

**Zenith® Renu™ AAA Ancillary Graft
 Post-Market Surveillance Registry: Final Report**

The Zenith Renu® AAA Ancillary Graft (Renu) was approved by FDA on June 9, 2005. It is intended to be used as a bailout device for situations in which a previously implanted (pre-existing) AAA stent graft does not provide adequate proximal fixation or seal (refer to [Instructions for Use](#) for complete indications, warnings, and precautions). A condition of approval was collection of physician experience with the Zenith Renu® AAA Ancillary Graft in a post-market surveillance registry. The registry was created with the specific aims to evaluate physician experience with the Zenith Renu® AAA Ancillary Graft and to confirm device performance as assessed by the absence of subsequent device-related events. Case accrual began on September 9, 2005, and this status report summarizes data entered into the registry as of February 8, 2011. To date, 151 Zenith Renu® AAA Ancillary Graft cases at 95 institutions have been reported in the registry. New cases are no longer being entered into this registry. The pre-existing grafts and their failure modes (based on site-reported data) are presented in Tables 1 and 2.

Table 1. Pre-existing grafts treated with the Zenith Renu® AAA Ancillary Graft

Pre-existing Graft Type	Number	(%)	Implantation time prior to treatment (months) ²
AneuRx®	126	83.4%	42.1 ± 17.1 (n=116)
Ancure®	9	6.0%	55.1 ± 8.6 (n=8)
Excluder®	6	4.0%	31.3 ± 26.2 (n=6)
Talent™	3	2.0%	38.5 ± 0.7 (n=2)
Vanguard™	2	1.3%	96.0 ± 0.0 (n=2)
Other ¹	2	1.3%	75.0 ± 14.1 (n=2)
Fortron™	1	0.7%	44.0 (n=1)
Lifepath™	1	0.7%	38.0 (n=1)
Zenith®	1	0.7%	15.0 (n=1)

¹ Hand-made grafts (1 aortouni-iliac and 1 bifurcated).

² The implantation times of 10 AneuRx® grafts, 1 Ancure® graft, and 1 Talent™ graft were not provided.

The average implantation time of pre-existing grafts treated with the Zenith Renu® AAA Ancillary Graft was 43.4 months (n=139). The implantation times of 10 AneuRx® grafts, 1 Ancure® graft, and 1 Talent™ graft were not provided.

Table 2. Failure modes of pre-existing grafts treated with the Zenith Renu® AAA Ancillary Graft¹

		Pre-existing Graft									
		All	AneuRx®	Ancure®	Excluder®	Fortron™	Lifepath™	Talent™	Vanguard™	Zenith®	Other ²
Devices Treated		151	126	9	6	1	1	3	2	1	2
Reported Failure Modes ³	Endoleak	108	89	6	4	1	1	2	2	1	2
	Proximal Type I	86	74	4	2	1	1	1	1	1	1
	Migration	136	120	6	2	1	1	3	2	0	1
	Stent Fracture/ Breakage	3	3	0	0	0	0	0	0	0	0
	Graft Tear	3	2	1	0	0	0	0	0	0	0
	Component Separation	2	1	0	0	0	0	0	1	0	0
	Occlusion	2	1	1	0	0	0	0	0	0	0
	Kink	7	5	1	0	0	0	0	0	0	1
	Other ⁴	2	1	0	1	0	0	0	0	0	0

¹ Failure modes of pre-existing grafts are based on site-reported data.

² Hand-made grafts (1 aortouni-iliac and 1 bifurcated).

³ Ninety-nine pre-existing grafts were reported as having multiple failure modes. Failure mode(s) of one AneuRx® graft was not provided by one implanting institution. Per Cook representative present at the procedure, the pre-existing graft had both migrated and had a proximal type I endoleak. These failure modes were confirmed by evaluation of pre-operative imaging and have been included in this analysis.

⁴ One AneuRx® was noted as having a loss of graft integrity discovered during the Renu procedure. One Excluder® was noted as having aneurysm sac growth due to the material.

The most commonly reported failure modes of pre-existing grafts were proximal type I endoleak (86 cases) and migration (136 cases). Other failure modes included additional endoleak, stent fracture, graft tear or leakage, component separation, kink, and occlusion. More than one failure mode was reported in 99 cases.

Demographics

Recipients of the Renu device were primarily male (87%, n=131) with an average age of 77 years (n=147).

Device Deployment

Table 3 presents site-reported deployment data for the 89 Zenith Renu® converters and 62 Zenith Renu® main body extensions used to treat failed or failing pre-existing grafts. The Zenith Renu® AAA Ancillary Graft is often used in a bailout capacity in patients with challenging pre-existing graft and anatomical characteristics. Some difficulty deploying the Renu device is expected in this suboptimal environment. Despite these challenges, a low occurrence of deployment problems was reported. In fact, no problems were reported for over 90% of the cases in each deployment category.

Table 3. Device deployment for the Zenith Renu[®] AAA Ancillary Graft and H&L-B One-Shot[™] Introduction System

Devices Used	Percentage	Frequency
Renu [™] converter was implanted	58.9%	(89/151)
Renu [™] main body extension was implanted	41.1%	(62/151)
Deployment Performance		
Renu [™] delivery system was inserted easily	96.7%	(146/151)
Renu [™] was deployed without difficulty	94.7%	(143/151)
Renu [™] was easily visualized under fluoroscopy	96.7%	(145/150 ¹)
Renu [™] delivery system was easily removed	94.0%	(142/151)
Renu [™] was deployed in the desired position	92.1%	(139/151)

¹ Information regarding visibility was not provided in one case.

Many of the cases with reported difficulty inserting or removing (e.g., retrieval of the top cap) the delivery system also reported tortuosity or angulation of the aorta, iliac arteries, or pre-existing graft. Angulation was also reported as contributing to difficult deployment in one case. The other remaining cases of reported deployment difficulty were a leaking hemostatic valve (1), migration of the device during deployment (1), difficulty retracting or removing the sheath (2), tilting of the Renu opposite the direction of the AneuRx[®] (1), and difficulty reaching the desired landing zone in an obese patient or a patient with a long aorta (2). Of the 12 devices reported as not deployed in the desired position, 8 were reportedly deployed too low (up to 10 mm), 1 was deployed high, but without any compromise to the renal artery, 2 were tilted and did not fit well within the pre-existing graft, and 1 did not acquire a one-stent overlap, so a main body extension was added.

All 151 implanted Zenith Renu[®] AAA Ancillary Grafts were deployed successfully (i.e., successful delivery and deployment of the device and successful removal of the delivery system). However, in 2 cases with reported problems during deployment, the physician converted intra-operatively (described further in [Table 7](#)). In both cases of conversion, the ultimate reason for conversion to open repair was unrelated to the deployment of the Renu device (i.e., rupture of aortic wall proximal to the Renu device, and proximal type I endoleak).

Endoleak

Identification and typing of endoleaks has, historically, been very difficult to accurately perform. The Renu post-market surveillance registry is no exception. Pre-operative imaging was accepted as long as it was adequate for planning and sizing of the Renu. In many instances, however, this imaging was inadequate to appropriately identify and type pre-existing endoleaks prior to the operation (e.g., inadequate or non-existent contrast on the CT imaging). At each time point, independent analysis of available imaging was performed by an angiographic core lab (CCF, Cleveland OH) to identify endoleaks. Table 4 lists the endoleaks (using best available information) either pre-operatively or during the procedure, and the number present at each follow-up time period.

Table 4. Incidence of reported endoleaks by type

Endoleak Type	Identified Pre-procedure or Intra-operatively	Endoleaks Present at 1-month Follow-up ¹	Endoleaks Present at 12-month Follow-up ²	Endoleaks Present at 24-month Follow-up ³	Endoleaks Present at 36-month Follow-up ⁴	Endoleaks Present at 48-month Follow-up ⁵	Endoleaks Present at 60-month Follow-up ⁶
Cases available for endoleak evaluation	151	139	112	59	39	36	12
Proximal Type I	96 (63.6%)	2 (1.4%)	1 (0.9%)	3 (5.1%)	2 (5.1%)	2 (5.6%)	0 (0%)
Distal Type I	9 (6.0%)	0 (0%)	1 (0.9%)	1 (1.7%)	1 (2.6%)	1 (2.8%)	0 (0%)
Type II	17 (11.3%)	21 (15.1%)	20 (17.9%)	8 (13.6%)	7 (17.9%)	2 (5.6%)	1 (8.3%)
Type III	10 (6.6%)	2 (1.4%)	2 (1.8%)	3 (5.1%)	1 (2.6%)	2 (5.6%)	0 (0%)
Type IV	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Unspecified/Unknown Endoleak	4 (2.6%)	2 (1.4%)	1 (0.9%)	2 (3.4%)	1 (2.6%)	0 (0%)	0 (0%)
Total (new and persistent)	136 endoleaks (111 cases, 73.5%)⁷	27 endoleaks⁸ (26 cases, 18.7%)⁹	25 endoleaks¹⁰ (25 cases, 22.1%)	17 endoleaks¹¹ (16 cases, 26.7%)¹²	12 endoleaks¹³ (12 cases, 30.8%)	7 endoleaks¹⁴ (7 cases, 19.4%)	1 endoleak¹⁵ (1 case, 8.3%)

¹ Imaging performed 0-6 months after Renu implantation was assessed as 1-month follow-up.

² Imaging performed 7-18 months after Renu implantation was assessed as 12-month follow-up.

³ Imaging performed 19-30 months after Renu implantation was assessed as 24-month follow-up.

⁴ Imaging performed 31-42 months after Renu implantation was assessed as 36-month follow-up.

⁵ Imaging performed 43-54 months after Renu implantation was assessed as 48-month follow-up.

⁶ Imaging performed 55-66 months after Renu implantation was assessed as 60-month follow-up.

⁷ Twenty-one cases were identified with 2 endoleaks and 2 cases were identified with 3 endoleaks.

⁸ Nineteen endoleaks (proximal type I: 1; type II: 14; type III: 2; unknown/unspecified: 2) were first identified at the 1-month follow-up period. Eight endoleaks (proximal type I: 1; type II: 7) persisted.

⁹ One case had multiple endoleaks at the 1-month follow-up period.

¹⁰ Twelve endoleaks (distal type I: 1; type II: 8; type III: 2; unknown: 1) were first identified at the 12-month follow-up period.

¹¹ Twelve endoleaks (proximal type I: 2; distal type I: 1; type II: 4; type III: 3; unknown/unspecified: 2) were first identified at the 24-month follow-up period.

¹² One case had multiple endoleaks at the 24-month follow-up period.

¹³ Seven endoleaks (distal type I: 1; type II: 4; type III: 1; unknown/unspecified: 1) were first identified at the 36-month follow-up.

¹⁴ Five endoleaks (proximal type I: 1; distal type I: 1; type II: 1; type III: 2) were first identified at the 48-month follow-up.

¹⁵ One endoleak (type II: 1) was first identified at the 60-month follow-up.

One hundred and eleven (111) cases (73.5%) were identified with endoleaks prior to or during the procedure. Of those cases with endoleak, 96 included proximal type I endoleaks. The vast majority of new endoleaks at follow-up have been identified as type II. It is likely many had been previously overlooked, misidentified, or masked by other existing endoleaks during review at earlier time periods.

Renu Migration

Migration of Renu components is based upon core laboratory determination with independent Clinical Event Committee (CEC) adjudication. One case of Renu migration has been confirmed to date. For this case, a 32 mm diameter Renu converter was implanted to treat a migrating (> 10 mm) 28 mm diameter AneuRx[®] with proximal type I endoleak 36 months after AneuRx[®] implantation. No endoleaks have been identified following the procedure; however, migration > 10 mm was identified at follow-up (12 months) by the core laboratory and confirmed by the CEC. The patient died of lung cancer 30 months following Renu implantation, which was adjudicated by the independent CEC as unrelated to the Renu. No new cases of CEC-confirmed migration have been reported.

Renu Patency

Patency of Renu components is based upon core laboratory determination. One occlusion has been identified at the 24-month time period. A secondary intervention (axillary-femoral and femoral-femoral bypass) was performed at 19 months to maintain blood flow to both legs (described further in [Table 7](#)).

Renu Device Integrity

Integrity of Renu components is based upon core laboratory determination. The core lab identified three cases of component separation. One case has since undergone conversion to open surgical repair (see [Conversion](#) for additional information) and another has been treated with an additional Gore stent-graft (see [Table 7](#) for additional information). For the third case, preliminary information from the site indicates that a secondary intervention (implantation of a Renu converter, iliac leg extension, and iliac plug in conjunction with a femoral-femoral bypass) at 33 months to treat the component separation was successful. A secondary intervention form has not been submitted within the registry, so this intervention is not included in [Table 7](#).

In addition, one case of Renu kink, one case of Renu in-folding, and one case of barb separation have been identified. No proximal type I endoleak, type III endoleak, secondary intervention, or occlusion has been noted by the site or core lab for any of these cases.

Morbidity

Table 5 lists the incidence of adverse events reported within 30 days, categorized by organ system.

Table 5. Incidence of adverse events within 30 days, by category

Category	Intra-operative	Adverse events reported within 30 days
Cases available for adverse event evaluation	151	143
Cardiovascular	0	0
Pulmonary	0	1
Renal	0	2
Bowel	0	1
Neurologic	0	0
Vascular	0	3
Wound	0	2
Other	0	3 ¹
Total	0 events (0 cases)	12 events (11 cases)²

¹ Spontaneous retroperitoneal hematoma (1), allergic reaction (1), and fall with subsequent pubic ramus fracture (1).

² One case was reported with both a renal event and an 'other' event (spontaneous retroperitoneal hematoma).

Seventeen additional adverse events (13 cases) have been reported after 30 days. In total, 29 adverse events have been reported for 24 different cases since initiation of this registry. All events underwent medical review and, if necessary, were adjudicated by the independent clinical events committee (CEC) to determine whether the event was related to the endovascular intervention. If related to the endovascular intervention, the CEC further determined whether the event was procedure-related, technique-related, or device-related (Renu or pre-existing graft).

Table 6 lists each specific adverse event.

Table 6. Reported adverse events

Adverse event category	Months after procedure	Specific adverse event
Vascular	0	Brachial artery pseudoaneurysm repair 2 days after Renu implantation
Renal	0	On 3-day follow-up form, a serum creatinine rise > 30% above baseline resulting in a persistent value > 2.0 mg/dL was reported
Other	0	Patient fell in a nursing facility with resultant pubic ramus fracture 18 days after Renu implantation
Vascular	0	Right groin exploration with revision of fem-fem bypass graft completed 1 day post-op
Vascular	1	On the first follow-up form (completed at 7 days), a limb occlusion and secondary intervention (implantation of stents) to treat the adverse event were reported
Bowel	1	Jaundice, biliary obstruction
Wound	1	Persistent drainage at the groin incision requiring surgical intervention
Other, Renal	1	1) Spontaneous retroperitoneal hematoma 2) Renal failure requiring temporary dialysis ¹
Other	1	Allergic reaction
Wound	1	Groin wound seroma requiring operative debridement and closure
Pulmonary	1	Intubation for pneumonia ²
Other, Pulmonary	4	1) Suspected graft infection with negative cultures was reported at day 124. ³ As a continuation to that event, the physician noted that the patient was admitted for CT-guided drainage of an abdominal abscess 7 months after Renu implantation 2) Pulmonary embolism reported 4 months after Renu™ implantation

Adverse event category	Months after procedure	Specific adverse event
Pulmonary	5 ⁴	Pneumonia
Cardio-vascular	12	Patient underwent coronary bypass grafting
Other	14	Hospitalization for prostate enlargement
Bowel	14	Fall with c-spine injury and abdominal perforated viscus unrelated to aneurysm
Vascular	23	Type III endoleak of the thoracic aortic aneurysm stent requiring a bridging stent
Other	24	Bladder wall soft tissue densities concerning for malignancy
Neurologic	36	Lumbosacral spine surgery for nerve root impingement and back pain
Renal	38	Renal insufficiency
Vascular	45	Iliac artery rupture and dissection of thoracic aorta during secondary intervention for distal type I endoleak. Patient was converted to open surgical repair for abdominal aortic aneurysm and iliac artery rupture and two thoracic Talent endovascular grafts were implanted to treat dissection and thoracic aneurysm. Patient died 2 days after conversion (see Conversion, Mortality)
Cardio-vascular	47	Patient admitted through ER for new onset of atrial fibrillation
Cardio-vascular	48	Defibrillator placement
Cardio-vascular	49	Patient admitted through ER with worsening shortness of breath (acute or diastolic heart failure)
Cardio-vascular	53	Diastolic CHF exacerbation/atrial tachyarrhythmia/atrial fibrillation/mitral valve regurgitation requiring hospitalization
Neurologic	60	Patient admitted to hospital for confusion and falling down
Renal	60	Persistent dialysis with normal pre-procedure serum creatinine levels

¹ The patient had a pre-existing renal morbidity (pre-procedure creatinine levels of 4.0 mg/dL).

² Patient is receiving pulmonary toilet and antibiotics.

³ One-month scan revealed sac shrinkage without CT evidence of graft infection.

⁴ Pulmonary event originally reported as occurring 13 months after Renu implantation. Additional information submitted by the site verified that pneumonia occurred 5 months after Renu implantation.

No adverse events have been considered related to the Zenith Renu[®] AAA Ancillary Graft to date, although nine reported events for eight cases have been considered related to the procedure in which the Renu was placed.

Secondary Intervention

Table 7 lists secondary interventions reported by the sites.

Table 7. Secondary Interventions

Time from Procedure (months)	Secondary Intervention Type	Reason for Secondary Intervention
1	Placement of additional stent	Limb occlusion on opposite side from Renu delivery
10	Placement of additional iliac leg graft component	Persistent distal type I endoleak
12 ¹	Coil embolization	Persistent type II endoleak
19	Axillary-femoral, femoral-femoral bypass	Limb occlusion
22	Placement of Zenith iliac leg graft to cover the endoleak	Persistent type III endoleak in the limb of the original endograft
24 ²	Angioplasty with implantation of a Palmaz stent	Proximal type I endoleak
25 ³	Coil embolization	Persistent proximal type I endoleak
29 ³	Placement of additional stent at neck	Persistent proximal type I endoleak
30	Placement of Renu converter, TFLE leg extension, and occluder plug with a fem-fem bypass	Device migration ⁴ with persistent type III endoleak
34 ²	Percutaneous angioplasty	Proximal type I endoleak
38	Zenith stent-graft placed within original graft	Persistent type III endoleak
38	Proximal Renu cuff implanted	Persistent type I endoleak
44	Implantation of Branched iliac endograft	Iliac artery dilatation at attachment site
45	Two iliac limbs attempted (AneuRx and Talent) in difficult anatomy, which caused iliac artery to rupture. Patient underwent conversion to open surgical repair (see Conversion). Two thoracic endografts (both Talent) were implanted.	Distal type I endoleak
48	Transfemoral catheter-based sac/lumbar embolization with Onyx biogluue	Persistent type II endoleak
50	Gore bifurcated graft implanted to traverse across the dissociation between the Renu main body extension and the AneuRx® graft	Pre-existing graft separation from Renu and persistent type III endoleak
52	Treatment with Renu converter	Graft separation and endoleak
60 ¹	Implantation of Renu converter with fem-fem bypass	Persistent proximal type I and type II endoleak

¹ Coil embolization at 12 months and implantation of a Renu converter with fem-fem bypass at 60 months were performed on the same patient.

² Angioplasty with implantation at 24 months and additional angioplasty at 34 months was performed on the same patient to treat proximal type I endoleak.

³ Coil embolization at 25 months and placement of an additional stent at the neck were performed on the same patient to treat proximal type I endoleak. When these interventions were not successful, conversion to open surgical repair was performed successfully at 30 months (see [Conversion](#) for additional information).

⁴ Reported by site as migration of the pre-existing graft.

All secondary interventions except one have been reported by the sites as successful to date. Given that the limb occlusion treated at 1 month occurred on the side opposite of Renu implantation, both distal type I endoleaks occurred in an iliac limb (distal to the Renu main body extension), one coil embolization at 12 months and one sac/lumbar embolization with biogluue at 48 months were due to type II endoleaks, and the type III endoleak treated at 22 months in the original endograft was between the main body of the pre-existing graft and the leg of the pre-existing graft (distal to the Renu main body extension), these six secondary interventions are

considered unrelated to the Renu component. One case of iliac artery dilatation at the attachment site (44 months after implantation of a Renu converter and iliac leg extension) was successfully treated with a branched iliac endograft. One case of limb occlusion within the Renu device at 19 months after Renu implantation was successfully treated with axillary-femoral and femoral-femoral bypass. Seven of the eight remaining cases of endoleak were considered resolved at the end of the secondary intervention procedure, although the sites reported persistent proximal type I endoleaks at the 48-month follow-up for two cases (no additional plans regarding treatment were provided). One case at 38 months was reported by the site as related to the pre-existing graft, not the Renu device; however, the exact location of the type III endoleak was not specified. The secondary interventions for one persistent proximal type I endoleak were not successful; therefore, the patient successfully underwent conversion to open surgical repair (see [Conversion](#) for additional information). Of note, these endoleaks were identified during routine follow-up, highlighting the need for continued follow-up to mitigate the risk of aneurysm expansion and rupture due to the presence of endoleak.

Aneurysm Enlargement

Aneurysm enlargement is based upon core laboratory determination. Nine cases of aneurysm enlargement (aneurysm growth > 5 mm) have been identified to date. Eight of these cases also have been identified with endoleak (4 type II, 1 distal type I and type II, and 3 type III). One case with type III endoleak underwent conversion to open surgical repair following aneurysm rupture (see [Conversion](#) and [Mortality](#) for additional information), the second was treated with an additional Gore stent graft to traverse the separation between the Renu and pre-existing graft, and the third was treated with a Renu converter, iliac leg extension, and occluder in conjunction with a femoral-femoral bypass. The case with distal type I and type II endoleak was implanted with an additional leg graft to treat the distal type I endoleak. One case with type II endoleak and aneurysm expansion underwent embolization with bioglu. No secondary interventions to treat the remaining type II endoleaks with aneurysm expansion were reported.

Aneurysm Rupture

Four aneurysm ruptures following Renu implantation have been identified since registry initiation. Three of the four patients were converted to open surgical repair following aneurysm rupture. The patient that was not converted to open surgical repair had previously declined surgery to treat a type II endoleak with subsequent aneurysm expansion and died following the aneurysm rupture (see [Mortality](#) for additional information). Of the three that were converted to open surgical repair, one subsequently recovered (see [Conversion](#) for additional information) and the other two expired intra-operatively or post-operatively (see [Mortality](#) for additional information).

Conversion

Nine conversions to open repair have been reported to date. Each conversion is listed in Table 8.

Table 8. Conversions

Months after procedure	Reason for conversion
0	Rupture of aortic wall proximal to aneurysm and Renu device
0	Leakage due to incomplete sealing/ persistent blood flow into the aneurysm from patent vessels (proximal type I endoleak)
3	Leakage due to incomplete sealing of the aneurysm (proximal type I endoleak) ¹
12	Leakage due to incomplete sealing of the aneurysm, inadequate sealing between the Renu main body extension and the AneuRx®, and aneurysm rupture ²
12	Inadequate sealing between the Renu main body extension and the AneuRx® graft, and aneurysm rupture ²
16	Leakage due to migration of pre-existing graft (AneuRx®) and aneurysm rupture
19	Infection of the pre-existing graft (AneuRx®) ³
30	Leakage due to incomplete sealing of the aneurysm (proximal type I endoleak)
45	Rupture of external iliac artery during secondary intervention to treat distal type I endoleak (distal to Renu main body extension)

¹ Proximal type I endoleak identified intra-operatively, but not treated.

² Failure to properly follow the instructions, warnings, and precautions in the [Instructions for Use](#) may lead to serious consequences or injury to the patient.

³ Core lab analysis of pre-Renu™ imaging noted stranded contrast that was potentially indicative of infection. An independent CEC adjudicated this case to be unrelated to the Renu endovascular repair.

Two intra-operative conversions and seven late (> 30 day) conversions have been reported. The intra-operative conversions to open repair were due to rupture of the aortic wall proximal to the Renu device (1) and proximal type I endoleak (1). The patient with aortic wall rupture did not survive the conversion (see [Mortality](#) for additional information). The late conversions were related to a suspected graft infection (1), persistent proximal type I endoleak (2), inadequate sealing between the Renu main body extension and the AneuRx® graft leading to component separation and aneurysm rupture (3), and rupture of the external iliac artery during secondary intervention to treat distal type I endoleak (1). In both conversions (1 intra-operative and 1 late) due to proximal type I endoleak identified intra-operatively, the physician chose not to use additional components (e.g., Palmaz® stent, main body extension, etc.) during the Renu implantation procedure to resolve the proximal type I endoleak. Both patients were considered candidates for open surgical repair by their implanting physicians, thus additional components may not have been implanted to avoid complicating the eventual conversion to open repair. In the third conversion due to proximal type I endoleak, the site identified the endoleak during the 24-month follow-up time period. Two unsuccessful attempts were made to treat the endoleak (i.e., coil embolization and additional stenting) prior to the successful conversion to open repair. In all three late conversions due to inadequate sealing between the Renu main body extension

and the AneuRx® graft with subsequent aneurysm rupture, physician peer review of pre-procedure imaging noted that a Renu converter would be a better treatment choice. Despite the physician’s recommendation, one patient requested the main body extension because it required a less extensive intervention than the converter; however, the recommended overlap with the pre-existing graft was not achieved following Renu deployment. Subsequently, the pre-existing graft separated from the Renu (by 12 months), the patient declined an intervention to treat the separation, the aneurysm ruptured, and the patient was successfully converted to open surgical repair. The other two patients with aneurysm rupture died following the conversion (see [Mortality](#) for additional information). In the case of late conversion performed due to rupture of the external iliac artery during secondary intervention to treat a persistent distal type I endoleak, attempts to advance iliac limbs (AneuRx and Talent graft implantations were attempted) past a hairpin turn resulted in rupture of the iliac artery. The patient underwent conversion to open surgical repair, requiring aortic cross-clamping. Dissection of the aorta occurred a few centimeters above the celiac artery, possibly due to aortic cross-clamping or ballooning. Two thoracic endografts (Talent) were implanted. The patient left the operating room in stable condition with well-perfused limbs, but died two days following the secondary intervention due to cardiopulmonary arrest, respiratory failure, and renal failure. This event was considered related to the pre-existing graft by the CEC.

Mortality

Table 9 summarizes the 44 deaths that have been reported to date, along with the results from CEC adjudication of each death.

Table 9. Deaths

Months after procedure	Age at registration	Cause of death	CEC adjudication
0	82	Intra-operative rupture of aorta proximal to aneurysm and Renu device with subsequent conversion ¹	Procedure-related and technique-related
1	90 ²	Low platelet count, hematological complications ³	Procedure-related
1	78	Congestive heart failure 35 days post-procedure	Not related ⁴
2	79	Wegener’s granulomatosis ⁵	Not related
3	80	Cardiopulmonary failure ⁶	Cause unable to be determined
4	83	Direct cause of death not available to reporting institution ⁷	Not related
7	90 ²	Failure to thrive/old age	Not related
10	73	Cardiorespiratory arrest secondary to hypotension and sepsis	Procedure-related and technique-related
10	79	Myocardial infarction ⁸	Cause unable to be determined
11	69	Recurrent cholangiocarcinoma	Not related
12	77	Unknown, information unable to be obtained by reporting institution ⁹	Not related

Months after procedure	Age at registration	Cause of death	CEC adjudication
12	80	Metastatic lung cancer	Not related
12	81	Multi-system organ failure following aortic aneurysm rupture and subsequent emergent conversion ¹⁰	Renu-related
13	82	Cancer	Not related
14	69	Pneumonia with fever and septic shock	Not related
16	76	Cardiac arrest following aneurysm rupture and emergent conversion to open repair ¹¹	Renu-related
17	77	Pulmonary emboli secondary to malignancy	Not related
17	65	Cancer	Not related
18	80	Paralysis secondary to cervical fracture from fall. Renal failure.	Not related
19	75	Ventricular fibrillation, ischemic cardiomyopathy, and GI bleed	Not related
20	73	Congestive heart failure and respiratory failure secondary to congestive heart failure	Not related
20	79	Pulmonary	Not related
21	81	Complications from pneumonia and organ failure	Not related
21	76	Heart attack	Not related
23	85	Unknown, but believed by site to be unrelated to the Renu	Cause unable to be determined
24	Not provided	Unknown ¹²	Cause unable to be determined
27	75	Unrelated to aneurysm, patient died at home ¹³	Cause unable to be determined
28	67	Cardiac issues related to CHF	Not related
29	82	Cancer	Not related
30	69	Lung cancer	Not related
30	78	Ruptured AAA after patient refused to return for repair of type II endoleak with aneurysm expansion	Pre-existing graft-related ¹⁴
33	84	Cardiopulmonary arrest	Not related
36	67	Cancer	Not related
36	61	Unknown ¹⁵	Cause unable to be determined
36	71	CVA, respiratory failure, cancer 2008	Not related
36	74	Cardiac causes	Not related
36	77	Respiratory/cardiac arrest	Not related
36	90 ²	Unknown ¹⁶	Cause unable to be determined
37	82	Unknown – notification came from primary care physician	Cause unable to be determined
40	79	Cardiogenic shock following hip repair of femoral neck fracture	Not related
40	90 ²	Respiratory failure	Not related
45	78	Cardiopulmonary arrest, respiratory failure, renal failure 2 days after secondary intervention ¹⁷	Pre-existing graft-related ¹⁸
48	72	Urinary bacteremia, prostate cancer, MRSA	Not related
48	87	Cancer	Not related
Unknown	76	Unknown ¹⁹	Cause unable to be determined

¹ The patient failed to recover from conversion to open surgical repair, which was performed to treat a rupture of the aorta proximal to the Renu device. The aorta was ruptured by a spicule of calcium after Renu deployment, either during deployment of a Palmaz stent or ballooning of the Renu™ device.

² To comply with HIPAA regulations, the age of any patient ≥ 90 years old was recorded and reported as 90 years.

³ The patient was admitted with a low platelet count and an AneuRx® with a proximal type I endoleak. The patient's aneurysm

ruptured prior to the scheduled Renu[™] implantation date, but was able to be treated emergently with the Renu[™] converter.

⁴ Previously reported as procedure-related; however, upon additional review of this event, the CEC adjudicated it to be unrelated to endovascular repair.

⁵ Wegener's granulomatosis was reported to be a pre-existing comorbidity identified after the procedure in which the Zenith Renu[®] AAA Ancillary Graft was implanted.

⁶ Exact cause of death was unknown. The family described the death as related to cardiopulmonary failure; the patient had a documented 10-year history of severe cardiopulmonary disease.

⁷ Patient was undergoing evaluation for neuromuscular degeneration. Per institution, there was no indication that death was related to the aneurysm or the endograft.

⁸ The patient died after an MI; however, the CEC was unable to adjudicate the death because the patient passed away at home and an autopsy was not performed.

⁹ Cause of death was unknown. Per the reporting institution, an autopsy was performed and the death was related to a pre-existing comorbidity. Based on the available information, the CEC determined the death to be unrelated to the endovascular repair.

¹⁰ Rupture with emergent conversion was secondary to separation of the Renu main body extension from the pre-existing AneuRx[®] graft. A Renu[™] converter had been recommended prior to the procedure.

¹¹ Rupture with emergent conversion was secondary to migration of the AneuRx[®] graft with subsequent type III endoleak. A Renu converter had been recommended prior to the procedure.

¹² Cause of death was unknown. Per the reporting institution, the death was reported to the physician by the family. The CEC was unable to adjudicate the death based on the information provided.

¹³ The site noted this death to be unrelated to the aneurysm; however, the CEC was unable to adjudicate the death without confirmation that the site obtained the information from a death certificate or an autopsy was performed.

¹⁴ CEC adjudicated death as related to endovascular intervention, but related to the pre-existing graft, not the Renu.

¹⁵ Cause of death was unknown. Per the reporting institution, the death was related to a pre-existing comorbidity and the graft was fine 2 months prior to death.

¹⁶ Cause of death was unknown. Per the reporting institution, a family member had called the office with the date of death, but the cause was unknown. The site noted that the patient was being treated for cancer.

¹⁷ Secondary intervention was to treat distal type I endoleak. Iliac artery rupture during advancement of additional iliac limbs led to conversion to open surgical repair. Patient died 2 days following intervention/conversion.

¹⁸ CEC adjudicated death as related to endovascular intervention, but related to the salvage procedure, which was for a distal type I endoleak of the pre-existing graft (distal to the Renu device).

¹⁹ Cause of death was unknown. Per the reporting institution, information was not available about cause of death or time of death with respect to Renu implantation. The last contact the site had with the patient was at 1-month follow-up.

One intra-operative, one early (≤ 30 -day), and 43 late (> 30 -day) deaths have been reported. One intra-operative, endovascular intervention-related death occurred after the patient failed to recover from conversion to open repair following rupture of the aorta proximal to the Renu device. One early death occurred approximately 2 weeks after the initial procedure; the patient died from a low platelet count and hematological complications. Of note, the patient was treated emergently with the Renu after being admitted with a low platelet count and after aneurysm rupture. This event was determined to be procedure-related.

Death beyond 30 days of the initial procedure occurred in 43 cases. Twenty-nine cases were determined to be unrelated to endovascular repair. Of the 14 remaining cases, 5 have been adjudicated as related to endovascular repair (i.e., procedure, technique, pre-existing graft and/or Renu-related) and 9 are unable to be adjudicated due to insufficient information from the site (no additional information is able to be collected). In one of the endovascular repair-related cases, death occurred 10 months after implantation and the cause was reported to be cardiorespiratory arrest secondary to hypotension and sepsis (procedure-related and technique-related). The second of the endovascular repair-related deaths (Renu-related) occurred prior to the 12-month follow-up exam. Anatomical changes in the patient over time contributed to device separation of the pre-existing graft from the Renu main body extension, leading to an eventual aneurysm

rupture. The patient was subsequently converted to open surgical repair, but died post-operatively due to multi-system organ failure. The third endovascular repair-related deaths (Renu-related and technique-related) occurred 16 months after implantation. Although 12-month follow-up form was not completed, 12-month imaging was provided. Core lab analysis of the 12-month imaging indicated component separation of the right leg component; however, a definitive type III endoleak was unable to be confirmed since non-contrast imaging was not provided. At 16 months, the physician noted that AneuRx[®] migration led to type III endoleak and rupture. The patient was emergently converted to open surgical repair, but did not survive the conversion. The remaining two endovascular repair-related deaths were identified as related to the pre-existing graft, rather than the Renu graft. One death at 45 months occurred following an emergent conversion to open repair, which was required to treat an iliac artery that ruptured during a secondary intervention to implant additional iliac limbs to treat a distal type I endoleak (endoleak was unrelated to the implanted Renu main body extension). The other death occurred 30 months after implantation. Approximately 10 months prior to Renu implantation (19 months after implantation of the pre-existing graft), the patient had undergone coil embolization to treat a type II endoleak; however, based on either site or core lab analysis, the type II endoleak persisted through 12 months with aneurysm expansion at 12 months. The physician discussed the need for additional intervention with the patient; however, the patient declined the surgery and died from aneurysm rupture 30 months following Renu implantation. The death was considered related to the pre-existing graft and not the Renu graft.

None of the CEC-adjudicated deaths were related to deployment of the Zenith Renu[®] AAA Ancillary Graft or Renu integrity. None of the endovascular repair-related deaths were unanticipated since they were noted as possibilities in the [Instructions for Use](#) of this device.

Summary

In summary, the post-market surveillance registry provides important information about physician experience during treatment of pre-existing grafts with the Zenith Renu[®] AAA Ancillary Graft. The majority (83.4%, 126/151) of the grafts treated with the Zenith Renu[®] AAA Ancillary Graft were AneuRx[®] grafts. However, Ancure[®], Excluder[®], Fortron[™], LifePath[™], Talent[™], Vanguard[™], and Zenith[®] endovascular grafts have also been treated for proximal fixation and/or seal failure.

Proximal type I endoleaks were identified as one of the primary failure modes for pre-existing grafts, with 96 being identified pre-operatively or during the procedure. Of the proximal type I endoleaks reported, 99% (95/96) resolved without further intervention following Renu implantation, 1 persisted through 1-month follow-up and was converted to open surgical repair.

Nine adverse events, 1 intra-operative and 2 late conversions with subsequent death, 4 additional conversions (1 intra-operative, 3 late), and 3 additional deaths related to the procedure, technique, and/or Zenith Renu[®] AAA Ancillary Graft have been reported since registry initiation. The six Renu-related conversions and deaths were related to either proximal type I (3 cases) or type III (3 cases) endoleaks, 4 of which were first identified after 30 days. Of note, no unanticipated adverse events have occurred to date (all procedure-related or device-related adverse events, deaths, and conversions were noted as possibilities in the [Instructions for Use](#) for this device).

Of the 151 registered cases of Renu implantation, 89.4% (135/151) have had no procedure or Renu-related adverse events, conversions, or deaths. These mid-term post-market registry data confirm that the Renu device may be used during secondary intervention to successfully treat proximal fixation failures.