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# A unique approach for identifying thoracic endovascular aortic repair stent graft landing zones 0/1/2 using revascularization procedure codes from a commercial claims database

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## Background

- Thoracic endovascular aortic repair (TEVAR) with stent grafting is a minimally invasive modality for treating thoracic aortic aneurysm, including dissection and rupture.
- Location of stent graft placement (i.e., "landing zone") in the thoracic aorta is an important anatomic consideration. **[Figure 1]**
- Procedure codes in health care claims data do not specify or distinguish TEVAR landing zones, which is a critical limitation in conducting health economics and outcomes research about aortic repair.

## Objectives

Using revascularization and TEVAR procedure codes in commercial claims data, we sought to retrospectively estimate location of stent grafts placed in aortic Zones 0, 1 or 2 of patients diagnosed with aortic aneurysm, dissection or rupture.

## Methods

### Study design and data source

- This study was a retrospective observational cohort design using U.S. insurance claims data on 65 million patients within the MERATIVE® MARKETSCAN® Commercial and Medicare Supplemental Database accessed via MERATIVE® Treatment Pathways.[1]
  - MarketScan provides clinical and cost information on individuals covered by a variety of employer-sponsored private health insurance plans and employer-paid Medicare supplemental insurance.
  - All MarketScan patient data are deidentified and comply with the Health Insurance Portability and Accountability Act (HIPAA).

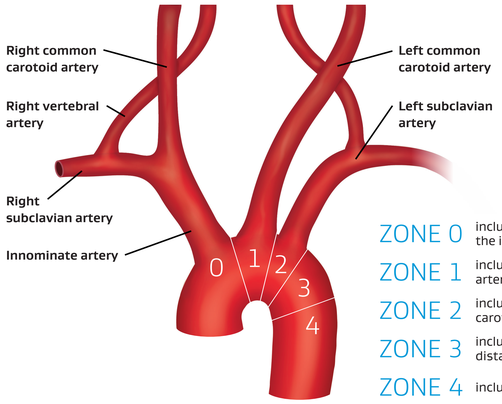
### Patient identification/inclusion

- Patients included in the analysis were identified using International Classification of Diseases, Tenth Revision (ICD-10) diagnosis codes and Current Procedural Terminology (CPT®) codes pertaining to aortic aneurysm, dissection or rupture for patients who underwent an inpatient TEVAR procedure between 1/1/2016 and 1/31/2023. **[Table 1 and Table 2]**

### TEVAR stent graft landing zone identification

- TEVAR proximal stent graft landing zone identification was determined by use of TEVAR-associated supra-aortic vessel bypass/transposition/occlusion procedure codes and/or codes associated with revascularization involving the thoracic aorta itself. **[Table 3]**
  - Proximal landing zone 0 (Zone 0): Codes generally involved revascularization of the innominate artery and other supra-aortic vessels, and/or revascularization of the ascending aorta and aortic arch, with or without coincident revascularization of vessels in Zones 1 and 2).
  - Proximal landing zone 1 (Zone 1): Codes were for revascularization of the left common carotid artery (LCA), often coincident with revascularization of the left subclavian artery (LSA), but with no revascularization of vessels in Zone 0).
  - Proximal landing zone 2 (Zone 2): Codes pertained exclusively to revascularization of the LSA (i.e., no revascularization of vessels in Zones 0 or 1).

## Figure 1: TEVAR stent graft proximal landing zones




ZONE 0 includes the ascending aorta and the innominate artery

ZONE 1 includes the aorta from the innominate artery to the left carotid artery

ZONE 2 includes the aorta from the left carotid to the left subclavian artery

ZONE 3 includes the proximal descending aorta distal to the left subclavian artery

ZONE 4 includes the mid-descending aorta

## Table 4: Analysis results: Estimated number of patients with TEVAR stent graft proximal landing in zones 0/1/2

| TEVAR proximal stent graft landing zone and revascularization type | Number of patients | Percentage of patients |
|---|---|---|
| **Aortic aneurysm/dissection/rupture patients with TEVAR identified in the data** | 1,463 | — |
| **No TEVAR-associated revascularization (TEVAR proximal landing zone is unknown)** | 1,136 | 77.6% of all TEVAR patients |
| **TEVAR-associated revascularization, any zone or multiple zones (revascularization occurred in Zone 2, Zone 1 and/or Zone 0)** | 327 | 22.4% of all TEVAR patients |
| **TEVAR proximal stent graft landing zones** | | |
| **Proximal landing Zone 2** (determined by exclusive LSA revascularization; no revascularization of vessels in Zones 1 and 0) | 82 | 25.1% of TEVAR patients with revascularization |
| **Proximal landing Zone 1** (determined by LCA revascularization with or without LSA revascularization; no revascularization of vessels in Zone 0) | 206 | 63.0% of TEVAR patients with revascularization |
| **Proximal landing Zone 0** (determined by thoracic aorta or supra-aortic vessel revascularization, with or without revascularization in Zones 1 and 2) | 39 | 11.9% of TEVAR patients with revascularization |

LCA, left carotid artery; LSA, left subclavian artery; TEVAR, thoracic endovascular aortic repair.

**Table 1: Diagnosis codes used to identify aortic aneurysm/dissection/rupture patients eligible for TEVAR**

| ICD-10-CM diagnosis codes | Code description |
|---|---|
| I71.01 | Dissection of thoracic aorta |
| I71.010 | Dissection of ascending aorta |
| I71.011 | Dissection of aortic arch |
| I71.012 | Dissection of descending thoracic aorta |
| I71.019 | Dissection of thoracic aorta, unspecified |
| I71.1 | Thoracic aortic aneurysm, ruptured |
| I71.10 | Thoracic aortic aneurysm, ruptured, unspecified |
| I71.11 | Aneurysm of the ascending aorta, ruptured |
| I71.12 | Aneurysm of the aortic arch, ruptured |
| I71.13 | Aneurysm of the descending thoracic aorta, ruptured |
| I71.2 | Thoracic aortic aneurysm, without rupture |
| I71.20 | Thoracic aortic aneurysm, without rupture, unspecified |
| I71.21 | Aneurysm of the ascending aorta, without rupture |
| I71.22 | Aneurysm of the aortic arch, without rupture |
| I71.23 | Aneurysm of the descending thoracic aorta, without rupture |
| S25.0 | Injury of thoracic aorta |
| S25.00 | Unspecified injury of thoracic aorta |
| S25.00X | Injury NOS thoracic aorta |
| S25.00XA | Unspecified injury of thoracic aorta, initial encounter |
| S25.00XD | Unspecified injury of thoracic aorta, subsequent encounter |
| S25.00XS | Unspecified injury of thoracic aorta, sequela |
| S25.01 | Minor laceration of thoracic aorta |
| S25.01X | Minor laceration thoracic aorta |
| S25.01XA | Minor laceration of thoracic aorta, initial encounter |
| S25.01XD | Minor laceration of thoracic aorta, subsequent encounter |
| S25.01XS | Minor laceration of thoracic aorta, sequela |
| S25.02 | Major laceration of thoracic aorta |
| S25.02X | Major laceration thoracic aorta |
| S25.02XA | Major laceration of thoracic aorta, initial encounter |
| S25.02XD | Major laceration of thoracic aorta, subsequent encounter |
| S25.02XS | Major laceration of thoracic aorta, sequela |
| S25.09 | Other specified injury of thoracic aorta |
| S25.09X | Injury NEC thoracic aorta |
| S25.09XA | Other specified injury of thoracic aorta, initial encounter |
| S25.09XD | Other specified injury of thoracic aorta, subsequent encounter |
| S25.09XS | Other specified injury of thoracic aorta, sequela |

**Table 2: TEVAR stent graft placement procedure codes**

| ICD-10-PCS codes* | Code description |
|---|---|
| 02VW3DZ | Restriction of thoracic aorta, descending with intraluminal device, percutaneous approach |
| 02VW3EZ | Restriction of thoracic aorta, descending with branched or fenestrated intraluminal device, one or two arteries, percutaneous approach |
| 02VW3FZ | Restriction of thoracic aorta, descending with branched or fenestrated intraluminal device, three or more arteries, percutaneous approach |
| 02VX3DZ | Restriction of thoracic aorta, ascending/arch with intraluminal device, percutaneous approach |
| 02VX3EZ | Restriction of thoracic aorta, ascending/arch with branched or fenestrated intraluminal device, one or two arteries, percutaneous approach |
| 02VX3FZ | Restriction of thoracic aorta, ascending/arch with branched or fenestrated intraluminal device, three or more arteries, percutaneous approach |

* Excludes codes pertaining to "extraluminal device" or "no device" or "endoscopic."

**Table 3: Revascularization procedure codes used to identify TEVAR stent graft placement landing zones**

| ICD-10-PCS and CPT codes | Procedure type | Code description |
|---|---|---|
| **TEVAR stent graft landing zone 2** | | |
| 03470L | Bypass | Bypass Left Subclavian Artery to Right Extracranial Artery with Autologous Venous Tissue, Open Approach |
| 03470K | Bypass | Bypass Left Subclavian Artery to Left Extracranial Artery with Autologous Venous Tissue, Open Approach |
| 03470J | Bypass | Bypass Left Subclavian Artery to Right Extracranial Artery with Autologous Arterial Tissue, Open Approach |
| 03470H | Bypass | Bypass Left Subclavian Artery to Left Extracranial Artery with Autologous Arterial Tissue, Open Approach |
| 03470D | Bypass | Bypass Left Subclavian Artery to Right Extracranial Artery with Synthetic Substitute, Open Approach |
| 03470C | Bypass | Bypass Left Subclavian Artery to Left Extracranial Artery with Synthetic Substitute, Open Approach |
| 03470A | Bypass | Bypass Left Subclavian Artery to Right Extracranial Artery with Nonautologous Tissue Substitute, Open Approach |
| 03470Y | Bypass | Bypass Left Subclavian Artery to Left Extracranial Artery with Nonautologous Tissue Substitute, Open Approach |
| 03470Z | Bypass | Bypass Left Subclavian Artery to Left Extracranial Artery, Open Approach |
| 03480N | Transposition | Open subclavian to carotid artery transposition performed in conjunction with endovascular repair of descending thoracic aorta, by neck incision, unilateral. |
| 3550A | Bypass | Bypass graft, with vein carotid-subclavian or subclavian-carotid |
| 3560A | Bypass | Bypass graft, with other than vein, carotid-subclavian |
| 3569A | Transposition | Transposition and/or reimplantation, subclavian to carotid artery |
| 3569B | Transposition | Transposition and/or reimplantation, carotid to subclavian artery |
| **TEVAR stent graft landing zone 1** | | |
| 03L3CZ | Occlusion | Occlusion of Left Common Carotid Artery with Extraluminal Device, Open Approach |
| 03L3ZZ | Occlusion | Occlusion of Left Common Carotid Artery, Open Approach |
| 03L3BZ | Occlusion | Occlusion of Left Common Carotid Artery with Bioactive Intraluminal Device, Percutaneous Approach |
| 03L3DZ | Occlusion | Occlusion of Left Common Carotid Artery with Intraluminal Device, Percutaneous Approach |
| 03L3CZ | Occlusion | Occlusion of Left Common Carotid Artery with Extraluminal Device, Percutaneous Endoscopic Approach |
| 03L4DZ | Occlusion | Occlusion of Left Common Carotid Artery, Percutaneous Endoscopic Approach |
| 03503L | Bypass | Bypass Left Common Carotid Artery to Right Extracranial Artery with Autologous Venous Tissue, Open Approach |
| 03503K | Bypass | Bypass Left Common Carotid Artery to Left Extracranial Artery with Autologous Venous Tissue, Open Approach |
| 03503Y | Bypass | Bypass Left Common Carotid Artery to Upper Artery with Autologous Venous Tissue, Open Approach |
| 03503L | Bypass | Bypass Left Common Carotid Artery to Right Extracranial Artery with Autologous Arterial Tissue, Open Approach |
| 03503K | Bypass | Bypass Left Common Carotid Artery to Left Extracranial Artery with Autologous Arterial Tissue, Open Approach |
| 03503Y | Bypass | Bypass Left Common Carotid Artery to Upper Artery with Autologous Arterial Tissue, Open Approach |
| 03503D | Bypass | Bypass Left Common Carotid Artery to Right Extracranial Artery with Synthetic Substitute, Open Approach |
| 03503C | Bypass | Bypass Left Common Carotid Artery to Left Extracranial Artery with Synthetic Substitute, Open Approach |
| 03503A | Bypass | Bypass Left Common Carotid Artery to Right Extracranial Artery with Nonautologous Tissue Substitute, Open Approach |
| 03503Y | Bypass | Bypass Left Common Carotid Artery to Upper Artery with Nonautologous Tissue Substitute, Open Approach |
| 03503Z | Bypass | Bypass Left Common Carotid Artery to Left Extracranial Artery, Open Approach |
| 03503K | Bypass | Bypass Left Common Carotid Artery to Left Extracranial Artery, Open Approach |
| 03503Y | Bypass | Bypass Left Common Carotid Artery to Upper Artery, Open Approach |
| 3989Y | Bypass | Bypass graft, with other than vein, transcervical retropharyngeal carotid-carotid, performed in conjunction with endovascular repair of descending thoracic aorta, by neck incision |
| 3550A | Bypass | Bypass graft, with vein, carotid-carotid |
| **TEVAR stent graft landing zone 0** | | |
| 03L23CZ | Occlusion | Occlusion of Innominate Artery with Extraluminal Device, Open Approach |
| 03L23DZ | Occlusion | Occlusion of Innominate Artery with Intraluminal Device, Percutaneous Approach |
| 03L24CZ | Occlusion | Occlusion of Innominate Artery with Extraluminal Device, Percutaneous Endoscopic Approach |
| 0250036A | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Innominate Artery with Zooplastic Tissue, Open Approach |
| 0250038B | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Subclavian with Zooplastic Tissue, Open Approach |
| 0250039D | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Carotid with Zooplastic Tissue, Open Approach |
| 025003BA | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Innominate Artery with Autologous Venous Tissue, Open Approach |
| 025003CB | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Subclavian with Autologous Venous Tissue, Open Approach |
| 025003DC | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Carotid with Autologous Venous Tissue, Open Approach |
| 025003EA | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Innominate Artery with Autologous Arterial Tissue, Open Approach |
| 025003FB | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Subclavian with Autologous Arterial Tissue, Open Approach |
| 025003GC | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Carotid with Autologous Arterial Tissue, Open Approach |
| 025003J8 | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Subclavian with Synthetic Substitute, Open Approach |
| 025003K9 | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Carotid with Synthetic Substitute, Open Approach |
| 025003MA | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Innominate Artery with Nonautologous Tissue Substitute, Open Approach |
| 025003NB | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Subclavian with Nonautologous Tissue Substitute, Open Approach |
| 025003PD | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Carotid with Nonautologous Tissue Substitute, Open Approach |
| 025003ZA | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Innominate Artery, Open Approach |
| 025003ZB | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Subclavian, Open Approach |
| 025004ZD | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Carotid, Open Approach |
| 0294046A | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Innominate Artery with Zooplastic Tissue, Percutaneous Endoscopic Approach |
| 0294048B | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Subclavian with Zooplastic Tissue, Percutaneous Endoscopic Approach |
| 0294049D | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Carotid with Zooplastic Tissue, Percutaneous Endoscopic Approach |
| 029404BA | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Innominate Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach |
| 029404CB | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Subclavian with Autologous Venous Tissue, Percutaneous Endoscopic Approach |
| 029404DC | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Carotid with Autologous Venous Tissue, Percutaneous Endoscopic Approach |
| 029404EA | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Innominate Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach |
| 029404FB | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Subclavian with Autologous Arterial Tissue, Percutaneous Endoscopic Approach |
| 029404GC | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Carotid with Autologous Arterial Tissue, Percutaneous Endoscopic Approach |
| 029404J8 | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Subclavian with Synthetic Substitute, Percutaneous Endoscopic Approach |
| 029404K9 | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Carotid with Synthetic Substitute, Percutaneous Endoscopic Approach |
| 029404MA | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Innominate Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach |
| 029404NB | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Subclavian with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach |
| 029404PD | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Carotid with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach |
| 029404ZA | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Innominate Artery, Percutaneous Endoscopic Approach |
| 029404ZB | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Subclavian, Percutaneous Endoscopic Approach |
| 029404ZD | Bypass | Bypass Thoracic Aorta, Ascending/Arch to Carotid, Percutaneous Endoscopic Approach |
| 03520N | Bypass | Bypass Innominate Artery to Right Extracranial Artery with Autologous Venous Tissue, Open Approach |
| 03520M | Bypass | Bypass Innominate Artery to Left Extracranial Artery with Autologous Venous Tissue, Open Approach |
| 03520L | Bypass | Bypass Innominate Artery to Right Extracranial Artery with Autologous Arterial Tissue, Open Approach |
| 03520M | Bypass | Bypass Innominate Artery to Left Extracranial Artery with Autologous Arterial Tissue, Open Approach |
| 03520J | Bypass | Bypass Innominate Artery to Right Extracranial Artery with Synthetic Substitute, Open Approach |
| 03520K | Bypass | Bypass Innominate Artery to Left Extracranial Artery with Synthetic Substitute, Open Approach |
| 03520Q | Bypass | Bypass Innominate Artery to Right Extracranial Artery with Nonautologous Tissue Substitute, Open Approach |
| 03520R | Bypass | Bypass Innominate Artery to Left Extracranial Artery with Nonautologous Tissue Substitute, Open Approach |
| 03520Z | Bypass | Bypass Innominate Artery to Right Extracranial Artery, Open Approach |
| 03520R | Bypass | Bypass Innominate Artery to Left Extracranial Artery, Open Approach |
| 3550A | Bypass | Bypass graft, with vein, extracranial-aortic, carotid-innominate, or aortic-carotid |
| 3560A | Bypass | Bypass graft, with other than vein, extracranial-aortic, carotid-innominate, or aortic-carotid |

## Results†

- A total of 1,463 aortic aneurysm/dissection/rupture patients who had TEVAR were identified in the data. **[Table 4]**
  - 327 (22.4%) patients had revascularization involving one or more TEVAR aortic landing zone areas (i.e., revascularization was required for stent graft placement in Zone 0, Zone 1 or Zone 2).
  - 1,136 (77.6%) patients had no revascularization and their TEVAR landing zone was indeterminate. Note: Patients without revascularization likely had their stent graft landing in Zone 2 treated using parallel stent grafting of the LSA branch, or with intentionally occluding the LSA without revascularizing, or their TEVAR proximal landing was in Zone 3 or Zone 4 where revascularization is not needed.
- Among patients who had TEVAR with associated revascularization codes, specific code utilization indicates that:
  - **Zone 0:** 39 (11.9%) patients were estimated to have stent graft placement in Zone 0.
  - **Zone 1:** 206 (63.0%) patients were estimated to have stent graft placement in Zone 1.
  - **Zone 2:** 82 (25.1%) patients were estimated to have stent graft placement in Zone 2.

## Conclusions

- Understanding location of placement of aortic stent grafts is important to evaluate their clinical effectiveness and associated costs.
- Results from this study demonstrate that commercial claims data can be effectively used to generalize location of TEVAR stent graft placement in the thoracic aorta.
- Health economists and outcomes researchers may consider using this methodology for claims data studies to understand costs and outcomes associated with treating thoracic aortic arch pathologies.

## Study limitations

- Because we used insurance claims data to conduct this study, we could not corroborate accuracy of our estimates with the actual TEVAR landing zones present in patient medical records.
- Our analysis focused only on Zone 0/1/2 proximal landing zones, whereas many TEVAR patients have stent graft placement in Zones 3 and 4 without need for revascularization (approximately 60%, as reported in published literature).[2]
  - Because our methods rely on use of revascularization codes, patients with stent graft placement in Zone 3 or Zone 4 were not accounted for in the analysis.
- Our analysis focused exclusively on stent graft landing zones for patients who had TEVAR-associated revascularization.
  - Our results do not account for patients who had stent graft placement without revascularization, particularly Zone 2 patients who had parallel stent grafting of the LSA or patients with intentionally unrevascularized LSA occlusion. Therefore the volume of Zone 2 patients is likely underestimated.
  - Published literature suggests that only 38% to 42% of patients with LSA occlusion have LSA revascularization.[3,4]
  - Our estimates also likely exclude patients undergoing frozen elephant trunk (FET) procedures, where substantial revascularization work or total arch replacement takes place in Zones 0 and 1 and then structurally united with antegrade delivery of a descending aortic stent graft which itself functions as a proximal landing zone.
- To our knowledge, this is the first study attempting to identify TEVAR proximal stent graft landing zones using claims data.
  - We caution that the study was meant to be an exploratory approach for filling conspicuous gaps in the literature about revascularization associated with TEVAR.
  - We intend to replicate this study using other data sources and publish comparative findings in the future.

† Due to changes made in included/excluded codes defining TEVAR and revascularization, results presented in this poster slightly differ from those in the published study abstract.


## References

**1.** Real-World Evidence. Merative MarketScan. Published 2023. Accessed April 11, 2024. https://www.merative.com/real-world-evidence **2.** Feezor RJ, Martin TD, Hess PJ, *et al.* Risk factors for perioperative stroke during thoracic endovascular aortic repairs (TEVAR). *Journal of Endovascular Therapy* 2007(4):568-573. **3.** Hajibandeh S, Hajibandeh S, Antoniou SA, Torella F, Antoniou GA. Meta-analysis of left subclavian artery coverage with and without revascularization in thoracic endovascular aortic repair. *Journal of Endovascular Therapy* 2016;23(4):634-41. **4.** Huang Q, Chen XM, Yang H, Lin QN, Qin X. Effect of left subclavian artery revascularisation in thoracic endovascular aortic repair: a systematic review and meta-analysis. *European Journal of Vascular & Endovascular Surgery* 2018;56(5):644-651.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