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Horizon Scanning Technology Prioritising Summary

Magnetic resonance imaging (MRI) for the diagnosis of pulmonary embolism

May 2008

AHTA

Adelaide Health Technology Assessment

ISBN
Publications Approval Number:

Electronic copies can be obtained from http://www.horizonscanning.gov.au

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The production of this Horizon scanning prioritising summary was overseen by the Health Policy Advisory Committee on Technology (HealthPACT), a sub-committee of the Medical Services Advisory Committee (MSAC). HealthPACT comprises representatives from departments in all states and territories, the Australia and New Zealand governments; and ASERNIP-S. The Australian Health Ministers' Advisory Council (AHMAC) supports HealthPACT through funding.

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PRIORITISING SUMMARY

REGISTER ID: **000357**

NAME OF TECHNOLOGY: **MAGNETIC RESONANCE IMAGING (MRI) FOR THE DIAGNOSIS OF PULMONARY EMBOLISM**

PURPOSE AND TARGET GROUP: **PATIENTS PRESENTING WITH SUSPECTED PULMONARY EMBOLISM**

STAGE OF DEVELOPMENT (IN AUSTRALIA):

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

AUSTRALIAN THERAPEUTIC GOODS ADMINISTRATION APPROVAL

- ☒ Yes — Many MRI scanners are approved by the TGA.
- ☐ No
- ☐ Not applicable

INTERNATIONAL UTILISATION:

COUNTRY	LEVEL OF USE		
	Trials Underway or Completed	Limited Use	Widely Diffused
France	✓		
USA	✓		
Germany	✓		
Canada	✓		

IMPACT SUMMARY:

Rapid diagnosis of pulmonary embolism (PE) is critical as this condition, if left untreated, is often fatal. MRI based diagnosis is being investigated as a diagnostic modality for PE. Compared to standard PE diagnostic techniques, such as CT and fluoroscopy, MRI has the advantage of not utilising ionising radiation, and uses safer or no contrast agents. **BACKGROUND**

Pulmonary embolism if properly diagnosed is readily treated with anti-coagulants, yet despite this it remains one of the most common preventable causes of death in hospital inpatients (Lee et al 2005). This is mainly due to the inadequate diagnosis of PE patients, which to be effective, needs to be rapid and accurate. Thrombi are produced in the extremities (leg or pelvis) and can become lodged in the pulmonary

blood vessels causing permanent lung damage, reduced blood oxygen levels and, in severe cases, sudden death. Current diagnosis of PE involves clinical observation and laboratory testing. Standard diagnostic work-ups include quantitative D-dimer assays, Wells score, and imaging (either Ventilation and perfusion (V/Q) scintigraphy or CT based imaging). The disadvantage of these imaging methods is the need for either radioactive tracers or ionising radiation. Several MRI based techniques are becoming more widely available including gadolinium-enhanced magnetic resonance angiography (Gd-MRA), real-time MR (rt-MR), and MR perfusion. All are based on variations in MRI with Gd-MRA and MR perfusion requiring both breath holding and contrast agents where rt-MR requires neither. If shown to be effective MRI based diagnosis of PE may be a safer diagnostic modality than the current standard techniques.

CLINICAL NEED AND BURDEN OF DISEASE

Pulmonary embolism occurs at a rate of approximately 1 to 2 events per 1000 general populace per year (Lee et al 2005, McRae & Eikelboom 2007). One third of PE events result in a symptomatic PE and of these there is a mortality rate of 30 per cent if left untreated (McRae & Eikelboom 2007). PE was responsible for 304 (0.2 % of all deaths) deaths in Australia in 2006 (ABS 2006). From 1994 to 2002 there were 16 deaths directly attributable to PE in pregnant women and in women eight months post natal. Safety of diagnostic methods is of very high priority in these women.

DIFFUSION

No evidence was found to support the diffusion of this technology into the Australian health care system.

COMPARATORS

Before imaging is performed on a suspected PE patient it is standard practice to administer a D-Dimer test and score the subject on the Wells criteria, with a score of <4.5 making PE unlikely and ≥ 4.5 making PE a likely diagnosis (Table 1). Subject to the results of these tests imaging may be required to investigate further.

Table 1 Wells criteria for PE diagnosis

Clinical sign	Points for positive sign
Clinical signs and symptoms of deep vein thrombosis (minimum of leg swelling and pain with palpation of the deep veins)	3.0
Pulmonary embolism as or more likely than an alternative diagnosis	3.0
Heart rate greater than 100/min	1.5
Immobilization or surgery in the previous 4 weeks	1.5
Previous deep vein thrombosis or pulmonary embolism	1.5
Hemoptysis	1.0
Malignancy (on treatment in the last 6 months or palliative)	1.0

Adapted from (Anderson et al 2007)

Ventilation and perfusion (V/Q) scanning was the main diagnostic imaging tool used for investigation of PE for many years. This involves the simultaneous administration of two radioactive tracers, one in gaseous form (ventilation) and one intravenously (perfusion). A scanner then images the lungs and vasculature. Regions where there are discrepant signals from the tracers, that is, where the ventilation image is normal and there is a defect visible on the perfusion image, indicate a site of potential PE. V/Q scans allow several designations to be assigned to the patient regarding their probability of having a PE. In a typical population of patients suspected of having PE with a prevalence of 30 per cent, a high V/Q probability scan has a PPV of 85 to 90 per cent. However, a high probability scan is not common with most patients categorised as low or intermediate probability. Low and intermediate probability categories have an incidence of 10 to 40 per cent and therefore the diagnostic uncertainty makes V/Q scanning a less than optimal testing method (Anderson et al 2007).

Computed tomography pulmonary angiography (CTPA) is emerging as the imaging method of choice for PE diagnosis. CTPA involves the intravenous administration of a radio contrast which is then visualised with a CT scanner. For optimal results a multidetector computed tomography (MDCT) scanner is needed (Anderson et al 2007). A RCT comparing V/Q scanning to CTPA found that both tests were equally effective at ruling out PE with one per cent or less of excluded patients showing further signs of venous thromboembolism. Although CTPA diagnosed more PE than V/Q scanning, this may be an overdiagnosis leading to the excessive administration of anti-coagulant therapy (Anderson et al 2007).

SAFETY AND EFFECTIVENESS ISSUES

Research into diagnosis of PE using MRI has focussed on which MRI modality to use, or which combination of MRI modalities to use. The effectiveness of MRI based methods is compared to standard techniques.

Gd-MRA was compared to CTPA, V/Q scanning and catheter angiography in a population of 48 suspected PE patients. The population consisted of 48 subjects with a mean age of 55 years. All patients underwent Gd-MRA and subsets were examined with the other diagnostic methods. V/Q scanning was performed on 45 patients, CTPA on 34 patients, and catheter angiography on 15 patients. Overall Gd-MRA sensitivity was 82 per cent (detected 9/11 patients diagnosed as having PE by other methods) and specificity was 100 per cent (37/37 PE negative patients correctly identified). Patients were followed up for 6-12 months and the diagnoses were found to be satisfactory with no changes required. The authors conclude that Gd-MRI is useful for patients where iodine contrast materials are contraindicated or radiation exposure risks are undesirable, for example in young populations with low probabilities of PE (Pleszewski et al 2006) (Level II diagnostic evidence).

A second study investigating Gd-MRA compared it to a multi-slice CT strategy in a population of 89 suspected PE patients. The CT strategy protocol included CT scanning, D-dimer testing, ultrasound leg compression, and pulmonary angiography. Of the 89 patients tested, 63 were confirmed to have PE. CT scanning detected all except one of these PE cases. Two independent teams reviewed the Gd-MRA results and gave diagnoses solely on this information. In contrast to the Pleszewski study, the sensitivity of Gd-MRA was low to moderate (71 % and 31% by respective review teams A and B). Specificity was higher with both review teams (A = 92% and B= 85%). The inter-observer agreement was low (kappa = 0.16) (Blum et al 2005) (Level II diagnostic evidence).

A study of 62 patients with suspected PE were investigated using three MRI based diagnostic techniques (rt-MRI, MR angiography, and MR perfusion imaging), and the reference standard, 16-MDCT. MDCT diagnosed 19/62(30.6%) patients with PE. Additionally a consensus of the three MRI diagnoses was compared to the MDCT result. At the patient level, the sensitivities of rt-MRI, MR angiography, MR perfusion imaging, and MRI consensus were 85, 77, 100, and 100 per cent, respectively and the specificities were 98, 100, 91, and 93 per cent, respectively. At a per-embolus level the sensitivities of rt-MRI and MR angiography decreased, indicating these MRI techniques did not detect all the emboli seen by the MDCT scan. MR perfusion showed 100 per cent sensitivity at the per-embolus level. Additionally, causes other than PE were investigated with both MDCT and MRI. MRI detected eight of the nine patients diagnosed with non-PE thoracic indications by MDCT. All MRI scans were performed with the same scanner (1.5-T MRI scanner (Magnetom Sonata, Siemens) (Kluge et al 2006) (Level III-2 screening evidence).

From the limited studies available MRI based PE diagnosis seems to be effective compared to the current standard techniques. More recent studies use faster MRI acquisition times, which may explain the poor results achieved in the Blum study. Further large scale studies are needed to assess the full potential of MRI diagnosis of PE. The current research shows that for some patients, in which standard diagnosis techniques are contraindicated, MRI based PE diagnosis may be the technique of choice.

COST IMPACT

A Medicare benefit schedule item number exists for patients undergoing MRA with the condition that they have had an anaphylactic reaction to iodinated contrast agents. The item number for this procedure is 63401 and the fee is $403.20.

ETHICAL, CULTURAL OR RELIGIOUS CONSIDERATIONS

No issues were identified/raised in the sources examined.

OTHER ISSUES

No issues were identified/raised in the sources examined.

SUMMARY OF FINDINGS

MRI is not as sensitive or specific as current standard methods of PE diagnosis. Despite this MRI technology is advancing rapidly and MRI is approaching CT based accuracy. For patients at low probability of PE and also patients for whom radiation or contrast agent risks are not acceptable MRI provides an optional diagnostic method.

HEALTHPACT ACTION:

At the current time, MRI for the diagnosis of pulmonary embolism will not replace CT pulmonary angiography. However, the technology is rapidly developing, therefore HealthPACT have recommended that this technology be monitored in 24 months.

NUMBER OF INCLUDED STUDIES

Total number of studies	
Level III-2 screening evidence	3

REFERENCES:

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McRae, S. J. & Eikelboom, J. W. (2007). 'Simplifying the diagnosis of pulmonary embolism', *Med J Aust,* 187 (6), 325-326.

Pleszewski, B., Chartrand-Lefebvre, C. et al (2006). 'Gadolinium-enhanced pulmonary magnetic resonance angiography in the diagnosis of acute pulmonary embolism: a prospective study on 48 patients', *Clin Imaging,* 30 (3), 166-172.

SEARCH CRITERIA TO BE USED:

Lung/radiography
Magnetic Resonance Angiography/methods
Magnetic Resonance Imaging
Pulmonary Embolism/ diagnosis/radiography
Sensitivity and Specificity
Tomography, X-Ray Computed