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Supplemental material

Comparison of clipping and coiling in elderly patients with unruptured cerebral aneurysms

K. Bekelis et al.

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Supplemental Table 1. Diagnostic codes used to define comorbidities	
Comorbidities	**ICD-9 Diagnostic Codes**
Hypertension	401.x, 402.x, 403.x, 404.x
Hyperlipidemia	272.1, 272.2, 272.3, 272.4
Chronic obstructive pulmonary disease (COPD)	415.0, 416.8, 416.9, 491.0, 492.0, 494.0, 496.0 305.1, V15.82, 989.84
Myocardial Infarction	410.0-6, 410.8x, 410.71, 410.70, 410.90, 410.91
Cardiac Arrhythmia	426.10, 426.11, 426.13, 426.2-426.53, 426.6-426.89, 427.0, 427.2, 427.31, 427.60, 427.9, 785.0, V45.0, V53.3
Coagulopathy	286.x, 287.1, 287.3, 287.4, 287.5
Renal Insufficiency	585-586, V420, V451, V56.x
Congestive Heart Failure	402.01, 402.11, 402.91, 425.0-9, 428.0-428.9, 429.3, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93
Pulmonary Disease (non-COPD)	493.xx
Obesity	278.00, 278.01
Alcohol abuse	291.xx, 303.9x, 305.0x, V113
Dementia	290.xx, 331.0-331.2
Ischemic Stroke	433.xx, 434.xx, 435.xx
Diabetes	250.x
Peripheral Vascular Disease	440.x, 441.x, 442.x, 443.x, 447.1, 785.4
Malignancy	140.x-1719.x 174.x-1959.x 200.x-2089.x 2730.x, 2733.x, V1046 196.x-1999.x

Supplementary Methods

Primer on Using Instrumental Variables

The methodology of instrumental variables has become increasingly popular over the past decade. This method provides a way to estimate a treatment effect without bias despite the presence of confounding (i.e. unknown baseline functional clinical status of patients, or aneurysm location and size).

A variable is defined as an instrument if it satisfies the following three assumptions; 1, the instrument has an effect on treatment choice; 2, the instrument has no effect on the outcome except through its effect on the treatment choice; 3, there are no variables that affect both the instrument and the outcome. The last assumption is the same as saying that there are no confounders of the instrument and the outcome. The properties of an instrument are exhibited in the figure below. This graphic, which is an example of a directed acyclic graph (DAG), shows the instrumental variable (IV) effects the outcome, Y, which is only through its effect on the treatment, X. The directed lines in red indicate paths that if true would disqualify the variable IV from being called an instrumental variable.

Instrumental variables do indeed exist. We make them all the time when we run a randomized trial. Randomization is an example of an instrumental variable, because the flip of a coin, or a computer generated random number determine the treatment a subject is assigned and therefore the treatment a subject receives. However, when health services or clinical researchers think of instrumental variables they are usually conceiving of some natural experiment. For instance, the Vietnam draft lottery could be used as an instrument of the effect of military service on outcomes.

Favored choices for instrumental variables in the medical literature so far have been geographic distances, or geographic rates. The thinking with distances is that the differential distance a patient has to travel to get treatment A, versus treatment B, will affect their choice of treatment but is not expected to otherwise have an effect on the outcome. Geographic rates may be regarded as a natural experiment. For instance, living in an area that has a high rate of treatment A compared to treatment B affects the treatment a subject receives but should have no direct effect on the outcomes. Likewise a provider propensity to prescribe one treatment over another may be employed as an instrument.