoracic aortic surgery. The Phase I study started in 2005. The population was 60% male (18/30) with an average age of 72.6 years.

At 1 year post-implant, data on 24 subjects were available, and there were 6 subjects who achieved 5-year follow-up. Imaging was submitted to the core laboratory for review and archiving, but only site-reported data was required for analysis. Table 27 presents the imaging and follow-up compliance as determined by the core laboratory.

Table 27 Relay® Phase I Imaging and Follow-up Compliance (Core Laboratory-reported)

Visit	Eligible for follow-up	# (%)			Adequate imaging to assess the parameter # (%) <sup>b</sup>				Events occurring before next interval # (%)			
		Subjects with data for that visit	CT	X-ray	Size Increase	Endoleak	Migration	Fracture	Death	Con- version	LTF/with drawal	Not due for next visit
Operative	30	30 (100%)	NA	NA	NA	NA	NA	NA				
Events between operative and 1 month visit									2 (6.7%)	0	0	0
30 day	28	28 (100%)	18 (64.3%)	14 (50%)	NA	18 (64.3%)	18 (64.3%)	14 (50%)				
Events between 1-month and 6-month visit									0	0	2 (7.1%)	0
6 month	26	26 (100%)	9 (34.6%)	17 (65.4%)	6 (23.1%)	8 (30.8%)	6 (23.1%)	10 (38.5%)				
Events between 6-month and 1-year visit									0	0	1 (3.8%)	0
1 year	25	24 (88.9%)	15 (60%)	13 (52%)	10 (40%)	14 (56%)	10 (40%)	11 (44%)				
Events between 1-year and 2-year visit									3 (12%)	0	4 (16%)	0
2 years	18	16 (88.9%)	14 (77.8%)	12 (66.7%)	11 (61.1%)	13 (72.2%)	12 (66.7%)	11 (61.1%)				
Events between 2-year and 3-year visit									2 (11.1%)	1 (5.6%)	3 (16.7%)	0
3 Years	12	12 (92.3%)	9 (75%)	8 (66.7%)	8 (66.7%)	8 (66.7%)	8 (66.7%)	8 (66.7%)				
Events between 3-year and 4-year visit									1 (8.3%)	0	4 (33.3%)	0
4 years	7	6 (85.7%)	6 (85.7%)	6 (85.7%)	6 (85.7%)	6 (85.7%)	6 (85.7%)	6 (85.7%)				
Events between 4-year and 5-year visit									0	0	0	1 (14.3%)
5 years	6	6 (100%)	5 (83.3%)	5 (83.3%)	5 (83.3%)	5 (83.3%)	5 (83.3%)	5 (83.3%)				
									Totals	8	1	14

### 6.11.2.2 Safety Evaluation (Relay® Phase I)

Safety was assessed by measurement of mortality and major morbidity. Major morbidity included serious cardiac complications, pulmonary complications, renal failure, neurological complications, post-procedural bleeding, conversion to open repair, lesion rupture and other complications rated serious by the physician. Mortality within 30 days was 6.7%. A total of 5 subjects experienced 1 or more major adverse event within 30 days for an overall rate of 16.7%. Complications included myocardial infarction, stroke, paraplegia, and procedural bleeding. There were no aneurysm ruptures. Beyond 30 days, there were 6 deaths and 1 conversion to surgery, but no additional major adverse events were reported.

### 6.11.2.3 Performance Evaluation (Relay® Phase I)

Preliminary performance of the device was evaluated on the basis of the following:

- a) Delivery/Deployment: Vessel access was achieved and the physician was able to insert the delivery catheter and deliver it to the treatment site and deploy the device.
- b) Stent-Graft Migration: Longitudinal movement of all or part of the stent-graft greater than 10mm relative to its placement as measured by imaging studies at the 1-month follow-up versus the 6-month and 12-month follow-ups.
- c) Stent-Graft Patency: The measure of blood flow through the vessel treated and the stent-graft.
- d) Stent-Graft Integrity: The assessment of stent-graft fractures, kinking, or twisting.
- e) Endoleak: Persistence of flow outside the lumen of the stent-graft but within the native aorta or adjacent vascular segment being treated by the stent-graft.
- f) Lesion Size Changes: The change in the diameter (10mm change) of the lesion relative to the measurement at 1 month versus 6-months and 12-months follow-up visit measurements.

The Relay® device was successfully delivered in all 30 subjects. Throughout 5 years of follow-up, Type I endoleaks were limited to 4 subjects. These Type I endoleaks presented at 4 months, 6 months, 1 year and 2 years post-implant, respectively. Three of these subjects underwent intervention. One subject (who also had associated aneurysmal degeneration at the distal attachment zone, migration, and lesion enlargement) was converted to open repair. The other 2 subjects received additional stent-grafts. This intervention resolved the endoleak in 1 of the subjects, but since the endoleak persisted in the other, the endoleak was reclassified as Type II. In general, less than optimal landing zone length was believed to be contributing factor for the endoleaks.

One Type III endoleak was detected during the implant procedure in 1 subject, and this resolved by the 1-month visit.

Migration was limited to 3 subjects throughout the 5-year study. One of these subjects also had a Type I endoleak as noted above. Lesion enlargement was detected in 3 subjects: 1 at the 1-year visit and 2 at the 2-year visit. Two of these subjects were those with Type I endoleaks as noted above. No other interventions besides those listed above were undertaken.

Throughout 5 years of follow-up, there have been no reports of lumen occlusion, wireform fracture, or aneurysm rupture.

### **6.11.3 Continued Access Study**

Bolton Medical initiated a continued access arm to the Relay® study in order to gain additional information on the device as premarket approval was being secured. Enrollment in this study started once all 120 endovascular subjects of the Relay® Phase II study had been enrolled.

#### **6.11.3.1 Subject Population and Subject Accountability (Relay® Continued Access)**

The same study protocol used for Relay® Phase II was used for continued access. Therefore, inclusion and exclusion criteria are identical. Additionally, the same device design used in Relay® Phase II was used in continued access. Table 28 includes the follow-up and imaging compliance for the continued access subjects.

#### **6.11.3.2 Study Follow-up Data**

Follow-up information has been collected for 12 subjects. There were no reports of endoleak, migration, lumen occlusion, wireform fractures, or conversion to surgery.

Table 28 Compliance Imaging and Follow-up for Continued Access Study (Core Laboratory-Reported)

Visit Interval <sup>a</sup>	Eligible for Follow-Up <sup>b</sup> n (%) <sup>c</sup>	Adequate Imaging to Assess Parameter (Core Lab) <sup>e</sup> n (%)							Events Occurring Before Next Interval <sup>f</sup> n (%)					
		Data for Visit (Site)	CT Scan (Core Lab)	X-Ray (Core Lab)	Size <sup>g</sup> <sup>h</sup>	Endoleak <sup>g</sup>	Migration <sup>g</sup>	Fracture <sup>g</sup>	Death	Technical Failure <sup>i</sup>	Con-version	Lost to Follow- Up	Withdrawn Early	Not Due for Next Visit <sup>j</sup>
Operative	12	12 (100%)	NA	NA	NA	NA	NA	NA						
Events between operative and 1 month visit									0	0	0	0	0	0
30 Day	12	12 (100%)	11 (91.7%)	11 (91.7%)	NA	11 (91.7%)	NA	11 (91.7%)						
Events between 1- month and 6- month visit									2 (16.7%)	0	0	0	0	2 (16.7%)
6 Month	8	8 (100%)	8 (100%)	8 (100%)	8 (100%)	6 (75%)	7 (87.5%)	8 (100%)						
Events between 6- month and 1- year visit									0	0	0	0	0	5 (62.5%)
1 Year	3	3 (100%)	3 (100%)	3 (100%)	3 (100%)	2 (66.7%)	3 (100%)	3 (100%)						
								Totals	2	0	0	0	0	

NA= Not Applicable.

<sup>a</sup> Visit Interval: Operative = Date of Procedure to Day 15, 30 Day = Day 16 to Day 151, 6 Month = Day 152 to Day 336, 1 Year = Day 337 to Day 673, 2 Year = Day 674 to Day 1038, 3 Year = Day 1039 to Day 1403, 4 Year = Day 1404 to Day 1768, 5 Year = Day 1769 to Day 1881. The intervals took into account the follow-up visit windows. The visit windows were ±2 weeks for 30 days, ±4 weeks for 6 months and 1 year, and ±8 weeks for 2 to 5 years.

<sup>b</sup> Eligible for follow-up if subject reached the start of the visit window and was not lost to follow-up, was not a technical failure, did not withdraw, did not die, or did not convert to open repair. Eligible for follow-up included any subject who reached the start of the visit window, but who had not reached the end of the visit window.

<sup>c</sup> Percentages are calculated based on the number of subjects eligible for follow-up. Data for visit information is site-reported. CT scan and x-ray reflect images received for evaluation by the core laboratory.

<sup>d</sup> Size increase, endoleak, and migration were assessed by CT Scan (core laboratory-reported data).

<sup>e</sup> Fracture was assessed by x-ray (core lab-reported data).

<sup>f</sup> Subjects for whom the procedure was attempted but aborted and who did not receive a Relay® Stent-Graft at a later additional procedure.

<sup>g</sup> Not due for next visit if subject had not reached the start of the visit window. Subjects who died, were technical failures, converted to open repair, were lost to follow-up, withdrawn early, or were not due for a previous visit are not counted.

## 7 PATIENT SELECTION AND TREATMENT

Each Relay® Thoracic Stent-Graft is individually loaded into a Plus Delivery System. Each package contains the preloaded system plus forms for device tracking (Device Tracking Card and Implant Information Form).

The risks and benefits should be carefully considered for each patient before use of the Relay® Thoracic Stent-Graft with Plus Delivery System. Additional considerations for patient selection include but are not limited to:

- Patient's age and life expectancy
- Co-morbidities (e.g., cardiac, pulmonary or renal insufficiency prior to surgery, morbid obesity)
- Patient's suitability for open surgical repair
- The risk of lesion rupture compared to the risk of treatment with the Relay® Thoracic Stent-Graft with Plus Delivery System
- Ability to tolerate general, regional, or local anesthesia
- Ilio-femoral access vessel size and morphology (thrombus, calcification and/or tortuosity) that is compatible with vascular access techniques and accessories.
- Vascular morphology suitable for endovascular repair, including:
  - Adequate iliac/femoral access compatible with the required introduction systems. Practitioner must ensure that the access vessel diameter is compatible with the selected delivery system's Outer Primary Sheath French size.
  - Non-aneurysmal proximal aortic diameter in the range of 19 – 42 mm
  - Non-aneurysmal proximal aortic neck length between 15 and 25 mm and non-aneurysmal distal aortic neck length between 25 and 30 mm, depending on the diameter stent-graft required

All aortic diameter measurements should be adventitia to adventitia. The final treatment decision is at the discretion of the physician and patient.

## 8 PATIENT COUNSELING INFORMATION

The physician should review the following with the patient (and/or family members) when counseling about the Relay® device and the endovascular procedure.

- Differences between endovascular and open surgical repair
- Risks of endovascular and open surgical repair
- Advantages and disadvantages of open surgical repair
- Advantages and disadvantages of endovascular repair
- The possibility of needing open surgical repair after endovascular repair
- The fact that the long-term safety of endovascular repair has not been established.
- The importance of committing to follow-up schedule
- Symptoms and warnings signs of rupture or other conditions that warrant prompt medical attention.

Patients should be provided a copy of the Relay® Patient Information Brochure for future reference.

## 9 HOW SUPPLIED

The Relay® Thoracic Stent-Graft with Plus Delivery System is sterilized by gamma irradiation and is supplied STERILE for single-use only. Do not use the device if it is visibly damaged or if it appears that the sterile packaging is compromised. Contact your Bolton Medical Endovascular Consultant for return information.

Do not attempt to re-sterilize. Re-sterilization of the device for re-use will result in loss of component integrity (e.g., reduction of stent-graft radial force, component cracking or discoloration, etc.).

Do not use the device after the labeled expiration date. Store the device at room temperature in a dark, dry place.

The Relay® Thoracic Stent-Grafts with the straight configuration are available in 4 approximate lengths:

- 100 mm
- 150 mm
- 200 mm
- 250 mm

The straight grafts are available in 2 mm incremented diameters ranging from 22 mm to 46 mm.

The Relay® Thoracic Stent-Grafts with the tapered configuration are available in 3 approximate lengths:

- 150 mm
- 200 mm
- 250 mm

Tapered stent-grafts are available with proximal diameters ranging from 28 mm to 46 mm, decreasing incrementally by 4 mm over the length of the stent-graft.

Products are identified on the label by a model designation. As an example, reference number 28M346250462690U can be decoded as follows:

Product ID	Device Type	Design Modification Number	Stent Diameter Proximal (mm)	Stent Covered Length (mm)	Stent Diameter Distal (mm)	Delivery System French Size	Delivery System Usable Length (cm)	Device Designation
28	M: Main	3	46	250	46	26	90	U: US Product

### 10.1 Physician Training Requirements

All physicians should complete an in-service training prior to using the Relay® Thoracic Stent-Graft with Plus Delivery System. Training requirements may vary depending on individual physician experience.

**Caution: Use of the Relay® Thoracic Stent-Graft with Plus Delivery System should only be undertaken by physicians and teams trained in vascular interventional techniques and in the use of this device.**

Below are the skill/knowledge requirements for physician teams using the Relay® Thoracic Stent-Graft.

- Knowledge of the natural history of thoracic aortic aneurysms (TAA), fusiform aneurysms, saccular aneurysms, and penetrating atherosclerotic ulcers (PAUs)
- Radiographic image interpretation (e.g., fluoroscopic, angiographic, etc.)
- Endovascular patient selection, device selection and sizing
- Femoral and brachial cutdown, arteriotomy, and conduit techniques
- Percutaneous access and closure techniques
- Non-selective and selective guidewire and catheter techniques
- Angioplasty
- Embolization
- Endovascular stent-graft placement
- Snare techniques
- Appropriate use of radiographic contrast media
- Techniques to minimize radiation exposure

### 10.2 Recommended Device Sizing

**Table 29** addresses the recommended healthy landing zone length depending on stent-graft diameter selected. Proximal and distal required landing zones vary with stent-graft size. Seal zones outside these recommendations could result in migration, endoleak, or other complications. Device lengths should be selected accordingly.

**Tables 30 and 31** address the selection of the appropriate stent-graft diameters and lengths for the Relay® Thoracic Stent-Graft. Appropriate oversizing has been incorporated into the recommended sizes. Adherence to these sizing guidelines is expected.

The minimum recommended amount of overlap between devices is three overlapping covered stents (approximately 50 mm). Less than this amount of overlap may result in endoleak (with or without component separation). For modular, unsupported junctions, a 2mm oversizing is recommended. Sizing outside these guidelines could result in endoleak, migration, stent-graft separation, infolding, or device damage.

Practitioner must ensure that the access vessel diameter is compatible with the selected delivery system's Outer Primary Sheath French size.

**Table 29: TARGET LANDING ZONE**

Stent-Graft Diameter	Proximal Length	Stent-Graft Diameter	Distal Length
22 – 28 mm	15 mm	22 – 38 mm	25 mm
30 – 38 mm	20 mm	40 – 46 mm	30 mm
40 – 46 mm	25 mm		

**Table 30: STRAIGHT STENT-GRAFTS**

Tapered Stent-Graft Size (mm)	Thoracic Proximal Vessel Size (mm)	% Graft Oversizing	Graft Covered Length (mm)				Graft Total Length (mm)				Delivery System French Size (O.D.)			
			100mm	150mm	200mm	250mm	100mm	150mm	200mm	250mm	100mm	150mm	200mm	250mm
22	19	16%	90	150	190	250	103	163	203	263	22	22	22	23*
24	20-21	14-20%	90	150	190	250	104	164	204	264	22	22	22	23*
26	22-23	13-18%	95	155	195	250	109	169	209	264	22	22	22	23*
28	24-25	12-17%	95	155	195	250	110	170	210	265	22	22	22	23*
30	26-27	11-15%	95	155	200	250	111	171	216	266	22	22	23	23
32	28-29	10-14%	95	155	200	250	112	172	217	267	22	22	23	24
34	30-31	9-13%	100	145	200	250	117	162	217	267	23	23	24	24
36	32-33	9-12%	100	145	190	250	118	163	208	268	23	24	24	24
38	34	11%	100	145	190	250	119	164	209	269	24	24	25	25
40	35-36	11-14%	105	145	195	250	125	165	215	270	24	25	25	25
42	37-38	10-13%	105	150	195	250	125	170	215	270	25	25	25	25
44	39-40	10-13%	105	155	200	250	126	176	221	271	25	25	25	26
46	41-42	9-12%	105	155	200	250	126	176	221	271	26	26	26	26

\*Special Order

**Table 31: TAPERED STENT-GRAFTS**

Tapered Stent-Graft Size (mm)	Thoracic Vessel Size (mm)		% Graft Oversizing		Graft Covered Length (mm)			Graft Total Length (mm)			Delivery System French Size (O.D.)		
	Proximal	Distal	Proximal	Distal	150mm	200mm	250mm	150mm	200mm	250mm	150mm	200mm	250mm
28x24	24-25	20-21	12-17%	14-20%	155	195	250	170	210	265	22	22	23
30x26	26-27	22-23	11-15%	13-18%	155	200	250	171	216	266	22	23	23
32x28	28-29	24-25	10-14%	12-17%	155	200	250	172	217	267	22	23	24
34x30	30-31	26-27	9-13%	11-15%	145	200	250	162	217	267	23	24	24
36x32	32-33	28-29	9-12%	10-14%	145	190	250	163	208	268	24	24	24
38x34	34	30-31	11%	9-13%	145	190	250	164	209	269	24	25	25
40x36	35-36	32-33	11-14%	9-12%	145	195	250	165	215	270	25	25	25
42x38	37-38	34	10-13%	11%	150	195	250	170	215	270	25	25	25
44x40	39-40	35-36	10-13%	11-14%	155	200	250	176	221	271	25	25	26
46x42	41-42	37-38	9-12%	10-13%	155	200	250	176	221	271	26	26	26

**10.3 Device Inspection**

Inspect the system packaging for visible tears, breaks or openings. DO NOT USE the system if defects are noted. Do not use if the expiration date has passed. Verify devices are correct for the patient. Contact your Bolton Medical Endovascular Consultant for return information.

#### 10.4 Equipment Recommendations

Fluoroscopic equipment including a high resolution image intensifier on a freely angled C-arm which can be ceiling or pedestal mounted or portable will be needed for the procedure. It is desirable if the image intensifier has a complete range of motion to achieve AP projections to lateral projections. Its capabilities should include:

- Digital Subtraction Angiography
- High resolution angiography
- Roadmapping

Supportive/supplementary equipment:

- .035" (0,89 mm)/300 cm Meier guidewire
- .035" (0,89 mm)/260 cm or 300 cm Lunderquist guidewire
- Guidewire torque device
- Inflation device with pressure gauge
- Aortic occlusion balloons
- Compliant stent-graft modeling balloons of the appropriate size
- Arterial puncture needles 18G or 19G
- Nitinol goose neck snare (10-15 mm diameter)
- Assortment of vascular stents
- Assortment of angiographic and graduated pigtail catheters

## 11 IMPLANT INSTRUCTIONS

REFER TO FIGURES IN FRONT OF IFU

### PREPARATION (Steps 1 through 10)

Position the patient on the surgical table where standard aseptic preparation of the surgical site is conducted. Drape the patient with sterile surgical drapes leaving exposed the bilateral groin access sites.

Anticoagulation and antiplatelet therapies are performed at the discretion of the physician. Similarly, blood pressure adjustment and spinal cord protection measures are also at the discretion of the physician.

1. Verify devices are correct for the patient.
2. Perform an arteriotomy of the common femoral artery (access site) that will be used to introduce the device.
3. Determine a suitable secondary access site for diagnostic and imaging purposes.
4. Under fluoroscopy, advance a 0.035 in (0.89mm) guidewire from the access site and a graduated pigtail angiographic catheter (via the secondary access site).
5. Place the C-Arm DSA system into a left anterior oblique position in preparation for the initial angiogram. Perform an angiogram to confirm the preoperative case planning and mark the target area.
6. Inspect the system packaging for visible tears, breaks or openings.
7. Take the Plus Delivery System from the sterile packaging and bring it to the surgical table. Examine the Plus Delivery System for structural integrity. DO NOT USE the system if defects are noted.

**NOTE:** Ensure that the Controller is in the "1" position, if it is not change it to the "1" position (*aligned with the arrow in Fig 3*). To change position, push the Controller

toward the Main Body Handle and rotate to desired position, then release. Check the distal end of the delivery system to ensure that the Delivery System Tip is properly seated in the Outer Primary Sheath (Fig. 4). If not, correct by moving the Deployment Grip until the Delivery System Tip is properly seated. Ensure that the tip side hole is not covered by the Outer Primary Sheath (Fig. 4).

8. Keep the controller in the "1" position to prevent premature deployment of the stent-graft. Check that the Shipping Retainer covers the delivery system Main Body. The Shipping Retainer aids in preventing premature advancement of the stent-graft from the outer sheath.

**WARNING: Do not remove the Shipping Retainer until the Inner Secondary Sheath is to be advanced out of the Outer Primary Sheath.**

9. Remove the silicone tubing from the Flush Port (Fig. 5a). Flush the delivery system with heparinized saline (approximately 50 cc) through the Flush Port (Fig 5b) to purge air from the sheaths. Ensure that a continuous stream of saline exits the tip side hole (Fig 4). It may be necessary to elevate the distal end of the system to different positions to bring air to the highest point for purging. The Flush Port Valve must be closed under pressure to prevent air from re-entering the system. Visually inspect it for remaining air and repeat if necessary. Then flush through the guidewire luer and Flush Port extension tubing (Fig 5c). Remove extension tubing after flushing.
10. Activate the hydrophilic coating by wetting the Tip and Introducer Sheath with saline.

#### **INTRODUCTION/ADVANCEMENT (Steps 11 through 20)**

11. While holding and directing the Outer Primary Sheath with one hand and holding the Stationary Grip with the other hand, advance the Outer Primary Sheath into the artery over the guidewire. The guidewire should always remain in the delivery system while inside the patient.
12. Under fluoroscopy, advance the Outer Primary Sheath until the Delivery System Tip is just below the intended distal landing zone. If the aorta presents tight tortuosity, the tip should be advanced past the tight curvature(s) of the descending aorta to facilitate navigation of the Inner Secondary Sheath.

**Do not advance the Outer Primary Sheath into the thoracic arch.**

If the Outer Primary Sheath cannot be advanced beyond the region of tight curvatures the delivery system should be removed from the patient and an alternate procedure be considered.

13. To advance the Inner Secondary Sheath out of the Outer Primary Sheath, remove the Shipping Retainer from the Main Body by grasping the fabric tab and pulling it away from the handle body (Fig. 5d).

**CAUTION: Once the Inner Secondary Sheath is advanced, the user will be committed to implant the graft.**

**CAUTION: The Controller must still be in the "1" position.**

14. While holding the black Stationary Grip so that the Main Body remains stationary, push the gray Deployment Grip forward (towards the Stationary Grip) until the stent-graft's proximal markers reach the proximal landing zone.

Verify that the gray Deployment Grip has reached or passed the black line on the main handle body (Fig. 6b). This will ensure that the Inner Secondary Sheath has completely exited the Outer Primary Sheath (Fig 6a). Also, the distal stent marker bands will be seen approximately 2cm out of Primary Outer Sheath.

If the gray Deployment Grip has not reached or passed the black line while the Controller is still in position 1, hold the gray Deployment Grip stationary while

pulling back on the black Stationary Grip until the gray Deployment Grip reaches or passes the black line, this will ensure that the Inner Secondary Sheath is fully out of the Outer Primary Sheath.

15. As the Inner Secondary Sheath is advanced out of the Outer Primary Sheath, note the alignment of the Spiral Support Strut by locating the Spiral Support Strut markers under fluoroscopy.
16. If the device is to be implanted in a curved section of the aorta, verify that the D-shaped marker on the Inner Secondary Sheath and the Spiral Support Strut marker(s) face the greatest curvature. If radial adjustment is needed, retract the gray Deployment Grip to bring the stent-graft to a straight portion of the vessel. When retracting the gray Deployment Grip, ensure that the distal end of the stent-graft is not pulled into the Outer Primary Sheath (the black line can be used as a reference). It may be necessary to withdraw the whole device a few centimeters to bring the stent-graft to a straight position.

After the stent-graft is in the straight position, while holding the stationary grip, rotate the gray deployment grip to manually align the Spiral Support Strut markers toward the greatest curvature of the aorta. The D-shaped marker can be used to aid in this placement (Fig 7). If the round portion of the D-shaped marker is facing the greater curvature, the gray deployment grip should be turned clockwise. If the round portion is facing the lesser curvature the turn should be counterclockwise. One to three handle revolutions maybe required before the stent-graft begins rotating. Once alignment is confirmed, re-advance the stent-graft into the desired position

17. Perform an angiogram of the area of interest to confirm proper position of the device in preparation for deployment.
18. Finalize the longitudinal placement of the stent-graft in relation to the proximal landing zone by adjusting the gray Deployment Grip as necessary. Confirm the position of the proximal and distal marker bands as well as the Spiral Support Strut markers.
19. If the gray Deployment Grip reaches its maximum travel before the stent-graft reaches the landing zone, the gray Deployment Grip should be retracted so as to recapture the distal stent within the Outer Primary Sheath, before adjustments are made.
20. Since the distal stent is captured within the Outer Primary Sheath, the gray Deployment Grip should be advanced once more until the stent-graft reaches the proximal landing zone and the distal stent is out of the Outer Primary Sheath. Ensure the gray Deployment Grip has reached or passed the black line on the Handle Body.

#### DEPLOYMENT (Steps 21 through 24)

21. With the stent-graft in the desired deployment position, turn the Controller to the "2" position (Fig. 8).
22. While holding the black Stationary Grip fixed, pull back on the gray Deployment Grip (Fig 9a) until the Inner Secondary Sheath is retracted enough to expose the bare stent and the first covered stent.
23. NOTE: The Inner Secondary Sheath has the D-Shaped radiopaque marker (See Fig 7, delivery system drawing) located near the tip that can be used to visualize its movement under fluoroscopy. Make any final linear position adjustments (proximally or distally) by first changing the Controller to position 1. Then using the gray Deployment Grip, move the stent-graft proximally or distally to the desired location. After the stent-graft is in the desired location, move the controller setting back to position 2.

**CAUTION: Verify that the Controller is in the "2" position during step 24.**

24. To continue deployment of the stent-graft, completely retract the Inner Secondary Sheath by holding the Stationary Grip fixed and retracting the gray Deployment Grip with one continuous motion without stopping until the stent-graft is fully deployed (Fig 9b).

**CAUTION: Failure to promptly deploy the stent-graft will cause blood pressure to increase and may result in distal migration of the device during deployment.**

**RELEASE (Steps 25 through 27)**

25. The proximal end of the stent-graft is still attached to the delivery system by the Apex Holder. To release the stent-graft from the Apex Holder, go to the thumbscrew on the Apex Release Retainer. Loosen the thumbscrew by rotating counterclockwise 2-3 turns (Fig 10).
26. Lift and remove the Apex Release Retainer.
27. Under fluoroscopy, release the bare stent apices by pulling the Apex Release Grip (Number 3, Fig 11) towards the Guidewire Luer until it reaches the end of the Stainless Steel Rod. The stent-graft is now fully released.

**CONCLUSION AND REMOVAL (Steps 28 through 35)**

28. Place the Controller in the "4" position to reseat the tip.
29. Retract the Stainless Steel Rod by pulling it completely distal slowly, allowing the tip to rejoin the outer sheath (Fig 12).

**CAUTION: Perform this step carefully and under fluoroscopy, monitoring the travel of the Delivery System Tip through the deployed stent-graft so that the stent-graft's position is not affected. If the tip does not reseat easily, apply slightly greater force until the tip seats properly.**

30. Perform a final angiogram to assess for any endoleaks and/or migration. Confirm successful aneurysm/lesion exclusion.
31. Withdraw the entire system from the patient.
32. If an endoleak is detected, consider balloon modeling to correct the leak.

**CAUTION: Do not exceed 1 atm. balloon pressure. Balloon only within the covered portion of the stent-graft. Ballooning outside the covered portion could cause aortic rupture, atherosclerotic plaque embolization, or other complications. Always recheck position of the stent-graft following ballooning.**

33. Straighten the angiographic pigtail catheter and remove the catheter and sheath from the percutaneous puncture site.
34. Perform standard surgical closure of the arteriotomy site.
35. Assess blood flow to the distal extremities.

## 12 FOLLOW-UP IMAGING RECOMMENDATIONS

### 12.1 General

All patients should be advised that endovascular treatment requires life-long, regular follow-up to assess their health and performance of their endovascular graft. Patients with specific clinical findings (e.g., endoleaks, enlarging aneurysms, or changes in the structure or position of the endovascular graft) should receive additional follow-up. Patients should be counseled on the importance of adhering to the follow-up schedule, both during the first year and at yearly intervals thereafter. Patients should be told that regular and consistent follow-up is a critical part of ensuring the ongoing safety and effectiveness of endovascular treatment of fusiform aneurysms, saccular aneurysms, and penetrating atherosclerotic ulcers.

Imaging pre-treatment is recommended to determine anatomic suitability and device selection. Post-treatment imaging is recommended to assess the lesion and device status. Annual imaging follow-up may include chest x-ray, and both contrast and non-contrast computed tomography (CT) or computed tomography angiogram (CTA) examinations. The combination of contrast and non-contrast CT imaging provides information on device migration, aneurysm diameter depth change, endoleak, patency, tortuosity, progressive disease, fixation length, and other morphological changes. Chest x-rays provide information on device integrity (separation between components, stent fracture, and barb separation) and device migration.

**Table 32** lists the minimum recommended requirements for follow-up of patients receiving the Relay® Thoracic Stent-graft. It is the responsibility of the physician to determine the most appropriate course of follow-up, based on the individual patient's clinical history. Additional surveillance should be considered for any patients demonstrating Type I or Type III endoleaks.

**Table 32: Minimum Follow-up Recommendations**

Visit	Angiogram	CT or CTA (contrast and non-contrast)	Chest X-ray
Pre-procedure		X <sup>a</sup>	
Procedural	X		
1 Month		X	X
6- Months		X	X
12 Months (annually thereafter)		X	X

<sup>a</sup>Pretreatment Assessment should be done within 3 months prior to treatment

In patients with impaired renal function or other conditions which may preclude the use of contrast media, the physician can consider using magnetic resonance imaging (MRI) or magnetic resonance angiography (MRA). Artifact related to the stent-graft may occur. Care should be taken to ensure adequate imaging of the lesion's outer wall so that size can be properly estimated. Additional MRI guidance is located in section 12.4. Additionally, site standard dose reduction techniques should be observed to minimize radiation exposure.

### 12.2 Contrast and Non-Contrast CT / CTA Imaging Recommendations

- Film sets should include all sequential images at lowest possible slice thickness (≤3 mm). DO NOT perform large slice thickness (>3 mm) and/or omit consecutive CT images/film sets, as it prevents precise anatomical and device comparisons over time.
- Both non-contrast and contrast runs are required, with matching or corresponding table positions.
- Pre-contrast and contrast run slice thickness and interval must match.
- DO NOT change patient orientation or re-landmark patient between non-contrast and contrast runs. Non-contrast and contrast enhanced baseline and follow-up

imaging are important for optimal patient surveillance. It is important to follow acceptable imaging protocols during the CT exam. Table 33 lists examples of acceptable imaging protocols.

**Table 33: Relay® Thoracic Stent-Graft CTA Imaging Guidelines**

Injection Volume (cc/ml)	100-150
Injection Rate (cc/second)	3 to 5
Bolus Timing	Test Bolus, SmartPrep, CARE or equivalent
Scan Range	Thoracic Inlet to Profunda Femoris Origin
Axial DFOV (32cm)	32
Scan Type	Helical
Slice Thickness (mm)	≤3.0
Reconstruction	1 to 2mm
kVp	120
mA	Auto

**\*NOTE:** These recommendations are meant to cover the range of acceptable protocols, but are not meant to be restrictive. The broad range of scanner configurations available will necessarily result in an individual site specific protocol definition.

### 12.3 X-ray

Chest x-rays (involving the entire device) should be used to assess the presence of wire form fracture. Upright anterior/posterior (AP) and lateral views of the entire Relay® device are recommended. Additionally, oblique views for x-ray can be useful for a full assessment and usually four views are obtained. A chest x-ray should be obtained in the event device integrity issues are suspected and magnified views should be used.

### 12.4 MRI Information

Non-clinical testing demonstrated that the Relay® Thoracic Stent-Graft is MR Conditional. A patient with this device can be scanned safely, immediately after placement under the following conditions:

#### **Static Magnetic Field**

- Static Magnetic Field of 1.5 Tesla or 3 Tesla only
- Maximum spatial gradient magnetic field of 720-Gauss/cm or less.
- Maximum whole-body averaged specific absorption rate of 4 W/kg for 15 minutes of scanning
- Normal operating mode or First level controlled operating mode

#### **MRI-Related Heating**

In non-clinical testing, the Relay® Thoracic Stent-Graft produced the following temperature rises during MRI performed for 15 minutes of scanning (i.e., per pulse sequence) in 1.5-Tesla/64-MHz (Magnetom, Siemens Medical Solutions, Malvern, PA. Software Numaris/4, Version Syngo MR 2002B. DHHS Active-shielded, horizontal field scanner) and 3-Tesla (3-Tesla/128-MHz, Excite, HDx, Software 14X.M5, General Electric Healthcare, Milwaukee, WI) MR systems.

	<u>1.5-Tesla</u>	<u>3-Tesla</u>
MR system reported, whole body averaged SAR	2.9-W/kg	2.9-W/kg
Calorimetry measured values, whole body averaged SAR	2.1-W/kg	2.7-W/kg
Highest Temperature change	+2.0 °C	+2.5 °C

These temperature changes will not pose a hazard to a human subject under the conditions indicated above. Analysis of this data indicates that the Relay® Thoracic Stent-Graft should produce a maximum temperature rise less than 3.8°C during 15 minutes of continuous MR scanning in First level controlled mode at a maximum whole-body averaged SAR of 4.0 W/kg.

**Artifact Information**

MR image quality may be compromised if the area of interest is in the exact same area or relatively close to the position of the Relay® Thoracic Stent-Graft. Therefore, optimization of MR imaging parameters to compensate for the presence of this device may be necessary. The maximum artifact size (i.e., as seen on the gradient echo pulse sequence) extends approximately 10-mm relative to the size and shape of this implant.

Pulse sequence	T1-SE	T1-SE	GRE	GRE
Signal Void Size	2,708-mm <sup>2</sup>	1,701-mm <sup>2</sup>	2,751-mm <sup>2</sup>	2,568-mm <sup>2</sup>
Plane Orientation	Parallel	Perpendicular	Parallel	Perpendicular

**12.5 Supplemental Imaging**

It may be necessary to order additional imaging to further assess a stent-graft based on the findings detected during previous imaging assessments. The following are some recommendations to consider.

- When severe angulation, migration, kinking, or irregular positioning of the stent-graft is detected, spiral CT should be considered to check for endoleak and evaluate lesion size.
- When CT reveals a new endoleak or an enlarging lesion, 3-D reconstruction and/or angiography of both the stent-graft and surrounding native vasculature may help assess changes in the lesion or stent-graft.
- MRI, MRA, and non-contrast spiral CT can be considered for patients with impaired renal function or patients unable to tolerate contrast media.

**13 ADDITIONAL SURVEILLANCE AND TREATMENT**

Additional surveillance and/or treatment should be considered for patients with the following conditions:

- Type I endoleaks
- Type III endoleaks
- Aneurysm sac enlargement > 5 mm of maximum diameter
- Stent-graft migration
- Inadequate fixation
- Wire form fracture

Consideration for reintervention or conversion to open surgical repair should include the attending physician's assessment of an individual patient's co-morbidities, life expectancy, and the patient's personal choices. Patients should be counseled that subsequent reinterventions, including catheter-based and open surgical repair, are possible following stent-graft placement.

## 14 DEVICE TRACKING INFORMATION

The Relay® Thoracic Stent-Graft with Plus Delivery System is packaged with the following:

- **Implant Information Form.** This form must be completed by the hospital staff and sent to Bolton Medical, Inc. for the purposes of tracking all patients who receive the Relay® Thoracic Stent-Graft (as required by U.S. Federal Regulation).
- **Device Identification Card.** This card must be completed by the hospital staff and provided to the patient. Patients should be instructed by their physician to keep this card with them at all times. Patients should refer to the card when visiting other healthcare practitioners, and especially when visiting MR imaging facilities since the card provides specific information on the safe imaging of the Relay® Thoracic Stent-Graft via MR.

## 15 DISCLAIMER OF WARRANTY

ALTHOUGH THE RELAY® THORACIC STENT-GRAFT WITH PLUS DELIVERY SYSTEM HAS BEEN MANUFACTURED UNDER CAREFULLY CONTROLLED CONDITIONS, BOLTON MEDICAL, INC., AND ANY ASSOCIATED AFFILIATES, HAVE NO CONTROL OVER THE CONDITIONS UNDER WHICH THIS PRODUCT IS USED. BOLTON MEDICAL, INC., THEREFORE, DISCLAIMS ALL WARRANTIES, BOTH EXPRESSED AND IMPLIED, WITH RESPECT TO THE PRODUCT, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. BOLTON MEDICAL, INC. SHALL NOT BE LIABLE TO ANY PERSON OR ENTITY FOR ANY MEDICAL EXPENSE OR ANY DIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES CAUSED BY ANY USE, DEFECT, FAILURE OR MALFUNCTION OF THE PRODUCT WHETHER A CLAIM FOR SUCH DAMAGES IS BASED ON WARRANTY, CONTRACT, TORT, OR OTHERWISE. NO PERSON HAS ANY AUTHORITY TO BIND BOLTON MEDICAL, TO ANY REPRESENTATION OR WARRANTY WITH RESPECT TO THE PRODUCT.

The exclusion and limitations set out above are not intended to, and should not be construed so as to, contravene mandatory provisions or applicable law. If any part or term of this disclaimer of warranty is held to be illegal, unenforceable, or in conflict with applicable law by a court of competent jurisdiction, the validity of the remaining portions of this disclaimer of warranty shall not be affected, and all rights and obligations shall be construed and enforced as if this disclaimer of warranty did not contain the particular part or term held to be invalid.

# RELAY<sup>®</sup> THORACIC STENT-GRAFT

with *plus* Delivery System

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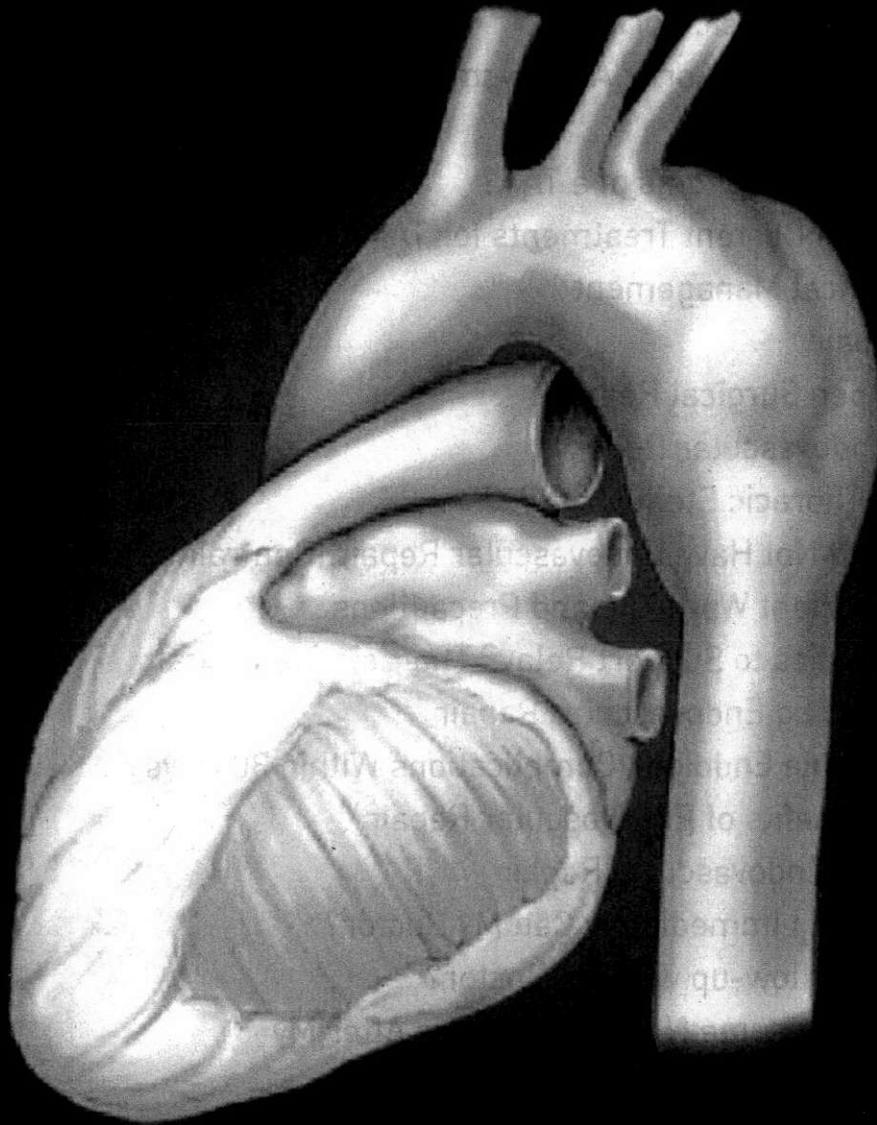
Protected by one or more of the following United States patents: 7,763,063; 8,070,790; 8,007,605; 8,062,345



Bolton Medical  
USA



Bolton Medical



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with **PLUS** Delivery System

## PATIENT INFORMATION BOOKLET

Endovascular Thoracic Stent-Grafts: A Treatment  
for Thoracic Aortic Aneurysms and Penetrating Ulcers

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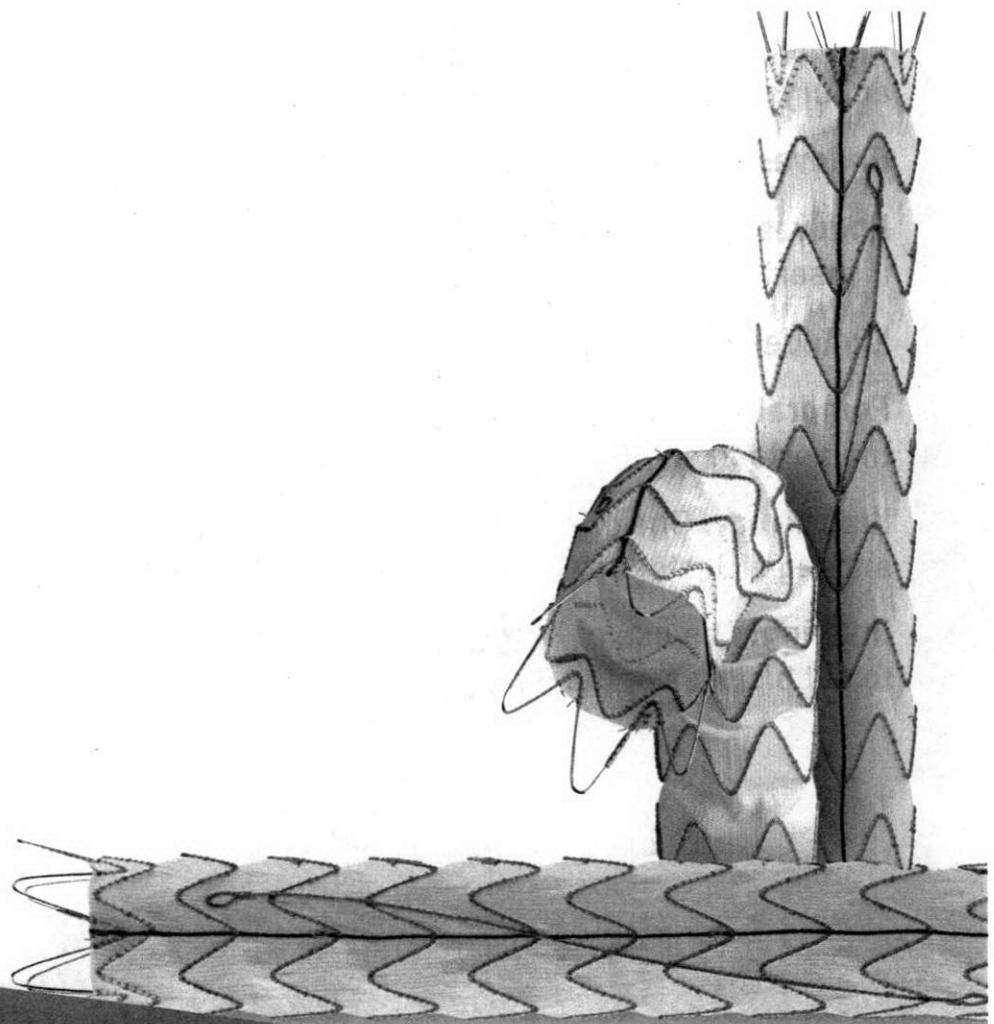
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\*See pages 10 to 12 for important safety information.

## Introduction

You have been told by your doctor that you have a **thoracic aortic aneurysm (TAA)** and discussed different types of treatments for this disease, including **Endovascular Repair** with a **thoracic stent-graft**. This booklet will help you understand your disease and what **Endovascular Repair** is. This booklet can be used as a reference, but only your doctor can say what type of procedure is good for you. Please consult your doctor prior to making any decisions regarding your **TAA**.

There are many hard-to-understand medical words related to **TAA**. Pages 2 and 3 of this booklet list some of these words and what they mean. These words are in **bold** throughout this booklet.



## Hard-to-Understand Words

**Anatomy:** The study of the parts of the body.

**Aneurysm/Thoracic Aortic Aneurysm (TAA):** A widening or ballooning of a portion of the thoracic aorta caused by a weakness in the wall of the blood vessel.

**Aorta:** The largest vessel in the body that carries blood from the heart to the rest of the body.

**Artery:** A blood vessel that carries blood away from the heart.

**Contraindication:** A medical reason to withhold a certain medical treatment.

**CT Scan:** Computerized tomography (CT scan) combines a series of X-ray views taken from many different angles to create cross-sectional images of your aorta.

**Endoleak:** The presence of a persistent flow of blood into the aneurysm sac after a stent-graft is put into place.

**Endovascular:** Inside or within a blood vessel.

**Endovascular Repair:** A treatment in which a tube-shaped stent-graft is inserted into an aneurysm without opening the chest or stomach.

**Exclude:** To seal off.

**Femoral artery:** A large artery in the thigh which doctors use to reach the aorta in endovascular repair.

**Iliac artery:** One of the large arteries supplying blood to your pelvis and legs. Doctors can use these as pathways to reach your aorta.

**Imaging:** The use of X-rays, CT scans, MRI scans or other techniques to get pictures of the inside of the body.

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**Minimally-invasive:** Involves tiny cuts to perform a procedure versus one large opening.

**Magnetic Resonance Imaging (MRI):** A type of scan that uses magnetic fields to see inside of the body.

**Open Surgical Repair:** A procedure in which a doctor makes a large cut in the chest or stomach to remove an aneurysm and then replaces it with a fabric graft.

**Penetrating Ulcers:** A rare condition that most commonly develops in the aorta when plaque starts to penetrate the aortic wall putting it at risk for rupture.

**Plaque:** A deposit of fatty material on the inner lining of an arterial wall.

**Rupture:** A tear in the blood vessel wall near or in the diseased part of the vessel.

**Stent-graft/Thoracic stent-graft:** A fabric tube supported by a metal framework that a doctor uses to treat a TAA.

**Thoracic Aorta:** The section of the aorta located in the chest. It is the first part of the aorta that the blood enters when it leaves the heart to move throughout the body.

## What is the Thoracic Aorta?

The **aorta** is the largest **artery** in the body. The **aorta** is about the thickness of a garden hose and runs from your heart through the center of your chest and abdomen. The **thoracic aorta** is the section of the **aorta** that sits within your chest (**see Figure 1**) and is the first part of the **aorta** that the blood enters when it leaves the heart to move throughout the body.

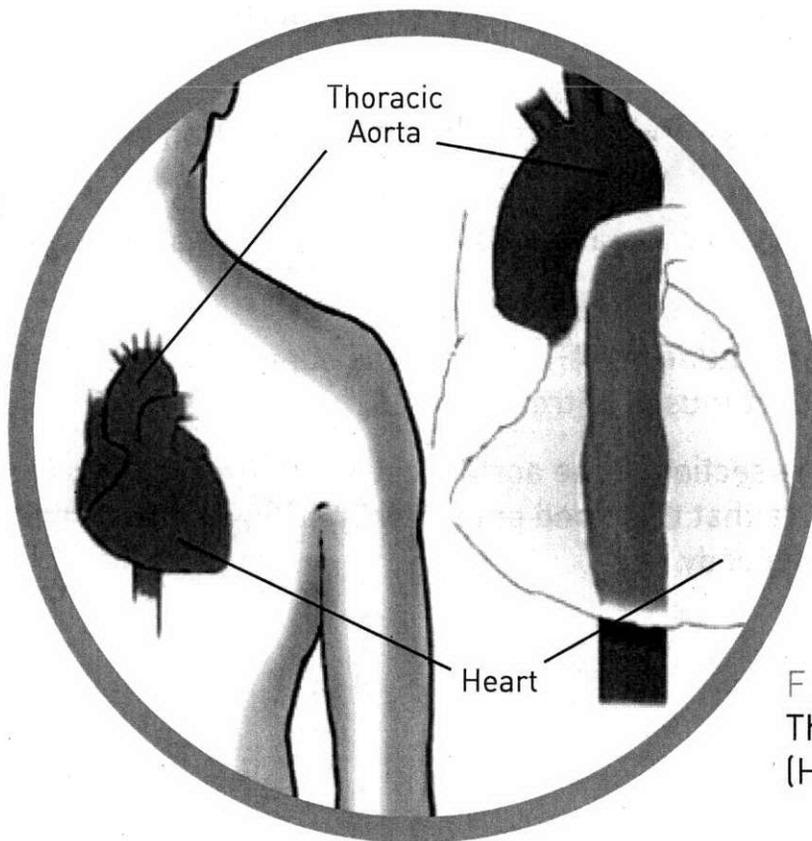


FIGURE 1  
Thoracic Aorta  
(Healthy)

## What is a Thoracic Aortic Aneurysm (Commonly Called TAA)?

A **thoracic aortic aneurysm** or **TAA** is a weakened and bulging area in the upper part of the **aorta**. Some **TAA**s are associated with **penetrating ulcers**. **TAA**s can continue to get larger, and it is possible for a **TAA** to burst, or **rupture**. Because the aorta is the body's main supplier of blood, a ruptured **TAA** can cause life-threatening bleeding.

Most small and slow-growing TAA's don't rupture, but large, fast growing TAA's may. Depending on the size and rate at which the **TAA** is growing, treatment may change from watchful waiting to elective surgery. Once a **TAA** or **penetrating ulcer** is found, doctors will closely monitor it so that if surgery is needed it can be planned. An emergency surgery can be life-threatening.

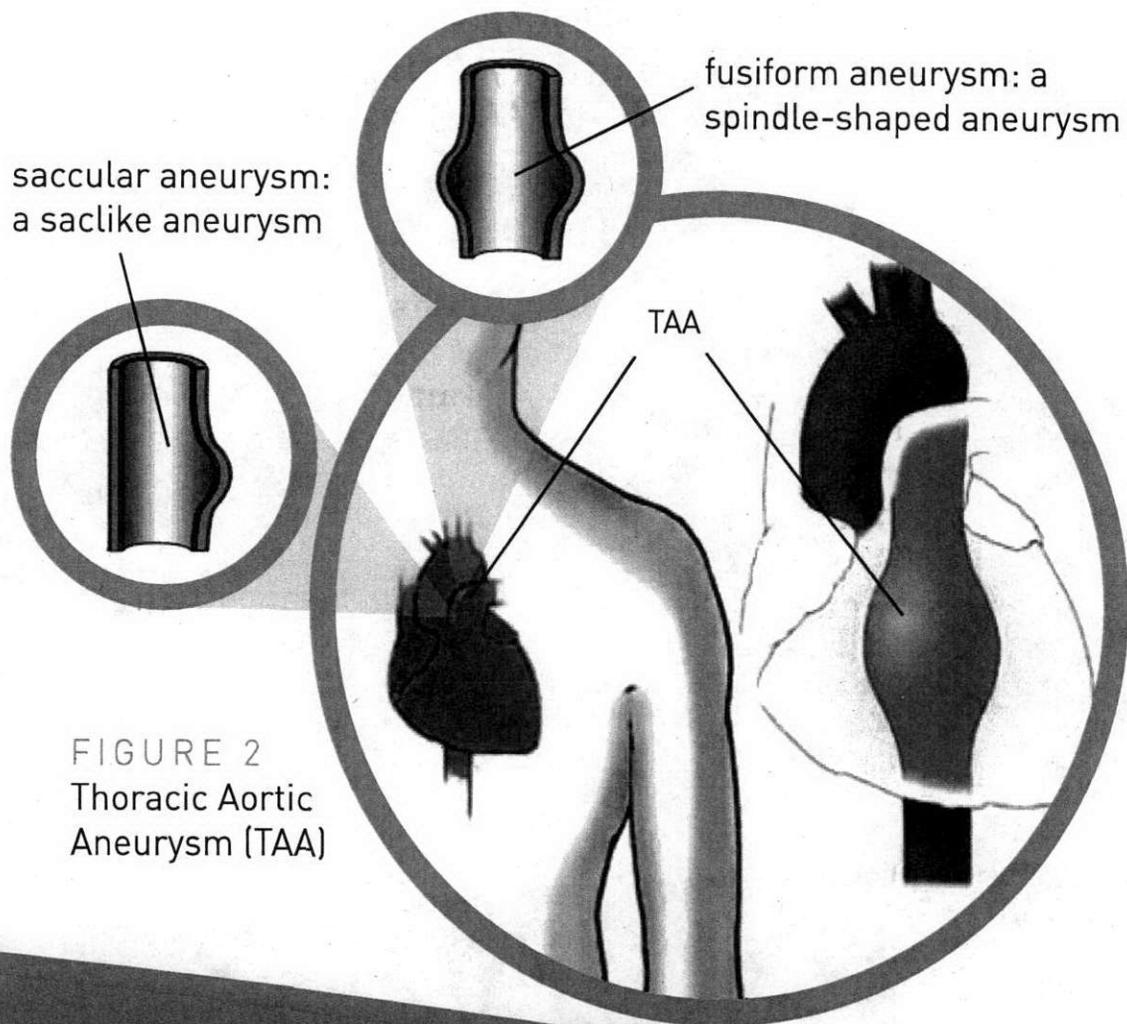


FIGURE 2  
Thoracic Aortic  
Aneurysm (TAA)

## What Causes TAA?

You have a greater chance of having a **TAA** if you:

- Are over 60
- Are male
- Smoke
- Have high blood pressure
- Have plaque build-up in your arteries
- Have a family member with a **TAA**
- Have certain diseases that may weaken the aortic wall  
(discuss with your doctor)

## What are the Symptoms of a TAA?

Many people with **TAA** do not feel any symptoms. For those with symptoms, the most common are<sup>1</sup>:

- Pain in the jaw, neck, chest, and back
- Coughing, hoarseness, or difficulty breathing

If you have any of these symptoms, tell your doctor immediately. Your doctor may order **imaging** to see if a **TAA** is present.

## What are the Current Treatments for TAA?

**1. Medical Management.** If your **TAA** is small and not causing any symptoms, your doctor may watch it for 6 months to make sure it's not getting larger. Your doctor may also try medical or lifestyle changes to reduce the stress on the **TAA**, especially if it is small. This treatment may include: blood pressure medication and/or lifestyle changes such as quitting smoking.

**2. Repair.** If your doctor feels your TAA has reached a size that is at risk for **rupture**, he or she may recommend repairing it. There are two types of repair:

- **Open Surgical Repair**
- **Endovascular Repair**

Both **TAA** treatment options have possible complications and benefits. Patients should talk with their doctor about which option is best for them. See pages 10 to 12 for important safety information about **Endovascular Repair**.

## What is Open Surgical Repair?

During **Open Surgical Repair**, your doctor will make a cut to find your TAA and put a fabric tube (graft) in your aorta above and below your aneurysm.. Blood will then flow through the graft. This surgery reduces the chance of vessel **rupture**.

**Open Surgical Repair** is performed under general anesthesia and typically takes four to six hours to complete (see **Figure 3**). After surgery, you may stay in the hospital for 7 to 10 days.<sup>1</sup> If your **TAA** is complicated, or if you have other conditions such as heart, lung, or kidney disease, you may require 2 to 3 months for a complete recovery.<sup>1</sup>

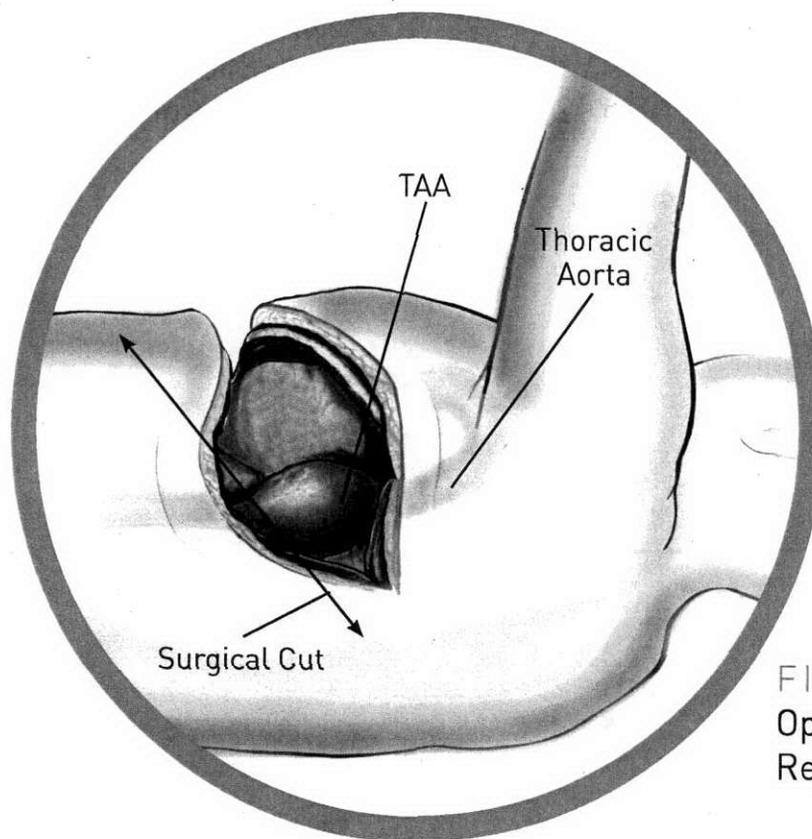


FIGURE 3  
Open Surgical  
Repair

## What is Endovascular Repair?

**Endovascular Repair** is a newer, **minimally-invasive** way to repair a **TAA**. During this procedure, a **stent-graft** that is compressed inside a narrow plastic tube called a delivery system is inserted through a small cut in your groin and threaded through your blood vessels (**see Figure 4**). During the procedure, your doctor will use live x-ray pictures viewed on a video screen to guide the **stent-graft** to the site of your **TAA**. The **stent-graft** will open inside your **aorta** and become the new channel for blood flow. The **stent-graft** shields the **TAA** from receiving more blood that might make it grow and helps prevent more pressure from building on the **TAA**. This should keep your **TAA** from rupturing.

Following **Endovascular Repair**, you may stay 2 or 3 days in the hospital.<sup>1</sup> You must speak to your doctor to understand if **Endovascular Repair** is the right treatment for you.

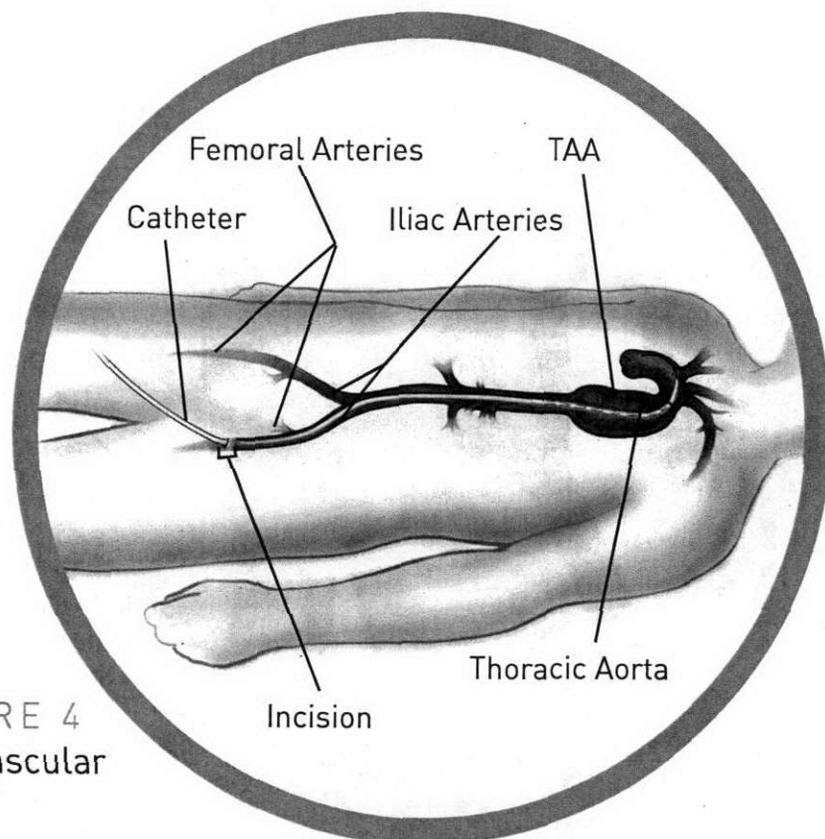


FIGURE 4  
Endovascular  
Repair

## What is a Thoracic Stent-Graft?

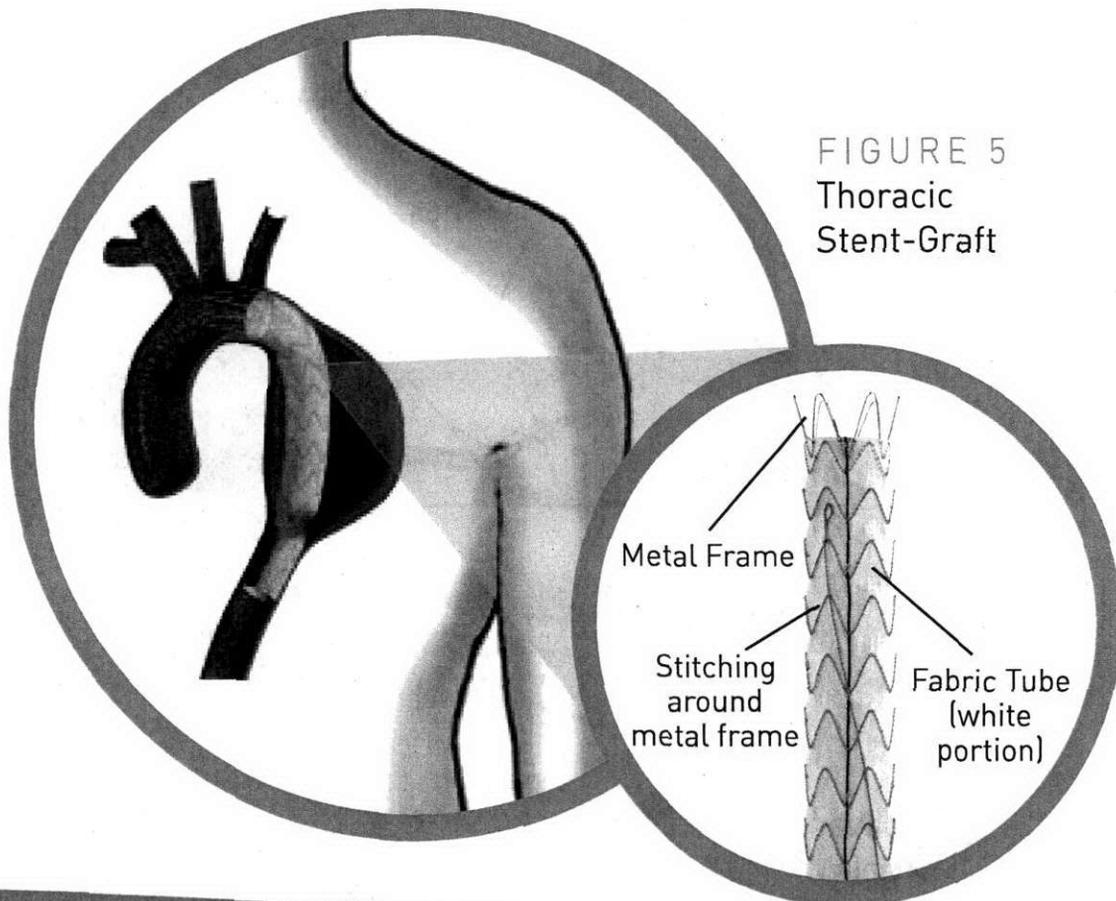
A **Thoracic Stent-Graft** is a fabric tube supported by a metal frame (see **Figure 5**) which is placed in the diseased **aorta** through a small incision in the groin. This seals off the **TAA** by fitting inside the diseased part of the **aorta** and allows blood to flow normally through your **aorta**.

## Who Should Not Have Endovascular Repair (Contraindications)?

You should not have an **Endovascular Repair** if you:

- Have an allergy to polyester, nickel, titanium, or platinum-iridium
- Have an allergy to the materials used to make the stent-graft

Only your doctor can say if **Endovascular Repair** is the right treatment for you.



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## Important Warnings and Precautions:

The following are general warnings and precautions. Please discuss with your doctor all warnings and precautions related to **Endovascular Repair**.

The use of **stent-grafts** has not been studied in patients who:

- Have a connective tissue disease
- Have a torn, ruptured, or bleeding **aorta**
- Have blood clotting diseases
- Have a systemic infection
- Are pregnant or breast-feeding
- Are less than 18 years old

Your doctor will need to help you decide whether it is appropriate for you to get a **stent-graft** if any of these situations apply to you.

A **stent-graft** may not be recommended by your doctor if you:

- Cannot complete regular follow-up visits and **imaging** examinations
- Cannot tolerate injectable dyes needed for **imaging** examinations
- Have bleeding disorders
- Have kidney disease
- Cannot use blood thinners

## Clinical Studies to Support Relay® Thoracic Stent-Graft

In order to understand the risks and benefits of **Endovascular Repair** with the Relay® Thoracic Stent-Graft with Plus Delivery System, Bolton Medical, Inc. conducted a clinical study in the United States with 120 patients.

The U.S. Relay® Phase II Clinical Trial included 120 patients between the ages of 28 and 91. Most patients had high blood pressure, high cholesterol, or smoked. Many had mild heart, lung, or kidney disease. Patients who had recent surgery, heart attack, stroke, or infection were not included in these studies. Some of the risks and benefits to having **Endovascular Repair** are explained in the following sections.

## Risks of Having Endovascular Repair<sup>2</sup>

Patients who were treated with a **stent-graft** in the U.S. clinical study experienced the following complications up to 30 days of their procedures:

Complications up to 30 days	Likelihood
Abnormal healing of the incision Major blood loss Death Severe difficulty breathing	5 - 10%
Stroke Fluid build-up in area around the lungs Tearing or damage to a blood vessel	3 - 5 %
Heart attack Permanent loss of feeling and muscle function in the legs Kidney failure Pneumonia Mild to moderate difficulty breathing Decreased blood flow to the intestines Infection	1 - 3%
Aneurysm rupture Second procedure due to continued <b>TAA</b> growth Need for surgical repair of <b>TAA</b>	Less than 1%

After your **Endovascular Repair**, there is a chance that an **endoleak** may cause your **TAA** to begin to grow again. If this happens, your doctor may recommend a second **Endovascular Repair** procedure to fix this. Depending on your condition, your doctor may decide that your **TAA** needs to be repaired by surgery. If the **TAA** continues to grow and is not repaired, it could **rupture**. In the U.S. clinical study, no patient had an **endoleak** up to 30 days after the procedure which required a second **Endovascular Repair** to treat this problem. Two patients had **endoleaks** after 30 days that required a second **Endovascular Repair**. One patient in the U.S. study required surgical repair of the **TAA** treated with a **stent-graft** due to an infection not related to the **stent-graft**. No patients in the U.S. study had suffered **ruptures** of the **TAA**s treated with **stent-grafts**.

## Possible Benefits of Endovascular Repair<sup>2</sup>

Repairing your **TAA** may reduce the risk of it rupturing. Using **Endovascular Repair** to treat your **TAA**, may have some additional benefits. As with any surgical procedure, there are risks. Please discuss these risks with your doctor.

In the U.S. clinical study, the results of patients treated by **Open Surgical Repair** were compared to the results of patients treated by **Endovascular Repair**. Clinical study results in the table below suggest advantages with **Endovascular Repair**.

Complication	Endovascular Repair	Open Surgical Repair
Death (within 30 days)	5.8%	10%
Major complications (within 30 days)	21.7%	48.3%
Patients requiring blood transfusion (average)	8%	85%
Blood loss during procedure (average)	less than 1 pint	4.3 pints
Length of procedure (average)	2 hours, 23 minutes	4 hours, 35 minutes
Time in ICU (average)	2 days	8 days
Total time in hospital (average)	5.5 days	13 days

For more clinical study information, visit [www.clinicaltrials.gov](http://www.clinicaltrials.gov) and search for Relay<sup>®</sup> or contact Bolton Medical at 855-7BOLTON (855-726-5866) or [uscustomer@boltonmedical.com](mailto:uscustomer@boltonmedical.com)

## Overview of Endovascular Repair

### What happens before the procedure?

Prior to the procedure, **imaging** tests are performed. These tests allow the doctor to check your **aneurysm**.

### What happens during the procedure?

Typically, the **Endovascular Repair** takes 2 to 3 hours to complete. You are usually asleep during the procedure and won't feel any pain.

1. A small cut is made on one side of your groin.

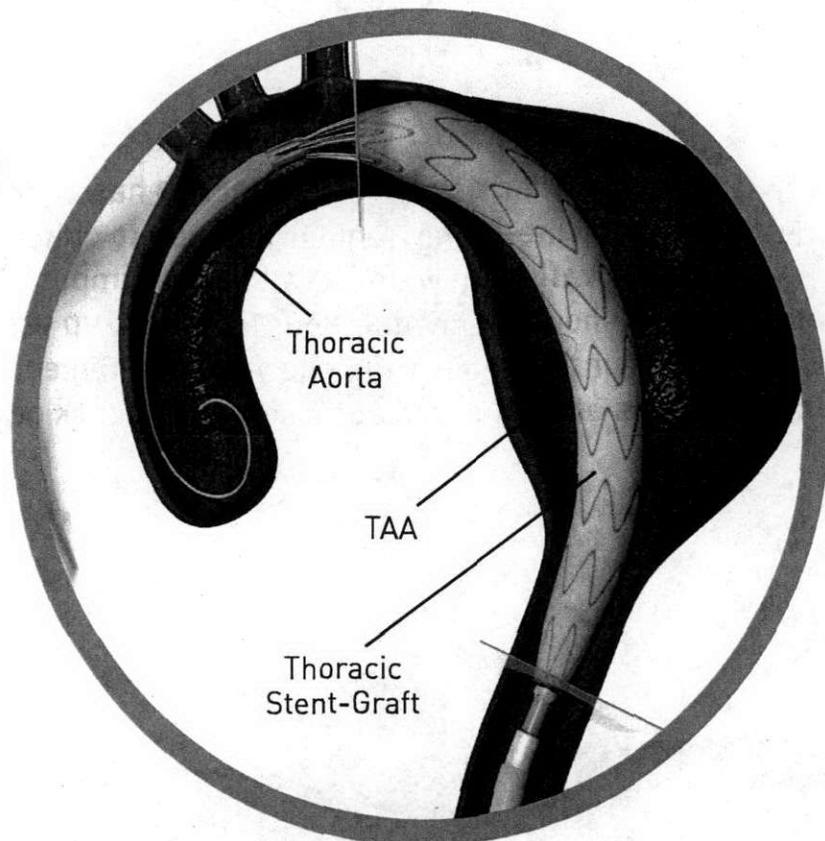


FIGURE 6  
Delivery System  
and Stent-Graft  
Placement

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with PLUS Delivery System

2. A thin plastic tube, called a delivery system, holding your **thoracic stent-graft** is inserted into the opening and threaded through your **femoral artery** to reach your **TAA**. During the insertion, the doctor will view live x-ray pictures of your **aorta** to make sure the **stent-graft** is properly placed. This requires the use of dyes (see warning section on page 11 regarding the use of dyes).
3. Once the delivery system reaches the correct location, the **stent-graft** is released into your **aorta** (**Figure 6**).
4. When your **stent-graft** is released, it expands to fit in your **aorta**, both above and below your **TAA** (**Figure 7**).  
**Note: The size and number of stent-grafts used will depend on your anatomy and your doctor's preference.**
5. Once the delivery system is removed, the doctor will recheck that your **stent-graft** is working properly.
6. The opening in the groin is closed and the procedure is complete.

FIGURE 7  
Stent-Graft  
Inside the  
**TAA**



### What happens after the procedure?

After the **Endovascular Repair**, you will go to a recovery room where you will lay flat for a few hours. This will allow the cut in your groin to start healing. You may have some pain or discomfort for up to two days, and you will probably need to stay in the hospital 2 to 7 days. Your doctor will provide you with instructions on how to care for yourself after this procedure.

### When Should I Immediately Call My Doctor?

If you have any of the following symptoms after your **Endovascular Repair** and before your first follow-up visit, call your doctor immediately.

- Pain in your back, chest or groin
- Dizziness
- Fainting
- Rapid heartbeat
- Sudden weakness
- Pain, numbness, coldness, or weakness in your legs or buttocks

### When Do I Follow-up with My Doctor?

The long-term performance of **stent-grafts** has not yet been confirmed. For this reason, life-long, regular follow-up to check the performance of your **stent-graft** and your overall health is important. Ask your doctor when you should schedule your first follow-up visit. Most often these visits will occur at one month, one year, and then each year thereafter. **Imaging** tests are required at these visits to check device performance.

## When Can I Resume Normal Activities After My Endovascular Repair?

Every patient and medical condition is different. Some patients can return to their normal activities more quickly than others after **Endovascular Repair**. You should consult your doctor about when you should return to normal activities.

## Questions I May Want to Ask My Doctor

- What are all of my options for treating my **TAA**?
- Is the Relay® Thoracic Stent-Graft with Plus Delivery System an appropriate treatment for my **TAA**?
- What are the risks of **rupture** with a **stent-graft**?
- Will I have any side effects from the Relay® Thoracic Stent-Graft procedure?
- After the procedure, how often will I need to see my doctor?
- What follow-up tests will be needed?
- What if the **TAA** continues to grow after endovascular treatment?
- Will I have to limit my activities after the treatment? If so, for how long?
- How long can the **stent-graft** remain inside my body?
- How many Relay® Thoracic Stent-Graft procedures has my doctor performed?
- What are the advantages and disadvantages of **Open Surgical Repair** compared to **Endovascular Repair** of a **TAA**?

## What is the Device Identification Card?

After your procedure, your doctor will give you a Device Identification Card. This card will list the following information:

- Type of device implanted
- Date of implant
- Your doctor's information
- **Magnetic Resonance Imaging (MRI)** information

You should keep this card in your wallet and with you at all times. Inform all your healthcare providers that you have a **stent-graft** and show them your Device Identification Card.

It is important to know that the Relay® Thoracic Stent-Graft is "**MR Conditional.**" This means that *under specific conditions* it is safe for you to undergo an **MRI** scan after receiving a Relay® Thoracic Stent-Graft. Show your Bolton Medical Device Identification Card to your doctor before having surgery or undergoing an **imaging** procedure.

Device Identification  
Card

<b>RELAY</b> <sup>®</sup> I have the Relay <sup>®</sup> Thoracic Stent-Graft(s) listed below implanted in my Thoracic Aorta:	
<b>THORACIC STENT-GRAFT</b>	
Model / Lot Numbers	Date of Implant

This booklet is only intended to provide you with basic information about **TAA**. It is not a substitute for consulting a doctor. Only your doctor can decide what procedure is best for you.

## Where Can I Find Additional Information?

Additional information about **TAA** can be found at:

[www.relaytaa.com](http://www.relaytaa.com)

[www.webmd.com/heart-disease/tc/aortic-aneurysm-overview](http://www.webmd.com/heart-disease/tc/aortic-aneurysm-overview)

[www.medlineplus.gov](http://www.medlineplus.gov)

[www.fda.gov](http://www.fda.gov)

[www.vascularweb.org](http://www.vascularweb.org)

## Contacting Bolton Medical

If you have any questions concerning Bolton Medical's Relay® Thoracic Stent-Graft, you should contact your doctor. If for any reason you need to contact Bolton Medical, please feel free to contact us at:

Bolton Medical  
799 International Parkway  
Sunrise, FL 33325  
USA

855-7BOLTON (855-726-5866)  
954-324-8761 (fax)  
[uscustomer@boltonmedical.com](mailto:uscustomer@boltonmedical.com)

[www.boltonmedical.com](http://www.boltonmedical.com)  
[www.relaytaa.com](http://www.relaytaa.com)

## Endnotes:

<sup>1</sup>Vascular Web: <https://www.vascularweb.org/vascularhealth/Pages/thoracic-aortic-aneurysm.aspx>. Retrieved 9/12/12

<sup>2</sup>U.S. Phase II Clinical Trial to Determine the Safety and Efficacy of Relay® Thoracic Stent-Graft, 2/2012







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