# Deep learning-based interpretation of basal/acetazolamide brain perfusion SPECT leveraging unstructured reading reports


## Abstract

**Backgrounds**: Basal/acetazolamide brain perfusion single-photon emission computed tomography (SPECT) has been used to evaluate functional hemodynamics in patients with carotid artery stenosis. We aimed to develop a deep learning model as a support system for interpreting brain perfusion SPECT leveraging unstructured text reports.

**Material and methods:** In total, 7345 basal/acetazolamide brain perfusion SPECT images and their text reports were retrospectively collected. A long short-term memory (LSTM) network was trained using 500 randomly selected text reports to predict manually labeled structured information, including abnormalities of basal perfusion and vascular reserve for each vascular territory. Using this trained LSTM model, we extracted structured information from the remaining 6845 text reports to develop a deep learning model for interpreting SPECT images. The model was based on a 3D convolutional neural network (CNN), and the performance was tested on the other 500 cases by measuring the area under the receiver-operating characteristic curve (AUC). We then applied the model to patients who underwent revascularization (n = 33) to compare the estimated output of the CNN model for pre- and post-revascularization SPECT and clinical outcomes.

**Results:** The AUC of the LSTM model for extracting structured labels was 1.00 for basal perfusion and 0.99 for vascular reserve for all 9 brain regions. The AUC of the CNN model designed to identify abnormal perfusion was 0.83 for basal perfusion and 0.89 for vascular reserve. The output of the CNN model was significantly improved according to the revascularization in the target vascular territory, and its changes in brain territories were concordant with clinical outcomes.

**Conclusion:** We developed a deep learning model to support the interpretation of brain perfusion SPECT by converting unstructured text reports into structured labels. This model can be used as a support system not only to identify perfusion abnormalities but also to provide quantitative scores of abnormalities, particularly for patients who require revascularization.

## References

1. Kuroda, S., et al., Long-term prognosis of medically treated patients with internal carotid or middle cerebral artery occlusion: can acetazolamide test predict it? Stroke, 2001. 32(9): p. 2110-6.

2. Knop, J., et al., 99mTc-HMPAO-SPECT with acetazolamide challenge to detect hemodynamic compromise in occlusive cerebrovascular disease. Stroke, 1992. 23(12): p. 1733-42.

3. Touho, H., J. Karasawa, and H. Ohnishi, Preoperative and postoperative evaluation of cerebral perfusion and vasodilatory capacity with 99mTc-HMPAO SPECT and acetazolamide in childhood Moyamoya disease. Stroke, 1996. 27(2): p. 282-9.

## Supplementary figure