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Australia and New Zealand Horizon Scanning Network

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Perfusion CT scanning to evaluate cerebral perfusion in patients presenting with acute ischaemic stroke symptoms.

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PRIORITISING SUMMARY

REGISTER ID: **000112**

NAME OF TECHNOLOGY: **PERFUSION CT SCANNING**

PURPOSE AND TARGET GROUP: **EVALUATE CEREBRAL PERFUSION IN PATIENTS PRESENTING WITH ACUTE ISCHAEMIC STROKE SYMPTOMS**

STAGE OF DEVELOPMENT (IN AUSTRALIA):

☐	Yet to emerge	☒	Established
☐	Experimental	☐	Established *but* changed indication or modification of technique
☐	Investigational	☐	Should be taken out of use
☐	Nearly established		

AUSTRALIAN THERAPEUTIC GOODS ADMINISTRATION APPROVAL

☐	Yes	ARTG number	
☐	No	☒	Not applicable

INTERNATIONAL UTILISATION:

COUNTRY	LEVEL OF USE		
	Trials Underway or Completed	Limited Use	Widely Diffused
United States	✓		
Switzerland	✓		

IMPACT SUMMARY:

Standard computerised tomography (CT) scanners may be utilised to perform perfusion CT (PCT) scans for the investigation of cerebral perfusion. PCT images are analysed with the aid of specific software (CT Perfusion) and hardware (Advantage Workstation), both of which are supplied by GE Medical Systems. CT perfusion would therefore be available in private and public hospitals with access to this equipment. PCT scans are a rapid and accurate way to measure cerebral blood flow and cerebral blood volume in patients with symptoms of a stroke.

BACKGROUND

Cerebral perfusion imaging in stroke patients allows the assessment of the severity and extent of brain tissue damage, and may be useful in determining whether thrombolytic therapy may be of benefit to patients. PCT may identify those patients with potentially salvageable tissue that is at risk of infarction (the ischemic penumbra) from those patients with extensive infarct. Patients with irreversibly damaged tissue will not benefit from reperfusion and may be at risk from haemorrhage if thrombolytic agents are administered (Hoeffner et al 2004).

Other applications of the PCT technique include measuring collateral blood flow and cerebrovascular reserve in patients undertaking temporary balloon occlusion, identifying

patients who experience vasospasm following subarachnoid haemorrhage and the ability to measure the permeability surface product area in patients with neoplasms.

PCT scans may be performed on standard spiral CT scanners and involve the monitoring of the passage of a bolus of iodinated contrast agent through the cerebral vasculature. Previous PCT methods have utilised the rapid injection of contrast agents (10-20 mL/second through an arm vein), which requires a large 14-gauge catheter. This method is considered unsuitable for many stroke patients who tend to be elderly with small fragile veins. A new PCT technique has been developed which allows the slower administration of contrast agent (4 mL/sec and as low as 1.5 mL/sec). This method is based on the principle of cerebral haemo-dynamics and the mathematical operation called deconvolution.

The perfusion procedure begins with first obtaining unenhanced CT images of the whole brain. After administration of the contrast agent, a continuous scan is performed for a duration of 50 seconds. PCT images are then analysed on the Advantage Workstation using the CT-Perfusion software. The software produces colour coded maps of cerebral blood flow (CBF), cerebral blood volume (CBV) and mean transit time of the blood (MTT). The central volume principle states that CBF= CBV/MTT. It is hypothesised that tissue *at risk of infarction* will have a decreased CBF, normal or elevated CBV and an elevated MTT, whereas *infarcted tissue* will have a decreased CBF and CBV with an elevated MTT. (Eastwood et al 2002; Hoeffner et al 2004).

CLINICAL NEED AND BURDEN OF DISEASE

In Australia, cerebrovascular disease (stroke) accounted for 4,969 male and 7,564 female deaths, equating to 7.2% and 11.7% of all male and female deaths, respectively, in the year 2002 (AIHW 2004). The total number of public hospital separations in Australia for cerebrovascular disease was 40,251 during the year 2001-02 (AR-DRG numbers I60-I69).

DIFFUSION

Perfusion CT has not widely diffused into the Australian health system, unlike the United Sates where PCT is in widespread use. Only a few major public hospitals in Australia, such as The Royal Perth Hospital and the Royal North Shore Hospital in Sydney, utilise the PCT technique (personal communication GE Medical Systems, Australia).

COMPARATORS

Current scanning methods used to measure cerebral perfusion include magnetic resonance (MR) perfusion, positron emission tomography (PET), single photon emission computed tomography (SPECT) or xenon computed tomography (CT). However, these specialist pieces of equipment, are expensive, demanding on the patient and may not be widely available in Australian hospitals. Conventional unenhanced head CT, which may help excluded intracranial haemorrhage and detect signs of brain ischemia, is the primary modality used to evaluate patients presenting with stroke symptoms (Hoeffner et al 2004).

EFFECTIVENESS AND SAFETY

The prospective study by Wintermark et al (2002) (Diagnostic level of evidence 2) reported on 22 patients admitted to the emergency department with symptoms of stroke, confirmed by a standard CT scan on admission and a delayed magnetic resonance (MRI) scan, the reference standard, performed a median of 3-days after stroke. Twenty-two patients underwent PCT and on the basis of these results, 8/22 (36%) patients were treated with thrombolytic agents. None of these patients suffered complications such as haemorrhage as a result of this treatment. In eight patients with arterial recanalisation, the size of the cerebral infarct on the MRI scan was larger or equal to the infarct on the PCT. However, the MRI scan for the size of ischemic lesion was smaller or equal to that of the PCT. The observed improvement in the National

Institute of Health Stroke Scale (NIHSS) correlated with the potential recuperation ratio (penumbra size/ penumbra size + infarct size) (r= 0.833). In the 14 patients with persistent arterial occlusion, the infarct size on the MRI correlated with the ischemic lesion size on the PCT (r=0.958). These findings conclude that PCT allows the accurate prediction of infarct size and the evaluation of clinical prognosis for stroke patients and may be a useful tool in the early management of these patients.

A similar level 2 study by Eastwood et al (2002) reported results of 12 patients with suspected acute stroke symptoms compared to 12 control patients without symptoms of acute stroke, but other symptoms of disturbed vasculature. Cerebral blood flow was significantly decreased (50%, p= 0.001) in the acute stroke patients compared to controls, as was the cerebral blood volume (decrease of 26%, p = 0.03). The mean transit time was markedly elevated (111%, p= 0.004).

COST IMPACT

PCT scans may be conducted on a standard spiral CT scanner after the injection of a contrast agent. Images are downloaded to an imaging workstation (Advantage Windows Workstation, GE Medical Systems) installed with CT perfusion analysis software (CT-Perfusion, GE Medical Systems). Costing of the software package and hardware is approximately A$95,000. Conventional CT scanners currently installed in Australian hospitals are able to download images in the Dicom format, which is suitable for use with this software.

ETHICAL, CULTURAL OR RELIGIOUS CONSIDERATIONS

No issues were identified/raised in the sources examined.

CONCLUSION

There is limited level 2 (diagnostic levels of evidence) with small patient numbers in these studies.

HEALTHPACT ACTION:

This technology is an established technique in Australia, being conducted under ‘CT with contrast’ item number. Therefore it is recommended that this technology be archived.

SOURCES OF FURTHER INFORMATION:

Australia Institute of Health and Welfare 2004. Australia’s health 2004. Canberra: AIHW.

Eastwood, J. D., Lev, M. H. et al (2002). 'CT perfusion scanning with deconvolution analysis: pilot study in patients with acute middle cerebral artery stroke', *Radiology*, 222 (1), 227-236.

Hoeffner, E. G., Case, I. et al (2004). 'Cerebral perfusion CT: technique and clinical applications', *Radiology*, 231 (3), 632-644.

Jain, R., Hoeffner, E. G. et al (2004). 'Carotid perfusion CT with balloon occlusion and acetazolamide challenge test: feasibility', *Radiology*, 231 (3), 906-913.

Wintermark, M., Reichhart, M. et al (2002). 'Prognostic accuracy of cerebral blood flow measurement by perfusion computed tomography, at the time of emergency room admission, in acute stroke patients', *Ann Neurol*, 51 (4), 417-432.

Wintermark, M., van Melle, G. et al (2004). 'Admission perfusion CT: prognostic value in patients with severe head trauma', *Radiology*, 232 (1), 211-220.

SEARCH CRITERIA TO BE USED:

*Balloon Occlusion
Carotid Artery, Internal/*radiography

Cerebrovascular Accident/radiography
*Cerebrovascular Circulation
*Tomography, X-Ray Computed
Brain Ischemia/radiography
Brain Neoplasms/blood supply/physiopathology/radiography
Cerebrovascular Disorders/*radiography
Image Processing, Computer-Assisted
Vasospasm, Intracranial/radiography
Angiography/methods
Brain/*blood supply/*radiography
Carotid Stenosis/physiopathology/radiography