NICE advice

Artificial intelligence for analysing CT brain scans

Medtech innovation briefing
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Summary

- The **technology** described in this briefing is artificial intelligence (AI) software for CT brain scans. It is to assess CT images of people with suspected brain abnormalities.
- The **innovative aspects** are that the software automates aspects of detecting brain abnormalities and assists in clinical prioritisation of critical cases.
- The intended **place in therapy** would be to support radiologists in secondary care when they are reviewing CT brain scans of people with suspected brain abnormalities. The technology may be of most benefit when images are not first reviewed by specialist neuroradiologists.
- The **main points from the evidence** summarised in this briefing are from 11 studies. Seven validation studies, including 31,118 CT brain scans, showed the technology to be as effective at detecting intracranial haemorrhages as neuroradiologists. However, study conditions did not reflect clinical practice. Four real-world observational studies including 59,655 CT brain scans suggest the technology may perform well in clinical practice. However, 3 of the studies are reported as abstracts and limited in

methodological detail.

- **Key uncertainties** around the evidence or technology are that 6 of the studies in the briefing are abstracts and limited in methodological detail. The evidence base would benefit from well-controlled comparative studies with an appropriate follow-up time to capture patient outcome and time to treatment.
- The **cost** of AI software for CT brain scans is between £8,250 and £80,000 per licence fee every year. The cost of the technology depends on the size of the NHS trust and the number of analyses done. Pay per use is also available for 1 of the listed technologies and costs £45. The **resource impact** would be greater than standard care. However, this may be offset by faster diagnosis of time-sensitive cases, reducing complications related to delayed treatment.

The technology

Diagnostic artificial intelligence (AI) software has been developed to review and report abnormalities in CT brain scans. These AI packages have automated analysis of CT brain scans, including non-contrast CT (NCCT), CT angiography (CTA) and CT perfusion (CTP) imaging. In most cases, the software aids detection and prioritisation of critical cases, such as intracranial haemorrhage and large vessel occlusion in stroke.

The AI software packages in this briefing are designed to automatically detect and notify healthcare professionals of abnormalities after analysis of brain CT scans. The software is designed to integrate with all standard imaging systems. They have automated patient prioritisation and alert systems for critical cases. Some can populate radiology reports with preliminary findings. The technologies are for use in addition to standard care. Two packages assess CT images for abnormalities because of trauma, dementia and stroke. The remaining 5 identify large vessel occlusion or intracranial haemorrhage in stroke. The packages are:

- Aidoc: head (Aidoc). Programmes for detecting intracranial haemorrhage and hyperdensities after NCCT imaging and for large vessel occlusion after CTA imaging. The software also has automated patient prioritisation and a real-time alert system. It integrates into current imaging systems and results can be viewed as digital imaging and communication in medicine (DICOM) output images.
- e-CTA and e-ASPECTS (Brainomix). e-ASPECTS analyses NCCT scans for hypodensity and generates a probability map of regional ischaemic change, the

volume of this change, and an automated ASPECT score. e-CTA is designed to detect large vessel occlusion location and standardised assessments of collateral scores after CTA imaging. Both applications help identify people eligible for thrombectomy or thrombolysis. The software integrates with current imaging systems and results can be viewed as visual reports through DICOM output images, email notifications and a web browser.

- Icobrain (Icometrix). This quantifies and reports the volume of relevant brain structures related to dementia, stroke and traumatic brain injury. In traumatic brain injury the software quantifies: epidural, subdural and intraparenchymal lesions; midline shift; left, right lateral ventricles and fourth ventricle. In stroke, core and penumbra sections of the brain are assessed, and in dementia the whole brain volume and lateral ventricles. The software integrates with current imaging systems and results can be viewed as visual reports through DICOM output images, email notifications and a web browser.

- qER (Qure). qER detects and quantifies a range of brain abnormalities after NCCT imaging, and populates a radiology reporting template with preliminary findings, patient prioritisation and alert systems including mobile notifications. Brain pathologies identified by qER include intracerebral bleeds and their subtypes, infarcts, mass effect, midline shift and cranial fractures. It integrates with current imaging systems.

- Zebra triage (Zebra Medical Vision). This detects and annotates intracranial haemorrhage after NCCT imaging and automates patient prioritisation and a real-time alert system. It integrates with the current imaging worklist and viewer with an accompanying alert widget.

- DLCExpert (Mirada Medical) has not been included in this briefing because of differences in indication and patient population. This technology uses AI to help treatment planning for radiation therapy (including head and neck cancers). It uses deep learning algorithms for automated contouring of organs at risk and anatomical structures. The company claims the algorithms have been trained on clinical examples and validated against consensus guidelines, such as the European Society for Radiotherapy and Oncology head and neck guidelines (ESTRO) for delineation of organs at risk.

Innovations

The software packages use AI to automatically analyse CT brain scans for abnormalities,

alert radiologists to critical cases, and prioritise cases. Some software systems also report preliminary findings, and some assess brain structures or abnormalities. Companies claim these advances in technology will result in time-sensitive cases being reviewed more quickly, meaning faster treatment and improved patient outcomes. Companies also claim reporting preliminary findings reduces reading and dictation time for clinicians and prevents subtle abnormalities being missed.

Current care pathway

The diagnosis of a suspected brain abnormality is usually confirmed by a radiologist after a review of brain imaging techniques, usually CT scans. Results from CT brain scans are typically available in a few days to a week, depending on the urgency of the case. However, in emergency situations reports are usually available within 24 hours, and urgent cases are often reviewed within a couple of hours.

For people admitted with suspected stroke, NICE's guideline on stroke and transient ischaemic attack in over 16s: diagnosis and initial management recommends the prompt use of a validated screening tool, FAST, to assess people with sudden onset neurological symptoms. On admission the validated tool, ROSIER, is used to diagnose stroke or transient ischaemic attack. When transient ischaemic attack is suspected, people are given 300 mg aspirin and referred for specialist assessment. Brain imaging is not recommended. People admitted with suspected acute stroke are referred to a specialist stroke unit. An NCCT is recommended as soon as possible and within 24 hours. People with an increased risk should be scanned immediately. When acute ischaemic stroke is suspected and symptom onset is more than 6 hours before, CTA or CTP is done. Stroke cases are time-sensitive and treatment is needed as soon as possible. The treatment decision depends on the outcome of the imaging and the time since symptom onset. Ischaemic causes of stroke need immediate treatment with aspirin or anticoagulants; haemorrhagic causes of stroke need anticoagulation reversal. NICE's interventional procedures guidance for mechanical clot retrieval for treating acute ischaemic stroke recommends thrombectomy to treat ischaemic stroke for people who are eligible after CTA or CTP imaging. For people who need a thrombectomy, the procedure should be done before admission to a specialist stroke unit.

For the diagnosis of dementia, the NICE guideline on dementia: assessment, management and support for people living with dementia and their carers recommends initial cognitive and physical assessments, and taking blood and urine samples. A person is referred to the specialist dementia diagnostic service where validated criteria guide diagnosis. If

Alzheimer's disease is suspected but not confirmed, fluorodeoxyglucose positron emission tomography (FDG-PET) or cerebrospinal fluid testing is recommended to inform the diagnosis. People diagnosed are offered interventions to promote cognitive function.

Population, setting and intended user

This technology is for people with suspected brain abnormalities. Most of the technologies described in this briefing are for people with a suspected intracranial haemorrhage or acute ischaemic stroke. Some are also designed to detect abnormalities related to traumatic brain injury and dementia.

The technology is used by radiologists and neuroradiologists in imaging facilities in secondary and tertiary care settings as a decision support tool.

Costs

Technology costs

- Aidoc: head. The licence cost of the technology ranges from £25,000 to £60,000 per year depending on the volume of exams and different workflow requirements. The cost covers the software for intracranial hyperdensities and large vessel occlusion as well as all associated costs, for example, training and maintenance.
- e-ASPECTS and e-CTA. The licence cost of the technology is £30,000 per year excluding VAT for unlimited stroke patients admitted to comprehensive stroke centres. The cost is reduced to £10,000 per year for primary strokes centres doing thrombolysis only if purchased as part of a full stroke network licence.
- Icobrain lx. Pay-per-use models start at £45, with reductions for increased volumes. Subscription models range from £8,250 for small hospitals (including 300 analyses) to £66,000 for large hospitals (including 2,400 analyses and services).
- qER. The cost for the technology as it has been described is £25,000.
- Zebra triage. The technology licence costs between £40,000 and £80,000 depending on the size of the NHS trust. These costs cover an 'all-in-one' bundle, including 5 AI algorithms for detecting intracranial haemorrhage, pneumothorax, pleural effusion, vertebral fracture and screening for breast cancer.

Costs of standard care

According to the national tariff payment system 2019/2020, a routine CT scan for 1 area costs £69 without contrast. A CT scan of 1 area with imaging before and after contrast costs £90. This includes the cost of reporting. When another healthcare trust is needed to review the CT scan there is an additional cost of £20.

Resource consequences

These technologies would typically cost more than standard care but may result in cost savings related to reduced radiologist's time in reviewing and reporting CT brain scans. Prioritisation of critical cases may also reduce complications related to delayed treatment. Radiologists would need training to ensure appropriate use of the technology.

Regulatory information

Aidoc: head is a CE-marked class 1 medical device.

e-CTA is a CE-marked class 2a medical device.

Icobrain Ix is a CE-marked class 1 medical device.

qER is a CE-marked class 1 medical device.

Zebra triage is a CE-marked class 1 medical device.

These and related technologies are likely to become class 2 devices during the transition from the Medical Device Directive to the Medical Device Regulation from May 2020 onwards.

Equality considerations

NICE is committed to promoting equality, eliminating unlawful discrimination and fostering good relations between people with particular protected characteristics and others.

There are no equality issues related to the use of artificial intelligence (AI) software for the detection of CT brain scans.

Clinical and technical evidence

A literature search was carried out for this briefing in accordance with the interim process and methods statement. This briefing includes the most relevant or best available published evidence relating to the clinical effectiveness of the technology. Further information about how the evidence for this briefing was selected is available on request by contacting mibs@nice.org.uk.

Published evidence

Eleven studies are summarised in this briefing.

The briefing includes 7 validation studies, 3 observational studies and a before-and-after historic control study including a total of 90,773 CT brain scans.

The clinical evidence and its strengths and limitations is summarised in the overall assessment of the evidence.

Overall assessment of the evidence

Six of the studies are reported as abstracts and lack methodological detail. The other 5 studies are peer-reviewed publications. The 7 validation studies report outcome measures relevant for establishing the accuracy, sensitivity and specificity of the software. The remaining 4 studies explore the usefulness of the technology in the clinical setting, including outcome measures related to the potential clinical and systematic benefits of the technology. It is not always clear whether the technology described in the studies has been updated since publication and many of the named authors involved in the studies work for the company. This is likely to be related to involvement in the technology development.

The evidence base would benefit from randomised controlled trials assessing the effect of the technology on patient outcomes. This should include a follow-up period to capture any adverse events related to misdiagnosis, time to treatment and time saved per scan reported.

Aidoc: head

Four studies presented in this briefing from 3 abstracts and 1 validation study, including 64,990 non-contrast CT (NCCT) head scans.

Davis et al. (2019)

Study size, design and location

Before-and-after study of 51,793 head scans in the US. Investigating the effect of using Aidoc: head to assist decision making for detecting intracranial haemorrhage (ICH) in emergency department and inpatient head scans on patient length of stay and turnaround time.

Intervention and comparator(s)

Aidoc: head compared with standard reporting.

Key outcomes

Compared with standard reporting, the use of Aidoc: head significantly reduced the turnaround time from 53 minutes to 46 minutes for head CT cases that were positive for ICH ($p<0.001$). Inpatient length of stay for positive cases decreased from 9,950 minutes to 8,870 minutes, but this was not statistically significant ($p>0.05$). Emergency department length of stay reduced significantly from 567 minutes to 508 minutes ($p<0.001$).

Strengths and limitations

This large before-and-after multicentre study reports relevant systematic outcomes. The study is reported as an abstract and has limited methodological information, limiting the value of the findings. The abstract does not report patient demographic data, the selection method for the historic control, or the protocol used for reporting ICH. Results may not be generalisable to the NHS because the study was done outside the UK.

Desbuquoit et al. (2019)

Study size, design and location

Prospective study of 500 NCCT head scans in Belgium. Validating the detection of ICH using Aidoc: head software compared with expert neuroradiologist in a retrospective analysis.

Intervention and comparator(s)

Aidoc: head and expert neuroradiologist review.

Key outcomes

Overall the software had a sensitivity of 95% and specificity of 94.3% for identifying pathological hyperintensities. The false positives were mainly because of hardening artefacts, hyperdense dural sinuses, or falcine or basal ganglia calcifications. False negatives were because of small haemorrhages.

Strengths and limitations

The study is presented as an abstract with limited information. The retrospective nature of the analysis increases the risk of selection bias. Confidence intervals are not reported and there is limited detail about the methodology presented in the abstract.

Ojeda et al. (2019)

Study size, design and location

Retrospective analysis of 7,112 NCCT head scans in the US. Validating the detection of ICH using Aidoc: head software compared with expert radiologist and picture archiving and communication systems (PACS) query.

Intervention and comparator(s)

Aidoc: head and expert neuroradiologist reports and PACS queries.

Key outcomes

Overall accuracy of the software to detect ICH was 98%, sensitivity was 95% and specificity was 98%.

Strengths and limitations

The data used for validating the software were not included in the development of the technology. The research team were blinded to the ground truth labels. The retrospective nature of the analysis increases the risk of selection bias. Confidence intervals are not reported and there is limited detail about the methodology presented in the abstract.

Rao et al. (2019)

Study size, design and location

A retrospective analysis investigating the effect of using Aidoc: head as a peer review tool on diagnosis of ICHs on 5,585 NCCT head scans in the US.

Intervention and comparator(s)

Aidoc: head compared with original report.

Key outcomes

Of the 5,585 NCCT head scans reported to be negative for ICH by a radiologist, Aidoc: head identified 28 cases that were positive for ICH. After review by 3 neuroradiologists, 16 of the 28 cases were confirmed to have an ICH that had not been found on the original report.

Strengths and limitations

The large multicentre study addresses a relevant clinical and systematic outcome. The study is reported as an abstract and is limited in methodological detail. The retrospective nature of the study increases the risk of selection bias. The abstract does not state the level of experience of the radiologists responsible for the original reports. Results of statistical analyses were not reported. Results may not be generalisable to the NHS as the study was done outside the UK.

e-CTA

Four studies are presented in this briefing. Two are published and 2 are abstracts, with a total of 2,519 patients. Only the most relevant studies have been presented. The evidence base for e-ASPECTS consists of a further 10 studies; 4 validation studies (Herweh et al. 2016; Nagel et al. 2017; Goebel et al. 2018; Sundaram et al. 2019), and 5 observational studies investigating the relationship between e-ASPECT score, clinical outcome, imaging measures and clinician decision making (Goberina et al. 2018; Nagel et al. 2019; Pfaff et al. 2017; Olive-Gadea et al. 2018; Grunwald et al. 2016).

Gunda et al. (2019)

Study size, design and location

A retrospective comparator study in Budapest assessing the impact of e-CTA and e-ASPECTs in supporting clinical decisions in 797 patients compared with standard care.

Intervention and comparator(s)

e-CTA and e-ASPECTS compared with standard care.

Key outcomes

After implementation of e-CTA and e-ASPECTS the number of patients having thrombolysis increased from 11.5% to 18.1% and the number of patients referred for thrombectomy increased (11 to 19). Mean time to treatment decreased from 44 minutes to 41 minutes for thrombolysis and from 174 minutes to 145 minutes for mechanical thrombectomy.

Strengths and limitations

The study assesses the impact of the technology on clinically and systematically relevant outcome measures. Using real-world data allows generalisability of findings, but generalisability should be addressed with caution because of differences between healthcare systems. The study data were presented in an abstract with limited information. The protocol used for imaging analysis during the 2017 standard care period is not outlined.

Nagel et al. (2018)

Study size, design and location

An observational study investigating clinical utility of e-ASPECTS software by analysing the NCCT scans of 1,480 patients with anterior circulation of ischaemic stroke in China.

Intervention and comparator(s)

e-ASPECTS and no comparator.

Key outcomes

Decreasing e-ASPECTS scores were significantly correlated with baseline NIHSS scores (r=-0.31; p>0.0001). Univariate analysis found lower e-ASPECT scores (per 1-point decrease) were significantly associated with worse 90-day clinical outcome; death or disability (modified Rankin score 2 to 6; odds ratio [OR] 0.81; 95% confidence interval [CI] 0.77 to 0.86), death or disability (modified Rankin score 3 to 6; OR 0.89; 95% CI 0.83 to 0.95), and death (OR 0.86; 95% CI 0.79 to 0.95).

Strengths and limitations

The large multicentre study used relevant measures of clinical outcome to show the relevance of the e-ASPECT score. Selection criteria and methodology were clearly outlined. Appropriate statistics were applied to investigate the relationship between e-ASPECT scores and clinical measures. Sensitivity analyses were reported to show robustness of findings. The retrospective nature of the study limits its value for interpretation of the real-time use of the technology. The study does not report the systematic benefits of the technology. The first author has received expenses and consultancy fees from the company. Results may not be generalisable to the NHS because the study was done outside the UK.

Grundwald et al. (2019)

Study size, design and location

Study validating the measure of CT angiography (CTA) collateral score using e-CTA

software compared with 3 independent radiologists in 98 patients eligible for mechanical thrombectomy in the UK.

Intervention and comparator(s)

e-CTA (Brainomix) and 3 neuroradiologists.

Key outcomes

Automated e-CTA score agreed with the consensus score in 90% of cases. The remaining 10% were 1 point off the consensus score (intraclass correlation coefficient 0.93, 0.90 to 0.95). Sensitivity and specificity for identifying favourable collateral flow were reported as 0.99 (0.93 to 1.00) and 0.94 (0.70 to 1.00), respectively. Automated e-CTA score correlated positively with Alberta Stroke programme early CT score (spearman correlation 0.46, p=0.0001).

Strengths and limitations

The study compared the automated e-CTA score with the scores of 3 blinded experienced neuroradiologists and with a consensus score from the experienced neuroradiologists after unblinding. The study uses appropriate bootstrapping for statistical analysis of imaging data. The combined scoring of the 3 neuroradiologists does not reflect real-world practice. Patient demographic data and clinical outcomes were not reported. Authors involved in the development of this publication work for the company.

Seker et al. (2019)

Study size, design and location

Study evaluating the detection of large vessel occlusion in 144 acute ischaemic stroke patients using e-CTA in Germany.

Intervention and comparator(s)

e-CTA compared with 2 blinded expert neuroradiologists and with a non-blinded experienced interventional neuroradiologist with unrestricted clinical and imaging data access.

Key outcomes

Compared with expert radiologist analysis, the accuracy of e-CTA to detect any occlusion was 0.88 (0.81 to 0.92), with a sensitivity of 0.79 (0.68 to 0.87) and specificity of 0.97 (0.91 to 1.00). Accuracy to detect proximal occlusions was 0.90 (0.84 to 0.94), with a sensitivity of 0.91 (0.79 to 0.98) and specificity of 0.90 (0.83 to 0.95). Scores were similar to the blinded neuroradiologist resident, and the blinded neuroradiologist scores matched the experienced neuroradiologist analysis.

Strengths and limitations

The study is presented as an abstract with limited information. It compared the technology with blinded specialists as well as non-blinded specialists. Accuracy, sensitivity and specificity were reported for both blinded specialist and the technology. No statistical analyses were performed to compare the differences between blinded specialists, the technology and the control. Time taken for algorithm to run and specialists to score were not reported. Authors involved in the development of this publication work for the company.

Icobrain

One study presented in this briefing, including 252 patients.

Jain et al. (2019)

Study size, design and location

A study evaluating the icobrain software in the quantification of intracranial lesion volume, midline shift and cistern segmentation compared with expert reference in 252 CT brain scans in Belgium.

Intervention and comparator(s)

Icobrain compared with expert segmentation.

Key outcomes

Median volume difference between expert assessment and icobrain were 0.07 ml for acute

intracranial lesions (n=144) and -0.01 ml for cistern segmentation (n=38). Correlation between expert assessments and icobrain was 0.91 for volume of acute intracranial lesion and 0.94 for volume of cisterns. Median precision and sensitivity of 0.75 and 0.75, respectively, for acute intracranial lesion. Precision and sensitivity were 0.72 and 0.69, respectively, for cistern segmentation. For midline shift, median shift difference was -0.22 mm with a correlation of 0.93 with expert measurement.

Strengths and limitations

The study outlines a detailed methodology describing training and validation. The data are multicentred, and varied protocols are used to address different injuries. The methodology states data for 5,000 patients were available and 252 patients included. The study does not state the selection criteria for the sample used. The training method describes a cascade approach which differs from other artificial intelligence systems but is considered appropriate for segmentation. The lead author works for the company.

Zebra

One study presented in this briefing from an abstract presented at a conference including retrospective analysis of 1,426 CT scans.

Bar et al. (2018)

Study size, design and location

A study describing the training of Zebra triage in 170 ICH positive and 102 ICH negative NCCT scans and detecting ICH in 1,426 expert-validated CT scans in the US.

Intervention and comparator(s)

Zebra triage compared with expert-validated annotation.

Key outcomes

Zebra triage had an area under the curve of 0.9481 in an enriched dataset (64% ICH positive scans) and 0.9487 in a randomly distributed datasets (16% ICH positive scans) in the accurate classification of ICH. Manual review of false positives showed

misclassification was most likely in cases of calcification.

Strengths and limitations

Information is limited because the publication is an abstract. The abstract describes the training of the technology and reports the area under the curve for detecting ICH across 2 datasets. It is unclear from the abstract whether the cases used for training were included in the test datasets. The abstract suggests further learning would improve performance; this indicates the technology used in the study may be different from the current version. Authors involved in the development of this publication work for the company.

qER

One study presented in this briefing including retrospective analysis of 21,586 CT scans.

Chilamkurthy et al. (2018)

Study size, design and location

A training and validation study for the detection of critical findings in a head CT scan using a retrospectively collected dataset of 313,318 head CT scans in India.

Intervention and comparator(s)

qER compared with the gold standard from the clinical report and the consensus of 3 independent radiologists.

Key outcomes

The technology was validated against 2 datasets, 1 of 21,095 (Qure25k) CT scans and another of 491 (CQ500) CT scans. At a high sensitivity operating point, sensitivities of the algorithm for ICH, calvarial fracture and midline shift in the Qure25k dataset were 0.90 (95% CI 0.89 to 0.91), 0.90 (95% CI 0.88 to 0.91) and 0.91 (95% CI 0.89 to 0.93), respectively, and specificities were 0.73 (95% CI 0.72 to 0.73), 0.77 (95% CI 0.77 to 0.78) and 0.84 (95% CI 0.83 to 0.84), respectively. For the CQ500 dataset, the sensitivities of the algorithm for ICH, calvarial fracture and midline shift at a high sensitivity operating

point were 0.94 (95% CI 0.90 to 0.97), 0.95 (95% CI 0.83 to 0.99) and 0.94 (95% CI 0.85 to 0.98), respectively, and specificities of 0.71 (95% CI 0.65 to 0.76), 0.86 (95% CI 0.82 to 0.89) and 0.89 (95% CI 0.86 to 0.92), respectively.

Strengths and limitations

This is a large and well-designed validation study. The training and methodology are well detailed. Scans used to train the software were not included in the datasets used for validating the software. Scans included in the Qure25k dataset were randomly allocated. The CQ500 dataset was not randomly allocated and could be subject to selection bias. Algorithm run time was not reported. Authors involved in the development of this publication work for the company.

Sustainability

The companies did not make any relevant claims about the sustainability aspects of these technologies.

Recent and ongoing studies

- AI ENRICH - AI detection of ICH. ClinicalTrials.gov identifier: NCT03865979. Status: recruiting. Indication: stroke. Devices: Vis RECRUIT. Expected completion date: March 2020. US.
- Endovascular treatment with stent-retriever and/or thromboaspiration vs. best medical therapy in acute ischemic stroke (RESILIENT). ClinicalTrials.gov identifier: NCT02216643. Status: completed. Indication: stroke. Devices: e-ASPECTS, Brainomix. Last updated: January 2020. Brazil.

Expert comments

Comments on this technology were invited from clinical experts working in the field and relevant patient organisations. The comments received are individual opinions and do not represent NICE's view.

Five experts contributed to the development of this briefing. Four were familiar with the technology and 3 had experience of using 1 or more of the technologies. One was not

familiar and had no previous experience.

Level of innovation

Four experts believed the technology was a novel or innovative concept for assisting neuroradiologists. One believed the technology was not a novel concept and replicated review by a radiologist. Three experts were not aware of any competing technologies. Two commented that there is a lot of commercial interest in the field because of the modest entry costs.

Potential patient impact

All experts believed the technology could improve the speed of diagnosis and the service for people that need urgent diagnosis and treatment. One believed the technology would be most beneficial to patients eligible for thrombectomy and could reduce patient transfer time. Two believed the technology could result in fewer errors in CT brain scan reporting. One believed the technology would be most beneficial to patients during times when expert neuroradiology skills were lacking. One believed the technology resulted in a faster diagnosis, meaning downstream savings, but only if the diagnostic accuracy better than current care.

Potential system impact

All experts felt the technology would benefit from more evidence to show safety. All experts recognised the potential systematic benefits of the technology, including improved triage of patients and faster treatment, a reduction in reviewers' time needed per scan and a more standardised diagnosis. Two felt IT adjustment would be needed and 1 did not. Experts' opinions about the cost of adopting the technology were mixed: 2 felt the technology would cost more than standard care and 2 believed the technology would be cost saving because of reduced resource use and reduced costs associated with long-term disability. One said the technology could increase time and costs because of careful review by radiologists to ensure accuracy, as well as legal questions relating to access to NHS databases.

General comments

All experts believe the technology would be used alongside standard care. Two experts that have used the technology describe it as user friendly. One added an additional comment acknowledging the black box nature of the technology. Two said a potential barrier to adoption might be the cost. One felt the compatibility with the varied hardware and software used by radiologists in the NHS might affect adoption. One believed more safety data would help, 1 believed evidence to show patient and systematic benefit would aid adoption. One commented that the technology might raise questions about the legalities of whether the company or the clinician is responsible for the correct diagnosis.

Expert commentators

The following clinicians contributed to this briefing:

- Dr Sotirios Bisdas, consultant neuroradiologist, associate professor of neuroradiology, professor of radiology, University College London Hospitals NHS Trust. Dr Bisdas is on the scientific advisory board of Image Analysis Group, London and Voxel, Warsaw, as well as a member of an artificial intelligence working group at UCLH and has consulted for companies producing similar technologies.
- Professor Nigel Hoggard, professor of neuroradiology, University of Sheffield. Declared no interests.
- Dr Bhupinder Sharma, consultant radiologist, The Royal Marsden NHS Trust. Declared no interests.
- Dr Nader Khandanpour, consultant neuroradiologist, St George's University Hospitals NHS Foundation Trust. Declared no interests.
- Dr Gary Ford, consultant stroke physician and professor in stroke medicine, Oxford University Hospitals NHS foundation trust and Oxford Academic Health Science Network. Dr Ford has previously worked on an advisory board for companies that develop thrombectomy devices, Medtronic and Stryker. Dr Ford received an educational grant for implementing mechanical thrombectomy.

Development of this briefing

This briefing was developed by NICE. The interim process and methods statement sets out the process NICE uses to select topics, and how the briefings are developed, quality-assured and approved for publication.

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