

SPECIAL ARTICLE



Definition and Prioritization of Data Elements for Cohort Studies and Clinical Trials on Patients with Unruptured Intracranial Aneurysms: Proposal of a Multidisciplinary Research Group

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Abstract

Introduction: Variability in usage and definition of data characteristics in previous cohort studies on unruptured intracranial aneurysms (UIA) complicated pooling and proper interpretation of these data. The aim of the National Institute of Health/National Institute of Neurological Disorders and Stroke UIA and Subarachnoid Hemorrhage (SAH) Common Data Elements (CDE) Project was to provide a common structure for data collection in future research on UIA and SAH.

Methods: This paper describes the development and summarization of the recommendations of the working groups (WGs) on UIAs, which consisted of an international and multidisciplinary panel of cerebrovascular specialists on research and treatment of UIAs. Consensus recommendations were developed by review of previously published CDEs for other neurological diseases and the literature on UIAs. Recommendations for CDEs were classified by priority into 'Core,' 'Supplemental—Highly Recommended,' 'Supplemental,' and 'Exploratory.'

Results: Ninety-one CDEs were compiled; 69 were newly created and 22 were existing CDEs. The CDEs were assigned to eight subcategories and were classified as Core (8), Supplemental—Highly Recommended (23), Supplemental (25), and Exploratory (35) elements. Additionally, the WG developed and agreed on a classification for aneurysm morphology.

Conclusion: The proposed CDEs have been distilled from a broad pool of characteristics, measures, or outcomes. The usage of these CDEs will facilitate pooling of data from cohort studies or clinical trials on patients with UIAs.

Keywords: Common data elements, Unruptured intracranial aneurysms, Risk factors, Morphology, Data standardization

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Introduction

Around 3% of the adult global population has unruptured intracranial aneurysms (UIAs) [1]. The increased usage and improved quality of cranial imaging have resulted in more frequent detection of these lesions. UIAs can remain clinically asymptomatic, present with focal neurological deficits from local mass effect or ischemia, or they may rupture. Rupture of an aneurysm results in aneurysmal subarachnoid hemorrhage (SAH), which has a case fatality rate up to 35% and a high risk for permanent neurological disabilities as well as neuropsychological disorders in survivors [2, 3].

Previous meta-analyses on development or rupture of UIAs have been hampered by varying definitions of risk factors, which sometimes led to inconsistent results [4, 5]. In a pooled analysis of individual patient data from six prospective cohort studies, six easily retrievable predictors enabled the calculation of the 5-year risk of aneurysm rupture: population, hypertension, patient age, aneurysm size, earlier SAH from another aneurysm, and aneurysm site. However, several other potential risk factors, such as smoking status during follow-up or aneurysm morphology, could not be included in the risk score because data were not collected at all or with varying methods [5, 6].

The Common Data Elements (CDE) project for standardizing data for neurological clinical research was initiated by cerebrovascular clinicians and scientists under the auspices of The National Institute of Neurological Disorders and Stroke to facilitate pooling and comparison of such data on cerebrovascular disease.

Process for Selecting CDEs

For a description of the UIA and SAH CDE project, we refer to the main article of this project [7]. For development of CDEs for the WG 'UIA' of 'UIA and SAH,' a multidisciplinary and international group of nine cerebrovascular specialists on research and treatment of UIAs was assembled by the two work group (WG) co-chairs (NE, GJER) (Fig. 1). Following systematic review and collection of the current data on UIAs by the two co-chairs, existing CDEs on ischemic stroke were integrated in data sheets. These were circulated to all WG members and subsequently reviewed, expanded, or modified by each member. Additionally, the WG developed a proposal for classification of aneurysm morphology based on current data. Further, CDEs that apply to multiple WGs (e.g., aneurysm size or location in the imaging WG) were crosschecked and/or adapted with these subcommittees to exclude heterogeneous definitions of the same CDEs.

Finally, the CDEs were categorized into four groups: (1) Core CDEs—elements which can be consistently collected across studies and which should be employed in

studies concerning the corresponding particular disease or therapeutic area; (2) Supplemental—Highly Recommended CDEs—elements that are essentially based on certain conditions or study types in clinical research studies and that are strongly recommended for the specific disease or therapeutic area; (3) Supplemental CDEs—elements that are commonly collected in clinical research studies, but whose relevance depends on the study design or type of research; and 4. Exploratory CDEs—elements which are reasonable to use, but whose validity is yet limited due to insufficient availability and validation of data. The categorization was proposed by the two co-chairs, and after another round of review and revision of all CDEs, all the WG members agreed on the final proposal of the UIA CDEs. These findings were presented at the 4th Neurocritical Care Research Conference in Houston, Texas, May 2016, for further review and revision within the SAH CDE research group. The final version of the CDEs was once more circulated within the WG, and upon agreement, the final case report forms were developed.

Common Data Elements Overview

The 'UIA' WG collected 91 CDEs, 69 new CDEs, and 22 already established CDEs where only minor changes had to be made for our purposes. The CDEs were divided into eight categories: demographics, reason of medical consult and diagnosis, clinical symptoms and assessment at baseline, risk factors, concomitant medications, concomitant diseases, radiological findings, as well as management of unruptured aneurysms. Each CDE was assigned a specific identification number, a CDE name, variable name, definition, classification, permissible values, a code name, a code description and if necessary, a unit of measure and a question text.

The CDEs were classified as 8 Core (see below), 23 Supplemental—Highly Recommended, 25 Supplemental, and 35 Exploratory elements (Tables 1–8).

Description of Core CDEs

Demographics (Table 1).

- Patient age (preexisting CDE) [5, 8–10].
- Risk factors (Table 4).
- Hypertension (defined as systolic blood pressure greater than or equal to 140 mmHg or greater than or equal to 90 mmHg diastolic in adults or systolic or diastolic blood pressure above the 95 percentile in children) (preexisting CDE) [5, 8, 11–13].
- Tobacco smoking status: (a) never, (b) former (including start and end date of smoking), (c) current (including starting date) and (d) unknown (modified CDE) [1, 9–17].

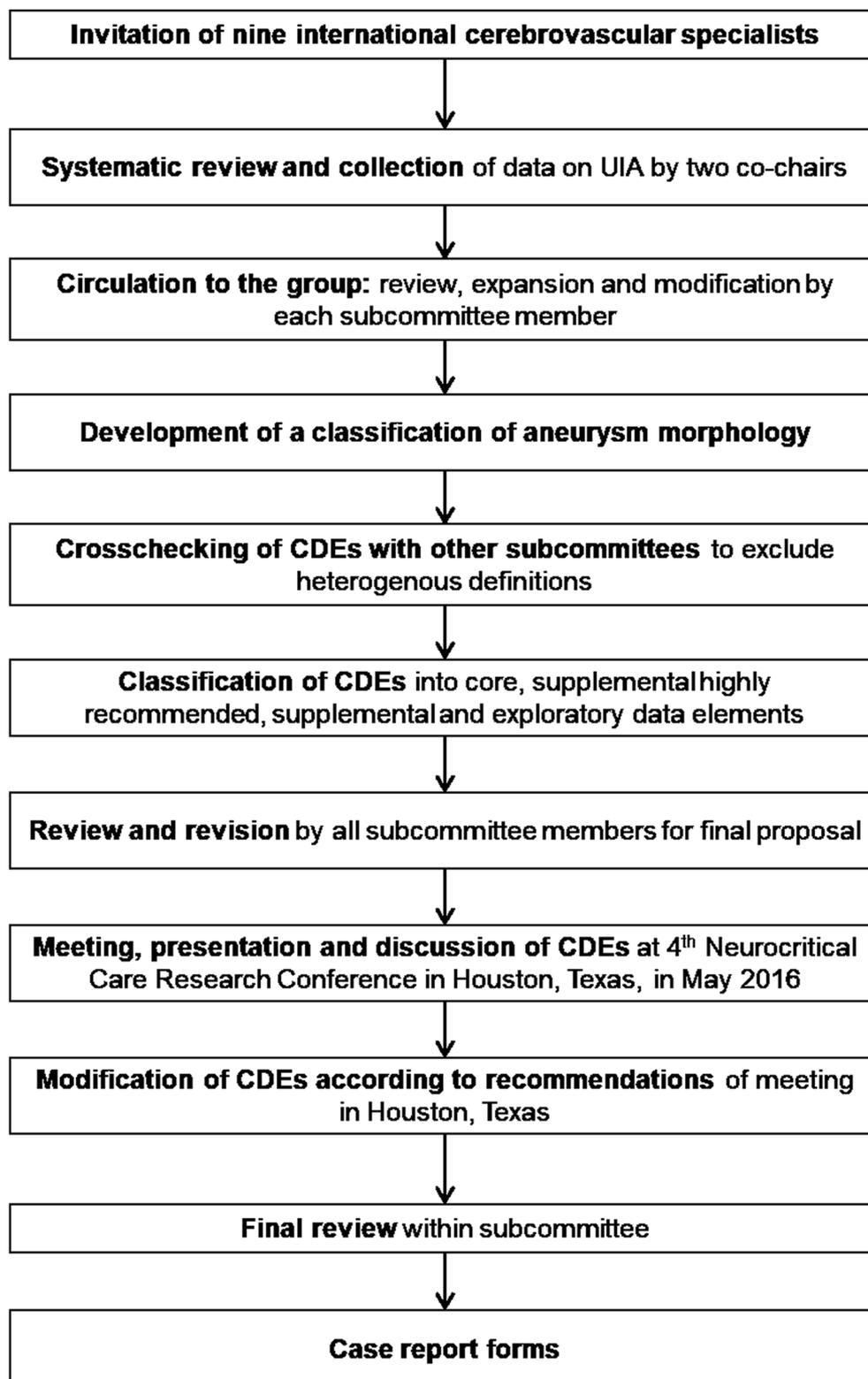
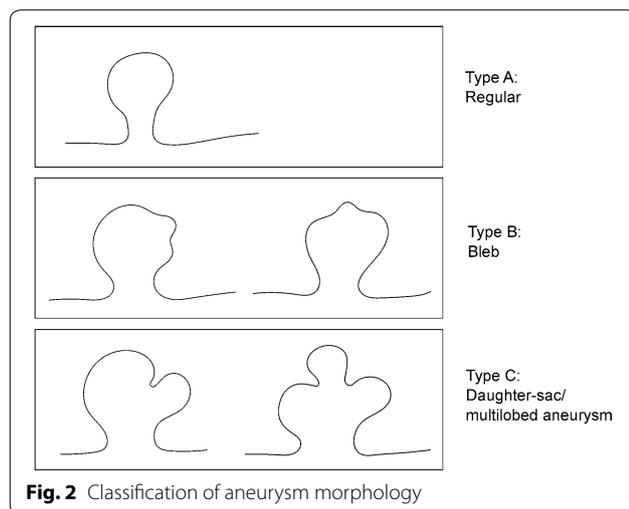


Fig. 1 Development of CDEs

Table 1 CDEs—demographics

| CDE ID | CDE name | Definition | Permissible value | Classification |
|-----------------|--|---|-------------------|---------------------------------|
| C00008 | Age value | Value for participant/subject's age, calculated as elapsed time since the birth of the participant/subject | | Core |
| C20391 | Sex participant or subject genotype type | The difference between male and female, based upon the interactions between genes and between the genotype and the environment. Genotype is identified based on the individual's reproductive organs and functions assigned by chromosomal complement | Male; female | Supplemental—Highly Recommended |
| C16174 modified | Menopause indicator | Indicates whether participant/subject is currently menopausal, if yes: age at begin of menopause | No; yes | Exploratory |

CDE common data element, ID identification number



Radiological findings (Table 7).

- Anatomical aneurysm site based on angiography (modified CDE) [5, 9, 18–26].
- Maximum aneurysm diameter (in mm) in any direction (new CDE) [5, 8, 9, 16–20, 22–29].
- Maximum aneurysm height (in mm) perpendicular to aneurysm neck (new CDE) [30].
- Maximum aneurysm width (in mm) perpendicular to aneurysm height (new CDE) [30].
- Aneurysm morphology type: (a) regular, (b) bleb, (c) daughter-sac/multilobed aneurysm (new CDE, Fig. 2) [20–23, 27, 30–33].

Description of UIA CDEs

For ‘reason of medical consult and diagnosis,’ one CDE with eight permissible values was established (Table 2). The subtopic ‘clinical symptoms and assessment at baseline’ contains eight CDEs, of which three were novel and the remaining were edited (Table 3). Twelve CDEs on ‘risk factors’ were established, comprised of six novel and six reutilized CDE. Permissible values and further information were added to the CDE ‘tobacco smoke history status’ as a core item (Table 4). Additionally, a classification concerning the morphology of an aneurysm was established (Fig. 2). There are 10 CDEs in the subtopic ‘concomitant medications,’ of which seven were novel and three were modified (Table 5). The subject area ‘concomitant diseases’ contains 21 novel CDEs and three already established CDEs (Table 6). For ‘radiological findings,’ we compiled 27 CDEs, out of these the CDE ‘imaging modality vessel imaging angiography type’ was reused and permissible values were added to the Stroke CDE ‘imaging vessel angiography aneurysm’ (Table 7). Six novel CDEs were established for ‘UIA management’ (Table 8).

Limitations

This project has limitations: We identified and defined numerous data elements in the setting of UIAs, based on existing and/or most commonly used definitions. We balanced between very detailed definitions, which would decrease the feasibility of using these, and broad

Table 2 CDEs—reason of medical consult and diagnosis

| CDE ID | CDE name | Definition | Permissible value | Classification |
|--------|---|---|---|----------------|
| NEW | Unruptured intracranial aneurysm reason medical consult diagnosis | Reason of medical consult and diagnosis of unruptured intracranial aneurysm | Screening of CNS during checkup of general health; evaluation of vague symptoms such as headache, vertigo, dizziness; symptoms probably related to aneurysm (cranial nerve palsies, embolic events, etc.); cerebrovascular imaging because of TIA, ischemic, or hemorrhagic stroke; evaluation of SAH (UIAs associated with other aneurysm caused SAH); familial screening; screening because of ADPKD; other | Supplemental |

ADPKD autosomal-dominant polycystic kidney disease, CDE common data element, CNS central nervous system, ID identification number, SAH subarachnoid hemorrhage, TIA transient ischemic attack, UIA unruptured intracranial aneurysm

Table 3 CDEs—clinical symptoms and assessment at baseline

| CDE ID | CDE name | Definition | Permissible value | Classification |
|-----------------|--|---|---|----------------|
| C14434 modified | Cranial nerve abnormal identifier | The identified cranial nerve that assessed as abnormal due to unruptured intracranial aneurysm | CN II; CN III; CN IV; CN V; CN VI; CN VII; CN VIII; CN IX; CN X; CN XI; CN XII | Supplemental |
| C14438 | Motor examination global abnormality present indicator | Global assessment whether an abnormality was present following the motor examination | Yes; no; not assessable | Supplemental |
| C14466 | Sensory system global assessment result | The condition and ability of sensory system | Normal; abnormal; not assessable; other, specify | Supplemental |
| NEW | Speech disturbance global assessment | Global Assessment of speech disturbance | Normal; dysarthria; amnesic dysphasia; aphasia; other, specify | Supplemental |
| NEW | Symptoms unruptured intracranial aneurysm mass effect | Clinical signs for mass effect due to aneurysm without SAH | Progressive headache; nausea; vomiting; focal neurological findings, if yes, specify; other, specify | Supplemental |
| NEW | Sentinel headache aneurysm | Presence or history of a sentinel headache/thunderclap | Yes; no | Supplemental |
| C05460 | Seizure indicator | Indicator of seizure activity | Yes; no | Supplemental |
| C13230 modified | Modified Rankin Scale (mRS) score | The overall modified Rankin Scale (mRS) score assigned to the participant/subject (at baseline) | 0 (no symptoms at all); 1 (no significant disability; despite symptoms, able to carry out all usual duties and activities); 2 (slight disability; unable to perform all previous activities but able to look after own affairs without assistance); 3 (moderate disability; requiring some help but able to walk without assistance); 4 (moderately severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance); 5 (severe disability; bedridden, incontinent and requiring constant nursing care and attention); | Supplemental |

CDE common data element, CN cranial nerve, ID identification number, SAH Subarachnoid hemorrhage

definitions, which are easier to use in clinical practice, but may provide less scientific details. Thus, the definitions and their scientific implication remain uncertain and need to be validated prospectively. Further, for several CDEs, we had to define limits or cut-off values. For example, for hypertension, we used the accepted definitions of the cardiac guidelines, a systolic pressure of 140 mmHg and a diastolic one of 90 mmHg, but it remains uncertain whether these cut-off values for hypertension are clinically relevant in terms of risk factor for growth or rupture. Further, a consensus approach was used to define and rank the individual importance of data elements based on existing literature. Thus, other potentially relevant data elements suggested by experimental or case-control studies could not be included at present because of the lack of validated measurement tools or grading scales for such outcomes (e.g., aneurysm wall inflammation in imaging studies). Additionally, the WG established and agreed on a novel classification system for aneurysm morphology, for which there were no

immediate data from the previous cohort or case-control studies to support this exact classification. However, since three-dimensional aneurysm morphologies are difficult to measure or to describe in standardized manner, the WG agreed on a two-dimensional classification as a basis for further research. Lastly, the established CDEs on UIAs may need to be adapted or even expanded, e.g., with neurocognitive outcome measures and grading scales in patients undergoing preventive UIA repair or follow-up imaging in the future, if there are sufficient data to support this. Despite these limitations, standardized collection of the proposed CDEs will at least provide data on whether the CDEs as currently defined are risk factors for the development and rupture of intracranial aneurysms.

Next Steps/Future Work

Future clinical studies need to test and validate the sensitivity and relative importance of the UIA CDEs established. Furthermore, data should be derived from more

Table 4 CDEs—risk factors

| CDE ID | CDE name | Definition | Permissible value | Classification |
|-----------------|--|--|---|---------------------------------|
| NEW | Familial history unruptured intracranial aneurysm or subarachnoid hemorrhage indicator | Familial history of 2 or more first-degree relatives with unruptured intracranial aneurysms or with history of subarachnoid hemorrhage due to an intracranial aneurysm | Yes; no | Supplemental—Highly Recommended |
| NEW | Familial history aneurysmal subarachnoid hemorrhage | Presence of aneurysmal subarachnoid hemorrhage in family | Father; mother; son; daughter; brother; sister; other: male or female | Supplemental—Highly Recommended |
| C05454 | Hypertension indicator | Indicator of hypertension. In adults, hypertension is defined as a systolic pressure ≥ 140 and a diastolic ≥ 90 . In children, it is defined as systolic blood pressure > 95 th percentile for age | Yes; no; suspected; unknown | Core |
| C19565 modified | Blood pressure measurement | Blood pressure measurement with systolic measurement over diastolic measurement | | Supplemental—Highly Recommended |
| C06102 modified | Tobacco smoke history status | Qualitative categorization of the participant's/subject's smoking history | Never smoked; former smoker; current smoker; unknown | Core |
| C00709 | Tobacco cigarettes smoked daily average number | Average number of cigarettes the participant/subject smokes daily (on the days you smoked cigarettes during the past 30 days, how many cigarettes did you smoke per day, on average?) | Less than 1 cigarette per day; 1 cigarette per day; 2–5 cigarettes per day; 6–15 cigarettes per day (about 1/2 pack); 16–25 cigarettes per day (about 1 pack); 26–35 cigarettes per day (about 1 1/2 packs); more than 35 cigarettes per day (about 2 packs or more); unknown | Supplemental—Highly Recommended |
| C06108 | Tobacco smoke pack-year value | If participant is a former or current cigarette smoker, documents the number of pack-years of smoking [(average number smoked daily)/20] \times (number of years smoked) = pack-years | | Supplemental—Highly Recommended |
| NEW | Alcohol use weekly measurement | Alcohol consumption of ≥ 210 g ethanol per week (7 \times 3 glasses per day) | Yes; no | Supplemental—Highly Recommended |
| NEW | Disease autosomal-dominant polycystic kidney | Presence of autosomal-dominant polycystic kidney disease | Yes; no | Supplemental—Highly Recommended |
| NEW | History previous subarachnoid hemorrhage other intracranial aneurysm | History of previous subarachnoid hemorrhage due to another intracranial aneurysm | Yes; no | Supplemental—Highly Recommended |
| NEW | Ethnicity: intracranial aneurysm | Ethnicity/ancestry of patient | Non-Japanese; non-finnish; Japanese; finnish | Supplemental—Highly Recommended |
| C11131 modified | Body mass index value | Value of the participant/subject's body mass index, calculated from height and weight | | Exploratory |

CDE common data element, ID identification number

Table 5 CDEs—concomitant medications

| CDE ID | CDE name | Definition | Permissible value | Classification |
|-----------------|---|---|--|----------------|
| NEW | Medication antihypertensive type | History of or current intake of type of antihypertensive medication | Thiazide diuretics; calcium channel blockers; ACE inhibitors; angiotensin II receptor blockers; β -blockers; α -blockers; | Supplemental |
| NEW | Medication antihypertensive current former take duration | Duration in months for which the subject/participant took or has taken the selected former or current antihypertensive medication | | Supplemental |
| NEW | Medication antihypertensive current former take age start value | Age in years at which the subject/participant began taking the selected former or current antihypertensive medication | | Supplemental |
| NEW | Medication antihypertensive former take age end value | Age in years at which the subject/participant stopped taking the selected former antihypertensive medication | | Supplemental |
| C14632 modified | Antiplatelet type | Type(s) of antiplatelets received | Aspirin; aspirin/dipyridamole (in separate formulations or as Aggrenox); clopidogrel; ticlopidine; other, specify | Supplemental |
| NEW | Medication antiplatelet current former take duration | Duration in months for which the subject/participant took or has taken the selected former or current antiplatelet medication | | |
| NEW | Medication antiplatelet current former take age start value | Age in years at which the subject/participant began taking the selected former or current antiplatelet medication | | |
| NEW | Medication antiplatelet former take age end value | Age in years at which the subject/participant stopped taking the selected former antiplatelet medication | | |
| NEW | Medication statin | History of or current intake of type of statins | | Exploratory |
| NEW | Medication statin current former take duration | Duration in months for which the subject/participant took or has taken the specified former or current statin medication | | Exploratory |
| NEW | Medication statin current former take age start value | Age in years at which the subject/participant began taking the specified former or current statin medication | | Exploratory |
| NEW | Medication statin former take age end value | Age in years at which the subject/participant stopped taking the specified former statin medication | | Exploratory |
| C10981 modified | Birth control method type | The female participant's/subject's method of birth control | Oral contraceptives—combined pill; oral contraceptives—progestin-only pill; transdermal patch; shot/injection; abstinence; hormonal (e.g., oral, implanted, injected); none of these; other, specify | Exploratory |
| NEW | Birth control method current former use duration | Duration in months for which the subject/participant used the selected current or former birth control method | | Exploratory |

Table 5 (continued)

| CDE ID | CDE name | Definition | Permissible value | Classification |
|-----------------|--|---|--|----------------|
| NEW | Birth control method current former use age start value | Value in years of the age at which the subject/participant began to use the selected current or former birth control method | | Exploratory |
| NEW | Birth control method former use age end value | Value in years of the age at which the subject/participant ended use of the selected former birth control method | | Exploratory |
| NEW | Medication non-steroidal anti-inflammatory drugs (NSAIDs) | History of or current intake of type of NSAID | | Exploratory |
| NEW | Non-steroidal anti-inflammatory drug current former take duration | Duration in months for which the subject/participant took or has taken the specified non-steroidal anti-inflammatory drug (NSAID) | | Exploratory |
| NEW | Non-steroidal anti-inflammatory drug current former take age start value | Age in years at which the subject/participant began taking the specified former or current non-steroidal anti-inflammatory drug (NSAID) | | Exploratory |
| NEW | Non-steroidal anti-inflammatory drug former take age end value | Age in years at which the subject/participant stopped taking the specified former non-steroidal anti-inflammatory drug (NSAID) | | Exploratory |
| NEW | Hormone therapy | History of or current intake of type of hormones | | Exploratory |
| NEW | Hormone therapy current former receive duration | Duration in months for which the subject/participant took or has taken the specified hormone therapy | | Exploratory |
| NEW | Hormone therapy current former receive age start value | Age in years at which the subject/participant began taking the specified former or current hormone therapy | | Exploratory |
| NEW | Hormone therapy former receive age end value | Age in years at which the subject/participant stopped taking the specified former hormone therapy | | Exploratory |
| C14630 modified | Anticoagulant type | Type(s) of anticoagulants received | Unfractionated heparin IV; full dose LMW heparin; warfarin; phenprocoumon; acenocumarol; dabigatran; fondaparinux; rivaroxaban; apixaban; edoxaban; other; specify | Supplemental |
| NEW | Medication anticoagulant current former take duration | Duration in months for which the subject/participant took or has taken the selected former or current anticoagulant medication | | Supplemental |
| NEW | Medication anticoagulant current former take age start value | Age in years at which the subject/participant began taking the selected former or current anticoagulant medication | | Supplemental |
| NEW | Medication anticoagulant former take age end value | Age in years at which the subject/participant stopped taking the selected former anticoagulant medication | | Supplemental |

Table 5 (continued)

| CDE ID | CDE name | Definition | Permissible value | Classification |
|--------|--|--|--|----------------|
| NEW | Stimulants | History of or current intake of type of stimulants | Amphetamine derivatives; caffeine (xanthine derivative); theophyllin (xanthine derivative); theobromin (xanthine derivative); cocaine; others; specify | Supplemental |
| NEW | Stimulant current former use duration | Duration in months for which the subject/participant took or has taken the selected former or current stimulant | | Supplemental |
| NEW | Stimulant current former use age start value | Age in years at which the subject/participant began taking the selected former or current stimulant | | Supplemental |
| NEW | Stimulant former use age end value | Age in years at which the subject/participant stopped taking the selected former stimulant | | Supplemental |
| NEW | Medication immunosuppressant | History of or current intake of type of immunosuppressants | Corticosteroids systemic; corticosteroids local; others; specify | Exploratory |
| NEW | Medication immunosuppressant current former take duration | Duration in months for which the subject/participant took or has taken the selected former or current immunosuppressant medication | | |
| NEW | Medication immunosuppressant current former take age start value | Age in years at which the subject/participant began taking the selected former or current immunosuppressant medication | | |
| NEW | Medication immunosuppressant former take age end value | Age in years at which the subject/participant stopped taking the selected former immunosuppressant medication | | |
| NEW | Medication potency-enhancing | History of or current intake of potency-enhancing medications | | Exploratory |
| | Potency-enhancing drug current former use duration | Duration in months for which the subject/participant took or has taken the specified potency-enhancing drug | | |
| | Potency-enhancing drug current former use age start value | Age in years at which the subject/participant began taking the specified former or current potency-enhancing drug | | |
| | Potency-enhancing drug former use age end value | Age in years at which the subject/participant stopped taking the specified potency-enhancing drug | | |

CDE common data element, ID identification number, NSAID non-steroidal anti-inflammatory drug

Table 6 CDEs—concomitant diseases

| CDE ID | CDE name | Definition | Permissible value | Classification |
|--------|--|--|--|---------------------------------|
| NEW | Disease chronic renal | History of or present chronic renal disease | Yes; no | Exploratory |
| NEW | Disease autosomal-dominant polycystic kidney | Presence of autosomal-dominant polycystic kidney disease | Yes; no | Supplemental—Highly Recommended |
| NEW | Disease renal artery stenosis | History of or present renal artery stenosis | Yes; no | Exploratory |
| NEW | Disease coronary artery | History of or present coronary artery disease | Yes; no | Exploratory |
| NEW | Disease peripheral artery | History of or present peripheral artery disease | Yes; no | Exploratory |
| NEW | Disease carotid artery | History of or present carotid artery disease | Yes; no | Exploratory |
| NEW | Disease valve | History of or present valve disease | Yes; no | Exploratory |
| NEW | Disease aortic coarctation | History of or present aortic coarctation | Yes; no | Supplemental |
| NEW | Disease aortic aneurysm | History of or present aortic aneurysm | Yes; no | Exploratory |
| NEW | Disease gingival, tooth decay | History of or present gingival disease, tooth decay | Yes; no | Exploratory |
| NEW | Disease intracranial atherosclerotic | History of or present intracranial atherosclerotic disease | Yes; no | Exploratory |
| NEW | Disease arteriovenous malformation | History of or present arteriovenous malformation | Yes; no | Exploratory |
| NEW | Disease dural arteriovenous fistula | History of or present dural arteriovenous fistula | Yes; no | Exploratory |
| NEW | Disease CNS tumor | History of or present CNS tumor | Yes; no | Exploratory |
| NEW | History previous cranial surgery | History of previous cranial surgery | Yes; no | Exploratory |
| C13758 | Imaging diagnosis stroke transient ischemic attack indicator | Indicates the diagnosis of stroke/transient ischemic attack (TIA) for imaging positive | Yes; no; unknown | Exploratory |
| NEW | Disease fibromuscular | History of or present fibromuscular disease | Marfan syndrome; Ehlers–Danlos syndrome; other, specify | Supplemental |
| NEW | Disease sepsis | History of or present sepsis | Yes; no | Exploratory |
| NEW | Disease transplant | History of or present transplant | Yes; no | Exploratory |
| C05460 | Seizure indicator | Indicator of seizure activity | Yes; no | Supplemental |
| C06358 | Diabetes mellitus type | Type of diabetes mellitus | Type 1; type 2 | Exploratory |
| NEW | Disease hyperlipidemia | History of or present hyperlipidemia | Yes; no | Exploratory |
| NEW | Disease coagulopathies | History of or present type of coagulopathy | Hemophilia; von Willebrand disease; other | Supplemental |
| NEW | Disease thrombophilic | History of or present type of thrombophilic disease | Factor V Leiden; antiphospholipid syndrome; antithrombin III deficiency; protein c/s deficiency; other | Supplemental |

CDE common data element, CNS central nervous system, ID identification number

Table 7 CDEs—radiological findings

| CDE ID | CDE name | Definition | Permissible value | Classification |
|-----------------|--|--|--|---------------------------------|
| NEW | Imaging unruptured intracranial aneurysm mass effect | Radiological signs for mass effect due to aneurysm | Edema; midline shift; cranial nerve compression; herniation | Exploratory |
| NEW | Imaging unruptured intracranial aneurysm ischemia infarction | Imaging of any ischemic lesion or infarction related to aneurysm location/parent artery | Yes; no | Exploratory |
| C13879 | Imaging modality vessel imaging angiography type | Imaging modality for vessel imaging angiography | DSA; MRA; CTA | Supplemental—Highly Recommended |
| C13884 modified | Imaging vessel angiography aneurysm anatomical site | Anatomical site of aneurysms in vessel imaging angiography | C1 cervical; C2 petrous; C3 lacerum; C4 cavernous; C5 clinoid; C6—ophthalmic to PCOM; C6—PCOM to terminus; PCOM; A1; ACOM; A2; M1 proximal to striate; M1 distal to striate; M2; M3; M4; vertebral origin; vertebral—cervical; vertebral—intracranial proximal to PICA; Vertebral—distal to PICA; basilar—distal to AICA; basilar—mid; basilar—proximal to AICA; P1; P2; P3; SCA; AICA; PICA | Core |
| NEW | Imaging unruptured intracranial aneurysm side | Aneurysm side for each unruptured intracranial aneurysm | Right; left; midline | Supplemental—Highly Recommended |
| NEW | Imaging unruptured intracranial aneurysm count | Number of unruptured intracranial aneurysms | | Supplemental—Highly Recommended |
| NEW | Imaging unruptured intracranial aneurysm maximum diameter | Largest diameter in any direction for each unruptured intracranial aneurysm | | Core |
| NEW | Imaging unruptured intracranial aneurysm height | Largest diameter perpendicular to neck of aneurysm for each unruptured intracranial aneurysm | | Core |
| NEW | Imaging unruptured intracranial aneurysm width | Largest diameter perpendicular to height of aneurysm for each aneurysm | | Core |
| NEW | Imaging aneurysm neck measurement | Largest diameter/width of aneurysm neck for each aneurysm | | Supplemental—Highly Recommended |
| NEW | Imaging aneurysm aspect ratio value | Largest height/largest neck diameter for each aneurysm | | Supplemental—Highly Recommended |
| NEW | Imaging unruptured intracranial aneurysm size ratio | Largest height/largest diameter of parent artery for each aneurysm | | Supplemental—Highly Recommended |
| NEW | Imaging unruptured intracranial aneurysm bottle neck factor | Largest aneurysm width/largest neck width | | Supplemental—Highly Recommended |
| NEW | Imaging unruptured intracranial aneurysm diameter parent artery proximal | Diameter of parent artery proximal to unruptured intracranial aneurysm | | Supplemental |
| NEW | Imaging unruptured intracranial aneurysm diameter parent artery distal | Diameter of parent artery distal to unruptured intracranial aneurysm | | Supplemental |
| NEW | Imaging unruptured intracranial aneurysm sidewall branch count | Number of sidewall branches for each unruptured intracranial aneurysm | | Supplemental |

Table 7 (continued)

| CDE ID | CDE name | Definition | Permissible value | Classification |
|--------|---|---|---|---------------------------------|
| NEW | Imaging unruptured intracranial aneurysm pre-aneurysmal parent artery stenosis | Presence of stenosis of pre-aneurysmal parent artery for each unruptured intracranial aneurysm | Yes; no | Exploratory |
| NEW | Imaging unruptured intracranial aneurysm contralat stenooclusive vessel disease | Presence of contralateral stenooclusive vessel disease | Yes; no | Exploratory |
| NEW | Imaging unruptured intracranial aneurysm calcification | Presence of calcification in aneurysm for each unruptured intracranial aneurysm | Yes; no | Supplemental |
| NEW | Imaging aneurysm thrombus indicator | Presence of mural thrombus or partial thrombosis in aneurysm | Yes; no; unknown | Supplemental |
| NEW | Imaging aneurysm shape type | Shape/pathology of aneurysm | Saccular; fusiform; dissecting | Supplemental—Highly Recommended |
| NEW | Imaging unruptured intracranial aneurysm shape follow-up | Shape of aneurysm during follow-up (irrespective of size) for each unruptured intracranial aneurysm | Constant; change in shape | Exploratory |
| NEW | Imaging unruptured intracranial aneurysm morphology type | Morphology type of aneurysm for each unruptured intracranial aneurysm | A: regular; B: bleb; C: daughter-sac, multilobed aneurysm | Core |
| NEW | Imaging unruptured intracranial aneurysm growth indicator | Increase of aneurysm diameter ≥ 1 mm in any direction in comparison to last imaging | Yes; no | Supplemental—Highly Recommended |
| NEW | Imaging unruptured intracranial aneurysm growth largest diameter measurement | Growth of aneurysm regarding largest diameter in any direction in comparison to last imaging | | Supplemental—Highly Recommended |
| NEW | Imaging unruptured intracranial aneurysm growth month interval | Growth of aneurysm regarding largest diameter in any direction in comparison to last imaging | | Supplemental—Highly Recommended |
| NEW | Imaging unruptured intracranial aneurysm de novo formation indicator | De novo formation of aneurysm in comparison to last imaging | Yes; no | Supplemental—Highly Recommended |

ACOM anterior communicating artery, AICA anterior inferior cerebellar artery, CDE common data element, CTA computed tomography angiography, DSA digital subtraction angiography, ID identification number, MRA magnetic resonance angiography, PCOM posterior communicating artery, PICA posterior inferior cerebellar artery, SCA superior cerebellar artery

Table 8 CDEs—Management

| CDE ID | CDE name | Definition | Permissible value | Classification |
|--------|--|---|--|----------------|
| NEW | Unruptured intracranial aneurysm initial management plan | Initial management plan for unruptured intracranial aneurysm | Observation without follow-up imaging; observation with follow-up imaging; microsurgical clipping; endovascular intervention; undetermined | Exploratory |
| NEW | Unruptured intracranial aneurysm reason advice observation | Reason for advice for observation of unruptured intracranial aneurysm | Patient's age; health status; risk of treatment; size of UIA; location of UIA; protocol; other | Exploratory |
| NEW | Unruptured intracranial aneurysm reason advice treatment | Reason for advice for treatment of unruptured intracranial aneurysm | Patient's age; health status; risk of rupture; size of UIA; location of UIA; aneurysm growth on serial imaging; protocol; other; | Exploratory |
| NEW | Unruptured intracranial aneurysm patient following advice | Patient following advice | Yes; no | Exploratory |
| NEW | PHASES aneurysm risk score | PHASES aneurysm risk score | | Supplemental |
| NEW | Unruptured intracranial aneurysm treatment score | Advice for treatment or observation of unruptured intracranial aneurysm | | Supplemental |

CDE common data element, ID identification number, UIA unruptured intracranial aneurysm

advanced imaging modalities in the setting of UIAs including their standardized measurement and morphological analysis.

Conclusions

We defined and categorized a total of 91 CDEs, of which 71 were novel for UIAs. These CDEs on UIAs could serve as a basis to standardize future studies and thereby help to harmonize data across studies. However, the CDEs remain to be validated, adapted, and updated in the future based on novel data for optimizing already existing CDEs and for establishing new CDEs.

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This article does not contain any studies with human participants or animals performed by any of the authors.

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