

## **Image Classification and Quantification Form for Stroke Lesions and Background Brain Appearance on CT and MR Imaging Including CT/MR Angiography and CT/MR Perfusion Imaging**

***These form(s) are available for academic use in other studies but please reference and acknowledge the source (SBIRC website, [www.sbirc.ed.ac.uk/imageanalysis.html](http://www.sbirc.ed.ac.uk/imageanalysis.html), J Wardlaw) and use specific references above where appropriate.***

### Acute Stroke Lesions

The following templates were initially devised as a rapid method of classifying and quantifying acute ischaemic and hemorrhagic stroke lesions on CT or MR imaging during JMW's MD project.<sup>1</sup> The method of dividing the brain into typical arterial territories involved in acute ischaemic stroke covered in Question 5, including the assessment of lesion swelling, was validated in an observer reliability study,<sup>2</sup> and subsequently used in stroke registers and observational studies.<sup>3-5</sup>

The combination of this vascular territory classification, swelling, hemorrhagic changes and background brain appearances of leukoaraiosis and atrophy and prior stroke lesions were implemented and tested in a hospital-based stroke registry (the Lothian Stroke Register) including several thousand patients which ran between 1991 and 1998 at the Western General Hospital Edinburgh.<sup>3</sup>

Subsequently, the form was extensively tested and developed during the pilot phase of IST-3. Following a systematic review of the literature on different infarct signs, their observer reliability and association with outcome in the presence or absence of thrombolytic therapy,<sup>6</sup> the initial four questions which cover an amalgam of all previously described signs was added. These signs all either reflect change in tissue attenuation, tissue swelling or hyperattenuated artery and therefore can be condensed into three simple features making it easier to focus the observer on looking for specific findings.<sup>6</sup> The images are © J Wardlaw, University of Edinburgh. The ACCESS scoring system<sup>7</sup> and the one-third MCA classification<sup>8</sup> were added to reflect alternative widely used stroke lesion classification systems. However, the vascular territory classification<sup>2</sup>, 1/3 MCA and ACCESS all do essentially the same job when tested side by side in the sense that they all improve observer consistency.<sup>9,10</sup>

However there are some important differences:

1) the vascular territory classification scale<sup>2</sup> is the only one that covers all arterial territories (not just the MCA as in the ACCESS and 1/3 MCA); 2) the vascular territory classification scale<sup>2</sup> is the only one that indicates lesion location at the same time as indicating lesion extent – i.e. the 1-8 codes for the MCA territory tell you what part of the MCA territory is affected, as well as how much, whereas the 10-0 and 0-2 scales of the ACCESS and 1/3 MCA respectively only tell you how much of the MCA territory is affected, not what part; 3) the vascular territory classification scale<sup>2</sup> is the only one that distinguishes the extent of the lesion from the amount of swelling in the lesion, thus allowing one to track the effect of treatment on, or the natural history of, lesion swelling and extent separately. The diagrams are all © J Wardlaw, University of Edinburgh except for the ACCESS diagrams.

### Appearance of the Background Brain

Quantification of changes in brain tissue volume was derived from extensive use of atrophy classification systems in studies of aging. Examples are provided from our archives. This approach was validated using a more extensive range of templates and shown to be practical and reliable<sup>11</sup> and in the ACCESS CT reading study,<sup>9</sup> and is used in IST-3 and ENOS.<sup>4,5</sup> The images are all © J Wardlaw, University of Edinburgh.

Periventricular lucencies – i.e. leukoaraiosis – are based on the van Swieten score<sup>12</sup> as a published and validated white matter rating score that is simple and practical to use and can

be applied to both CT and MR. The example images given are from the Edinburgh archive and are © J Wardlaw, University of Edinburgh. The diagram is from van Swieten.<sup>12</sup>

The classification of *old vascular lesions* and *non-stroke lesions* is based on our extensive validation work in the Lothian Stroke Register<sup>3</sup> and during the IST-3 pilot,<sup>9</sup> not any other scales.

#### Angiography and Perfusion Imaging Classification

In the forms used for coding scans which include angiography or perfusion, the angiography classification is based on previously described validated scores, the TIMI<sup>13</sup> and MORI<sup>14</sup> scores.<sup>15</sup>

The perfusion data are captured by visual assessment of lesion extent relative to the lesion on plain CT or MR DWI according to a range of different possible perfusion parameters.<sup>16</sup> These are sub-divided according to their size in relation to the plain CT or MR diffusion abnormality and in a separate section are also captured using the ASPECTS score.

Except where otherwise stated, all images and diagrams in these forms are © J Wardlaw, University of Edinburgh and the overall design of the form is also © J Wardlaw, University of Edinburgh.

Queries – please contact [Joanna.Wardlaw@ed.ac.uk](mailto:Joanna.Wardlaw@ed.ac.uk)

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