

## Supplemental Material

Haverkamp C, Kaier K, Shah MJ, et al.: Cerebral Aneurysms: Germany-Wide Real-World Outcome Data of Endovascular or Neurosurgical Treatment from 2007 to 2019

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**eTable 1: Billing codes used for cohort definition**

| Category | System | Code     | Description  |
|----------|--------|----------|--|
| AVM/AVF  | ICD10  | G28.0-   | Arteriovenous malformation of precerebral vessels  |
| AVM/AVF  | ICD10  | G28.00   | Congenital arteriovenous aneurysm of precerebral vessels   |
| AVM/AVF  | ICD10  | G28.01   | Congenital arteriovenous fistula of precerebral vessels  |
| AVM/AVF  | ICD10  | G28.08   | Other congenital arteriovenous malformations of precerebral vessels  |
| AVM/AVF  | ICD10  | G28.09   | Congenital arteriovenous malformation of precerebral vessels, unspecified  |
| AVM/AVF  | ICD10  | G28.1-   | Other malformations of precerebral vessels   |
| AVM/AVF  | ICD10  | G28.10   | Congenital aneurysm of precerebral vessels   |
| AVM/AVF  | ICD10  | G28.11   | Congenital fistula of precerebral vessels  |
| AVM/AVF  | ICD10  | G28.18   | Other congenital malformations of precerebral vessels  |
| AVM/AVF  | ICD10  | G28.19   | Congenital malformation of precerebral vessels, unspecified  |
| AVM/AVF  | ICD10  | G28.2-   | Arteriovenous malformation of cerebral vessels   |
| AVM/AVF  | ICD10  | G28.20   | Congenital arteriovenous aneurysm of cerebral vessels  |
| AVM/AVF  | ICD10  | G28.21   | Congenital arteriovenous fistula of cerebral vessels   |
| AVM/AVF  | ICD10  | G28.28   | Other congenital arteriovenous malformations of cerebral vessels   |
| AVM/AVF  | ICD10  | G28.29   | Congenital arteriovenous malformation of cerebral vessels, unspecified   |
| AVM/AVF  | ICD10  | G28.3-   | Other malformations of cerebral vessels  |
| AVM/AVF  | ICD10  | G28.31   | Congenital fistula of cerebral vessels   |
| AVM/AVF  | ICD10  | G28.38   | Other congenital malformations of cerebral vessels   |
| AVM/AVF  | ICD10  | G28.39   | Congenital malformation of cerebral vessels, unspecified   |
| AVM/AVF  | ICD10  | G28.8-   | Other congenital malformation of the circulatory system, unspecified   |
| AVM/AVF  | ICD10  | G28.80   | Other congenital aneurysm  |
| AVM/AVF  | ICD10  | G28.81   | Other congenital fistula of the circulatory system   |
| AVM/AVF  | ICD10  | G28.88   | Other specified congenital malformations of the circulatory system   |
| AVM/AVF  | ICD10  | G28.9    | Congenital malformation of the circulatory system, unspecified   |
| AVM/AVF  | ICD10  | I67.11   | Cerebral arteriovenous fistula (acquired)  |
| AVM/AVF  | OPS    | 8-836.9d | Percutaneous transluminal vascular intervention: selective embolization with embolizing fluids: Vascular malformations |
| AVM/AVF  | OPS    | 8-836.9f | Percutaneous transluminal vascular intervention: selective embolization with embolizing fluids: Vessels spinal         |
| AVM/AVF  | OPS    | 8-836.kd | Percutaneous transluminal vascular intervention: selective embolization with particles: Vascular malformations         |
| AVM/AVF  | OPS    | 8-836.kf | Percutaneous transluminal vascular intervention: selective embolization with particles: Vessels spinal                 |
| SAH      | ICD10  | I60      | Subarachnoid hemorrhage  |
| ICH      | ICD10  | I61      | Intracerebral hemorrhage   |
| IA       | ICD10  | I67.10   | Cerebral aneurysm (acquired)   |
| IA       | ICD10  | I72.0    | Aneurysm and dissection of carotid artery  |
| IA       | ICD10  | I72.5    | Aneurysm and dissection of other precerebral arteries  |
| IA       | ICD10  | I72.6    | Aneurysm and dissection of vertebral artery  |
| IA       | ICD10  | Q28.30   | Congenital aneurysm of cerebral vessels  |
| EVT      | OPS    | 8-836.m0 | Selective embolization with metal coils: Vessels intracranial  |

|     |     |          |  |
|-----|-----|----------|--|
| EVT | OPS | 8-84b.00 | Percutaneous transluminal implantation of stents for flow lamination in aneurysms: one stent, vessels intracranial           |
| EVT | OPS | 8-84b.10 | Percutaneous transluminal implantation of stents for flow lamination in aneurysms: two and more stents, vessels intracranial |
| EVT | OPS | 8-84b.20 | Percutaneous transluminal implantation of stents for flow lamination in aneurysms: 2 stents, vessels intracranial            |
| EVT | OPS | 8-84b.30 | Percutaneous transluminal implantation of stents for flow lamination in aneurysms: 3 Stents, vessels intracranial            |
| EVT | OPS | 8-84b.40 | Percutaneous transluminal implantation of stents for flow lamination in aneurysms: 4 Stents, vessels intracranial            |
| EVT | OPS | 8-84b.50 | Percutaneous transluminal implantation of stents for flow lamination in aneurysms: 5 Stents, vessels intracranial            |
| EVT | OPS | 8-84b.60 | Percutaneous transluminal implantation of stents for flow lamination in aneurysms: 6 or more stents, vessels intracranial    |
| EVT | OPS | 8-83b.37 | Intraaneurysmal closure device for intracranial aneurysms  |
| NSC | OPS | 5-025.3  | Incision, excision, destruction, and closure of intracranial blood vessels: Dissection and clipping, intracerebral           |
| NSC | OPS | 5-025.5  | Incision, excision, destruction, and closure of intracranial blood vessels: Dissection and destruction, intracerebral        |
| NSC | OPS | 5-025.7  | Incision, excision, destruction, and closure of intracranial blood vessels: Clipping   |
| NSC | OPS | 5-025.9  | Incision, excision, destruction, and closure of intracranial blood vessels: other combined procedures                        |
| NSC | OPS | 5-026.3  | Reconstruction of intracranial blood vessels: Combined procedures  |
| NSC | OPS | 5-026.4* | Reconstruction of intracranial blood vessels: Number of clips on intracranial blood vessels                                  |

AVF: arteriovenous fistula, AVM: arteriovenous malformation, EVT: endovascular treatment, IA: intracranial aneurysm, ICD10: International Statistical Classification of Diseases and Related Health Problems 10, ICH: intracranial hemorrhage, NSC: neurosurgical clipping, OPS: "Operationen- und Prozedurenschlüssel" = key of operations and procedures, SAH: subarachnoid hemorrhage

**eTable 2: Ordinal functional outcome according to type of hospital discharge**

| Ordinal outcome at discharge   | Type of discharge             | Discharge codes according to §301german social code V* |
|--|-------------------------------|--|
| 1: Good outcome = discharge to home  | Discharge to home             | 01, 02, 03, 04   |
| 2: Intermediate Outcome = Further hospital care, rehabilitation, or nursing required | Discharge to other hospital   | 06, 08   |
|  | Discharge to rehabilitation   | 09   |
|  | Discharge to nursing facility | 10   |
|  | Discharge to hospice          | 11   |
| 3: Poor outcome = Intrahospital death  | Intrahospital death           | 7  |

\* Source: <http://fhir.de/CodeSystem/dkgev/EntlassungsgrundErsteUndZweiteStelle>

**eTable 3: Definition of National Inpatient Sample-Subarachnoid hemorrhage Outcome Measure (NIS-SOM)\***

**Good outcome:** discharge to home or a rehabilitation facility and/or other hospital.

**Poor outcome:** in-hospital mortality; discharge to a nursing facility, extended care facility, or hospice (as defined above); placement of a tracheostomy tube (OPS codes: 5-311, 5-312), and/or placement of a gastrostomy tube (OPS codes: 5-431.2)

OPS: “Operationen- und Prozedurenschlüssel” = key of operations and procedures

\* *Washington CW, Derdeyn CP, Dacey RG, Dhar R, Zipfel GJ. Analysis of subarachnoid hemorrhage using the Nationwide Inpatient Sample: the NIS-SAH Severity Score and Outcome Measure: Clinical article. Journal of Neurosurgery. 2014;121:482–489*

**eTable 4: Definition of National Inpatient Sample-Subarachnoid hemorrhage Severity Score (NIS-SSS)\***

| Item                       | ICD-10   | OPS             | multivariate logistic regression coefficient (B) as described by Washington et al.* |
|----------------------------|--|-----------------|---|
| mechanical ventilation     | directly contained in the DRG dataset  |                 | 2,023   |
| hydrocephalus              | G91.[0-1]  |                 | -0,073  |
| treatment of hydrocephalus |  | 5-022.00, 5-023 | 0,223   |
| coma                       | R40.1  |                 | 1,793   |
| cranial nerve palsy        | H49, H57.1   |                 | -1,139  |
| paralysis/paraparesis      | G8.[1-3]   |                 | 0,507   |
| aphasia                    | R47  |                 | 0,445   |
| Score                      | $\text{NIS-SSS} = e^{(\sum_{i=1}^7 B_i \cdot x_i)}$ <p>where <math>x_i = 1</math> when the item is present and 0 if absent</p> |                 |   |

ICD-10: International Statistical Classification of Diseases and Related Health Problems 10, OPS: “Operationen- und Prozedurenschlüssel” = key of operations and procedures, DRG: diagnosis related groups

\* Washington CW, Derdeyn CP, Dacey RG, Dhar R, Zipfel GJ. Analysis of subarachnoid hemorrhage using the Nationwide Inpatient Sample: the NIS-SAH Severity Score and Outcome Measure: Clinical article. *Journal of Neurosurgery*. 2014;121:482–489

**eFigure 1: Time course of in-hospital mortality in treatment of intracranial aneurysms (years 2007-2019)**

