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How It Works

e-ASPECTS (Brainomix Limited) uses machine learning — a form of AI — to facilitate the automated extraction and classification of imaging features taken with non-contrast computed tomography (CT) in the emergency setting. The machine learning algorithm uses the CT imaging data to quantify the volume of ischemia (inadequate blood supply) and apply the Alberta Stroke Program Early CT Score (ASPECTS).³

ASPECTS is a quantitative, 10-point, validated scoring tool that measures the extent of early ischemic changes — changes in blood flow to the brain — and provides an accurate prediction of functional outcomes after thrombolytic treatment — the breakdown of blood clots formed in blood vessels.⁴ It is used with non-contrast CT as part of the assessment to determine patient eligibility for mechanical thrombectomy.^{5,6} ASPECTS was developed to help interpret CT images taken within the first hours of the onset of suspected stroke. The interpretation of CT images is generally challenging,⁷ requires considerable expertise, and can be subject to inter-rater variability.⁸ While ASPECTS scores can also be affected by differences in the reader's experience and clinical background,⁶ overall it is regarded as a useful tool for the standardized evaluation of the extent of ischemic damage.⁵

Using Artificial Intelligence for Stroke in the Emergency Setting

e-ASPECTS is an AI-enhanced decision support tool that measures the extent of ischemic damage in patients with suspected stroke.¹ It is not intended to replace the expert assessment of an image but rather to assist physicians in treatment decisions by providing an unbiased and standardized approach to image interpretation.²

e-ASPECTS was developed to further standardize these variables and interpret data objectively.⁹ The e-ASPECTS application generates a heat map to aid clinicians in interpreting its output. This heat map provides information on the mechanism of arriving at the final score (Olivier Joly, Brainomix, Oxford, UK: personal communication, 2018 Aug 16). e-ASPECTS results can be accessed via picture archiving and communication systems (PACS), through a Web browser user interface, or sent via email to a smartphone.¹⁰

The software is intended to assist clinical experts in decision-making by providing a second opinion and confirming expert assessment. In addition to reviewing the AI assessment, a physician is required to assess each CT image to rule out hemorrhage and other pathologies.²

It has been shown that the integration of e-ASPECTS into mobile stroke units can help with triage decisions related to selecting the appropriate hospital to send stroke patients to, such as those with a comprehensive stroke unit or a primary stroke unit.³ e-ASPECTS may also play a role in aiding decision-making for patient selection conducted via telemedicine and in selecting patients for transfer to stroke centres that perform mechanical thrombectomy.¹¹

Who Might Benefit?

Approximately 62,000 Canadians experience a stroke each year, and approximately 13,000 die after having a stroke.¹² It is estimated that 405,000 Canadians are living with the effects of stroke¹² and this number is expected to increase to between 654,000 and 726,000 over the next 20 years.¹³

People over the age of 70 are the most likely to experience a stroke.¹⁴ However, according to a 2014 report, over the preceding decade, the number of strokes in people in their 50s and 60s increased by 24% and 13%, respectively.¹⁴ As well, stroke rates in younger people (between the ages of 24 and 64) are expected to double by 2030.¹⁴ Early treatment with thrombolytic drugs reduces the mortality and the morbidity of stroke, and more patients who receive early treatment are discharged home, rather than to a rehabilitation centre.^{15,16}

Availability in Canada

e-ASPECTS is not currently approved in Canada. It was granted the Conformité Européenne (CE) certification as a Class IIa medical device in 2015 by the European Union and is used in Europe and Brazil.¹⁷

Beyond Europe and Brazil, e-ASPECTS is installed for research purposes in Canada (Olivier Joly: personal communication, 2018 Jul 2).

“Since... e-ASPECTS is anticipated to speed up the diagnosis of acute ischemic stroke – allowing earlier thrombolytic treatment – it may change how quickly stroke is diagnosed and managed.”

What Does It Cost?

Brainomix sells e-ASPECTS as an annual licence subscription that allows the hospitals to process the scans of all stroke patients who are admitted (Olivier Joly: personal communication, 2018 Jul 2).

The cost of the device is not known and may vary depending on the setting in which it is used. In facilities with rapid network connections that do not require the installation of hardware, one installation can be accessed by several hospitals. In hospitals with less modern technological infrastructure, remote installation may not be feasible and the cost of the device may subsequently be higher.¹⁷

Current Practice

The 2015 Canadian Stroke Best Practice Recommendations note that brain imaging with non-contrast CT should be completed without delay for any patient with suspected stroke. To determine the eligibility for endovascular therapy, it is suggested that the initial brain CT should be assessed

using ASPECTS to identify patients with a score of six points or higher. Patients may be eligible for endovascular therapy within six to 12 hours of onset of symptoms and should ideally begin treatment within 60 minutes of CT imaging.¹⁸

The American Heart Association guidelines also recognizes ASPECTS as a key tool for the management of acute stroke and suggests mechanical thrombectomy for patients with a baseline ASPECTS score of 6 or more.⁶

Published Studies

Four clinical utility studies on e-ASPECTS have been published, including one randomized controlled trial,¹ one prospective cohort study,¹¹ and two retrospective cohort studies.^{2,19} Three of the studies compare e-ASPECTS with either expert-derived clinical scores using ASPECTS^{2,19} or expert opinion alone¹¹ to predict functional outcomes. Two of these studies examine the correlation of e-ASPECTS scores with clinical outcomes after thrombectomy¹¹

or thrombolysis.¹ As well, a feasibility study was published that examines the clinical integration and utility of e-ASPECTS into a mobile stroke unit³ (an ambulance equipped with portable imaging equipment).

Issues to Consider

A concern for any AI application used in health care is that the data informing algorithms is applicable to the population that the AI tool will be used in. This underscores the importance of using AI to augment, rather than replace, a physician's perspective. No information was found on how e-ASPECTS' predictions are made or on the demographic used to train the algorithm.

It is suggested that, to be consistent with evidence-based practices, issues concerning transparency should be addressed prior to the integration of machine learning tools into clinical practice. Transparency regarding how predictions are made is lacking because the technical logic and mechanisms can be difficult to understand. This is known

as the black-box paradox.²⁰ Consideration should be given to the appropriate use of AI in reading and interpreting medical images. This may include establishing standards for AI interoperability, testing algorithms, and addressing regulatory, legal, and ethical issues.²¹

According to the manufacturer, the e-ASPECTS program was developed and tested using a largely Caucasian, adult population. While ethnic differences in brain anatomy and CT-based ischemic changes are reported to be minor,²² the generalizability of the e-ASPECTS platform to other ethnic groups could be further validated (Olivier Joly: personal communication, 2018 Jul 2).

e-ASPECTS can only be used in facilities that have access to CT. Canada has approximately 561 CT units²³ but 89% of rural hospitals do not have access,²⁴ indicating potential inequity in access to stroke care in urban and rural settings.

Related Developments

In addition to e-ASPECTS, Brainomix has developed a platform called e-CTA²⁵ to analyze CT angiography of stroke patients and has partnered with Olea Medical to introduce the e-STROKE SUITE²⁶ in Europe and Brazil. The e-STROKE SUITE utilizes information from other acute imaging modalities for stroke, including perfusion imaging. (Olivier Joly: personal communication, 2018 Jul 2).

Numerous AI-enhanced support systems have been developed to detect the presence of stroke from brain images. In 2018, the FDA approved a similar decision support software, developed by Viz.ai, that incorporates AI and analyzes CT images of the brain.²⁷ The software sends a text notification to a patient's specialist to alert them if a suspected large vessel blockage has been identified.²⁷ There are a number of other AI-enhanced tools for stroke that use machine learning to automate segmentation to measure the volume of ischemic damage in brain CT to predict the outcome of stroke.^{28,29}

Looking Ahead

Since "time is brain"³⁰ and e-ASPECTS is anticipated to speed up the diagnosis of acute ischemic stroke — allowing earlier thrombolytic treatment — it may change how quickly stroke is diagnosed and managed. This software may be particularly useful to medical staff with limited experience in stroke imaging, such as family physicians and paramedics.²⁰

The window of time in which it is optimal to treat stroke patients with mechanical thrombectomy has recently expanded from six hours up to 24 hours in select patients.³¹ e-ASPECTS may play a role in helping to quickly identify patients for mechanical thrombectomy within the expanded time frame.

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