Australian Government

Department of Health and Ageing

Australia and New Zealand Horizon Scanning Network

ANZHSN

AN INITIATIVE OF THE NATIONAL, STATE AND TERRITORY GOVERNMENTS OF AUSTRALIA AND THE GOVERNMENT OF NEW ZEALAND

National Horizon Scanning Unit
Horizon scanning prioritising summary

Volume 12, Number 4:

Computed tomography coronary angiography for the detection of coronary artery disease.

March 2006

AHTA

Adelaide Health Technology Assessment

[add ISSN]
[add Publications Approval Number]

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

Enquiries about the content of this summary should be directed to:

HealthPACT Secretariat
Department of Health and Ageing
MDP 106
GPO Box 9848
Canberra ACT 2606
AUSTRALIA

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 health departments in all states and territories, the Australia and New Zealand governments; MSAC and ASERNIP-S. The Australian Health Ministers' Advisory Council (AHMAC) supports HealthPACT through funding.

This *Horizon scanning prioritising summary* was prepared by Linda Mundy, Janet Hiller and Tracy Merlin from the National Horizon Scanning Unit, Adelaide Health Technology Assessment, Department of Public Health, Mail Drop 511, University of Adelaide, South Australia, 5005.

PRIORITISING SUMMARY

REGISTER ID: **000184**

NAME OF TECHNOLOGY: **COMPUTED TOMOGRAPHY CORONARY ANGIOGRAPHY**

PURPOSE AND TARGET GROUP: **FOR THE DETECTION OF CORONARY ARTERY DISEASE**

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
- ☐ No
- ☐ Not applicable

ARTG number: Numerous numbers

INTERNATIONAL UTILISATION:

COUNTRY	LEVEL OF USE		
	Trials Underway or Completed	Limited Use	Widely Diffused
Australia		✓	
United States	✓	✓	
Germany	✓		
The Netherlands	✓		
Japan	✓		

IMPACT SUMMARY:

There are many computed tomography (CT) scanners registered by the TGA which would be capable of performing CT angiography (CTA), including units supplied by Toshiba Australia P/L, Imaxeon Pty Ltd, GE Medical Systems Australia Pty Ltd, Siemens Limited, Shimadzu Medical Systems Oceania Pty Ltd and Philips Electronics Australia Ltd. Many private imaging companies currently offer CTA, however this procedure is not routinely available in public hospitals. Multislice computed tomography (MSCT) has recently emerged as an alternative to invasive coronary angiography for the detection of obstructive coronary artery disease. Multislice CT is also known as multidetector CT, helical CT or spiral CT (Schussler et al 2005).

BACKGROUND

Coronary artery disease (CAD) is the most common form of heart disease in Australia and New Zealand and is generally caused by atherosclerosis or a build up of plaque in the arteries. CAD may cause angina, heart attack and can lead to heart failure. Angina is caused by the partial blockage of an artery by a plaque. Blood flow to the heart is still sufficient, however during times of physical or emotional stress or activity blood flow may be restricted resulting in temporary chest pain. A heart attack is the result of a complete blockage of the artery by a ruptured plaque, causing blood flow to the heart to cease and severe chest pain, collapse and sudden death (AIHW and NHF 2004; Ministry of Health 2004). A coronary angiogram can be used to visualise the severity and position of plaques or a narrowing of the arteries.

The use of CT for diagnostic cardiology in the past has been limited as a consequence of motion artefacts created by the constant motion of the heart, especially in patients with resting heart rates greater than 80 beats/min. Beta- blockers have been routinely administered intravenously to slow the heart rate to below 60 beats/min and in so doing reduce motion artefacts (Garcia 2005). However, recent improvements in spatial (allowing for improved imaging of smaller structures of the heart) and temporal (improved imaging of patients with faster heart rates) resolution, hardware and software now allow coronary imaging within a single breath-hold (Chow et al 2005).

MSCT scanners consist of a rapidly rotating X-ray source. Directly opposite the X-ray source is an array of X-ray detectors which rotate at the same rate as the X-ray source. Patients are placed on a table which moves through the rotating X-rays, producing a continuous spiral scan. As the patient moves through the gantry a series of axial slices are acquired and the heart is imaged throughout the cardiac cycle. Images of the heart during diastole (the stationary portion of the cardiac cycle) are then "stitched" together to give continuous data, a process called *retrospective gating*. Patients with atrial fibrillation or frequent atrial or ventricular ectopy are still prone to motion artefacts. By increasing the number of detector rows, the number of slices that can be acquired simultaneously increases, which shortens the scanning time and increases spatial resolution. Initial cardiac CT imaging was conducted with four-slice detector CT. Scanning times were reduced from 40 seconds down to 20 seconds with 16-slice detector CT and with the advent of 64-slice detector CT, scanning times have been reduced to a 10 second breath-hold (Chow et al 2005, Schussler et al 2005, Schussler & Grayburn 2005). CTA involves at least two scans, the first being a "scout" image without contrast media for localisation of the coronary arteries. Contrast media is then administered intravenously and the final images are acquired. Sublingual nitroglycerine (4mgs) may be given to patients to improve image quality by "plumping" up the arteries. Total image acquisition can be achieved in five minutes and the total time required in hospital is approximately one hour (Schussler et al 2005, Schussler & Grayburn 2005).

CTA requires high doses of ionising radiation, with an average dose of 8.1 mSieverts for patients weighing 75 kgs. This dose is approximately 2-3 times higher than the average radiation dose administered to patients during conventional coronary angiography. Although the risk associated with a dose of this size is minimal, it may raise concerns about repeated doses, or in children and women of child-bearing age. In addition, CTA image resolution may be compromised in obese patients. With obesity increasing in the population, this patient group may represent a high proportion of patients with potential cardiac disease in the near future (Garcia 2005). In addition, a greater volume of contrast media is required for CTA (150 mls) compared to conventional coronary angiography (approximately 20ml) (Schussler et al 2005).

In addition to providing information about plaque formation in coronary arteries, CT angiography may be used to image arterial and venous bypass grafts, peripheral arterial disease, coronary stents and to assess myocardial perfusion. Images can also be used to assess left ventricular ejection fraction, regional wall motion and left ventricular volumes (Chow et al 2005).

CLINICAL NEED AND BURDEN OF DISEASE

In Australia, the 2001 National Health Survey reported 1.9 per cent of individuals had some form of coronary heart disease, corresponding to 355,600 Australians affected. Approximately three-quarters of those surveyed reported having angina and one-third reported having experienced a heart attack. The age-standardised prevalence for males and females was 2.4 and 1.6 per cent, respectively. CAD rates increase rapidly with age from 4.0 percent in individuals 55-64 years to 8.2 per cent in the 65-74 year olds. The majority of patients with CAD were aged 65 years and over. In Australia during 2001-02 there was an estimated 48,700 CAD events. Of these events 22,400 were fatal with a case fatality rate of 46 per cent. The majority of the coronary deaths (86%) occurred outside hospital. In 2001-02 there were 159,572 hospitalisations for which CAD was the principle diagnosis (AIHW and NHF 2004).

During the period 2003-04, there was a total of 94,427 coronary angiography procedures performed in Australian hospitals (procedure numbers 38215-00, 38218-00, 38218-01, 38218-02). Of these procedures, the majority were performed on individuals aged 40 years and over (94.6%), with 66 and 34 per cent performed on males and females, respectively. Only one third of coronary angiographies were performed on the same day as admission (AIHW 2006).

During the period 2002-03, one in ten adults (10.4%) have been diagnosed with heart disease, with no significant difference in the rates of CAD between males (9.6%) and females (8.4%) in New Zealand. The prevalence of heart disease was highest in Māori, followed by individuals of European, Asian and Pacific ethnic descent, however these differences were not statistically significant. As in Australia, the prevalence of CAD increases with age, with the majority of individuals aged over 45 years (Ministry of Health 2004).

In New Zealand during the period 2002-03, there were a total of 10,063 coronary angiography procedures performed in public hospitals (ICD-10 block code 668). As in Australia, the majority of these procedures were performed on individuals aged 40 years and over (96.4%), with 65 and 35 per cent performed on males and females, respectively. Thirty-three per cent of coronary angiograms were performed as day procedures, with the remaining 67 per cent of procedures requiring a mean stay of 5.7 days in hospital (New Zealand Health Information Service).

DIFFUSION

In Australia, CTA is predominantly utilised in the private sector with limited use in public hospitals. Many radiologists operate within both the public and private health systems. The use of CTA is limited by the presence of 64-slice CT scanners and appropriate software. These are the scanners of choice for cardiac imaging due to their increased speed, spatial and temporal resolution. Medicare statistics reveal that there were 63,497 conventional angiographic procedures (MBS item numbers 38215-38246) and 38,818 CT spiral angiographic procedures (MBS item numbers 57350-57356) performed in an outpatient setting (Health Care Providers 2006). Of the CTA procedures, the majority were performed in New South Wales (37.8%) and Queensland (23.9%) which may be a reflection of population numbers or the capacity to perform the scans with the appropriate equipment.

COMPARATORS

The gold standard for the diagnosis of obstructive heart disease is coronary angiography. This procedure is invasive and involves the placement of a catheter into a blood vessel in the arm or groin. The catheter is then positioned either in the heart or the arteries supplying the heart and contrast media is injected, allowing visualisation of the vessels by X-ray (American Heart Association 2005). Although coronary angiography is considered safe, the invasive nature of the procedure means there are associated risks. In the United States coronary angiography has an adverse event rate of approximately two per cent including vascular complications (1.6%), arrhythmia (0.3%), stroke (0.1%), myocardial infarction (0.05%) and death (0.12%) (Chow et al 2005). Coronary angiography is often the diagnostic test choice for patients presenting with symptoms suggestive of CAD, however 20-27 per cent of diagnostic angiographies performed return a normal or minimal atherosclerosis result. If a blockage is noted during an invasive coronary angiogram, a percutaneous coronary intervention such as balloon angioplasty may be performed at the same time. A coronary angiography takes approximately an hour to perform but may require several hours of preparation beforehand and a recovery period afterwards, therefore an overnight stay in hospital may be required (Schussler et al 2005).

EFFECTIVENESS AND SAFETY ISSUES

Sensitivity, specificity, positive predictive values (probability of the test correctly identifying patients with the disease) (PPV) and negative predictive values (probability of the test correctly identifying patients without the disease) (NPV) data are presented in Table 1 for the four studies (level II Diagnostic evidence) which reported these values.

An early study by Maruyama et al (2004) reported on the diagnostic effectiveness of *8-slice CTA* compared to conventional angiography (CA) (level II Diagnostic evidence). Twenty-five consecutive patients underwent both procedures and no adverse events were reported. Conventional angiography visualised a total of 357 segments, of which 37 had significant stenoses or obstruction. Due to the presence of nine implanted coronary stents in nine segments, only 348 segments were investigated. Sixteen patients had more than one clinically significant stenotic lesion. Of the 348 segments visualised by CA, 258 (74.1%) were visualised by CTA with an average of 3.6 ± 1.9 segments per patient being “invisible”. The most frequent cause for invisibility of the segment was the presence of the adjacent structure (47%), followed by small vascular diameter (33%). Motion artefacts accounted for 16 per cent of invisible segments. CTA correctly identified the 16 patients with more than one clinically significant coronary lesion. Heart rate data were collected for some patients during the CTA procedure. Patients with a lower mean heart rate of ≤70 beats/min had a higher CTA/CA ratio of visible segments (79 ± 10%) than patients with a heart rate >70 beats/min (65 ± 13%).

Two studies reported on the use of *16-slice CTA* compared to CA (level II Diagnostic evidence) (Hoffman et al 2005, Cury et al 2005). The largest study by Hoffman et al (2005) reported on 103 consecutive patients. Conventional angiography identified 58/103 (56%) and CTA 55/103 (53.4%) patients with clinically significant stenosis (stenosis >50%). Of the patients identified by CTA, six were false positives and two were false negatives. CTA identified 1384 segments, an average of 13.4 ± 2.2 segments per patient. Of these 88/1384 (6.4%) were considered non-diagnostic quality due to motion artefacts (68%), extensive calcification (19%) and small vascular diameter (13%). Motion artefacts increased significantly with an increase in heart rate (heart rate 71-80 and >80 beats/min, $p<0.01$) when compared to heart rates ≤70 beats/min. Cury et al (2005) reported on 29 consecutive patients undergoing both CTA and CA. The mean degree of stenosis detected by CTA was 65 ± 26 per cent (range 19-100%) compared with 61 ± 30 percent (range 20-100%) for CA. There was a high correlation between degree of stenosis as measured by CTA and CA (r^2 =0.93).

Two studies reported on the use of *64-slice CTA* compared to CA (level II Diagnostic evidence) (Raff et al 2005, Mollet et al 2005). The largest study by Raff et al reported on 70 consecutive patients. CTA identified 1065 segments of which 935 (88%) could be analysed quantitatively or qualitatively. Of these 773/935 (83%) could be quantitatively measured by both CTA and CA. Stenoses were identified in 130/773 (17%) of these segments. The correlation coefficient between CTA and CA was 0.76 ($p<0.0001$). CTA remained highly accurate in the presence of moderate calcification (0-400 Agatston units), however in the presence of extreme calcification (>400 Agatston units) specificity (67%) and negative predictive values (67%) were reduced. In addition Raff et al analysed the effect of obesity on the accuracy of CTA. Sensitivity, specificity, positive and negative predictive values were all 100% for patients with a normal body mass index (<25 kg/m^2). For overweight individuals (25-29.9 kg/m^2), CTA remained reasonably accurate, however for obese patients (≥30 kg/m^2) sensitivity, specificity, positive and negative predictive values were all reduced (90, 86, 91, 86% respectively). There was also deterioration in the diagnostic accuracy for patients with a heart rate ≥70 beats/min. Mollet et al (2005) reported on 52 consecutive patients who received CTA and CA. Inter-observer and intra-observer variability for the detection of significant lesions had kappa values of 0.73 and 0.79, respectively. The average scan time for CTA was 13.3 ± 0.6 seconds and an average of 17 segments were identified per patient. CA identified an absence of disease in 25% (13/52), single vessel disease in 31% (16/52) and multi-vessel disease in 45% (23/52) of patients, all of which were identified by CTA. However, CTA did over estimate the severity of disease in one patient who was classified as having multi-vessel rather than single vessel disease.

Both of these studies reported high sensitivity, specificity, PPV and NPVs for patients. Mollet et al (2005) did report 92 per cent specificity, with a wide confidence interval, indicating variability in the patient group, and that there may be a subset of patients where the test has low specificity. The studies by Raff et al (2005) and Maruyama did not report confidence intervals.

In summary, it would appear that CTA is capable of providing accurate diagnostic data when compared to invasive conventional CA. Data acquisition is rapid for CTA compared to CA. In addition, by increasing the number of detectors (from 8 to 64) the diagnostic accuracy of CTA is increased. Accuracy is also enhanced by controlling for motion artefacts (ie high heart beat rates) by the administration of beta-blockers prior to CTA.

Table 1 CT coronary angiography compared to conventional angiography (%[95% CI])

Study	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Maruyama et al (2004) 8-slice 25 patients with stable angina (n=11), myocardial infarction (n=4), follow-up coronary intervention (n=10)	By segment 90% (27/30)	By segment 99.1% (226/228)	By segment 93% (27/29)	By segment 98.7% (226/229)
Hoffman et al (2005) 16-slice 103 patients with suspected CAD	By segment 95% [90.2, 97.8] By vessel 97% [91.1, 99.3] By patient 97% [87.9, 99.6]	By segment 98% [96.9, 98.6] By vessel 96% [93.3, 98.3] By patient 87% [73.7, 95.1]	By segment 87% [85.9, 89.6] By vessel 91% [83.8, 95.8] By patient 90% [79.8, 96.3]	By segment 99% [98.6, 99.7] By vessel 99% [96.5, 99.8] By patient 95% [83.8, 99.4]
Raff et al (2005) 64-slice 70 patients with suspected CAD	By segment 86% (79/92) By vessel 91% (63/69) By patient 95% (38/40)	By segment 95% (802/843) By vessel 92% (194/210) By patient 90% (27/30)	By segment 66% (79/120) By vessel 80% (63/79) By patient 93% (38/41)	By segment 98% (802/815) By vessel 97% (194/200) By patient 93% (27/29)
Mollet et al (2005) 64-slice 52 patients with suspected CAD	By segment 99% [94, 99] By patient 100% [91, 100]	By segment 95% [93,96] By patient 92% [67, 99]	By segment 76% [67, 89] By patient 97% [86, 99]	By segment 99% [99, 100] By patient 100% [73, 100]

CAD = coronary artery disease

Cost Impact

With improved spatial and temporal resolution, the 64-slice CT scanner is considered the scanner of choice for conducting CT angiography. To purchase a new 64-slice CT scanner with cardiac capabilities would cost approximately $1.25-1.35 million. Existing 64-slice CT scanners may be upgraded to cardiac capability with the purchase of the appropriate software and hardware at a cost of approximately $100,000. These components include the hardware to enable the scanner to acquire the cardiac images, software to reconstruct the images and software for workstations which enable the analysis of the acquired images (personal communication, Toshiba Australia, February 2006).

Coronary angiography is covered by Medicare Benefit Schedule (MBS) item numbers 38215-38246 with fees ranging from $384 to $1152. CT spiral angiography is covered by the MBS item numbers 57350-57356 with fees ranging from $264 to $510.

Ethical, Cultural or Religious Considerations

No issues were identified/raised in the sources examined.

Other Issues

A large, multi-centred trial, sponsored by Toshiba, has recently begun enrolling patients. Countries participating in this trial include the United States (Johns Hopkins), Israel, Brazil, Canada, Singapore and The Netherlands. All patients enrolled will undergo a conventional angiogram and a CT angiogram. Data from this trial is expected to be analysed by September 2006 (personal communication, Toshiba Australia, February 2006).

Since this prioritising summary has been prepared, it has come to the attention of the evaluators that a submission has been made to the MSAC for CT coronary angiograms to be assessed (application 1105). This submission has been received by the Health Technology Section of the Medicare Benefits Branch, however at this point the merit of this application has not been evaluated.

Conclusion:

There is good quality evidence available describing the results from studies comparing CTA to conventional angiography, however there is limited evidence available on the use of 64-slice CT scanners. CTA appears to be capable of providing diagnostically accurate data, is non-invasive and rapid when compared to conventional angiography, however it may be prudent to await further comparative results and cost-effectiveness data on the most recent generation of the technology.

HealthPACT Action:

This Prioritising Summary has been superseded by an application for a full HTA to the MSAC, which will be conducted in the near future by Adelaide Health Technology Assessment.

Sources of Further Information:

The Canadian Cardiovascular Society are preparing a "position statement" on cardiac CT and other advanced cardiac imaging modalities, which is expected to be finalised and published within the next six months in the Canadian Journal of Cardiology (Personal communication Chow, B.J., February 2006).

AIHW (2006). *National Hospital Morbidity Database* [Internet]. Australian Institute of Health and Welfare. Available from: http://www.aihw.gov.au/cognos/cgi-in/ppdscgi.exe?DC=Q&E=/AHS/principaldiagnosis0304 [Accessed 24th January 2006].

AIHW and NHF (2004). *Heart, stroke and vascular diseases - Australian facts 2004,* Australian Institute of Health and Welfare and National Heart Foundation of Australia, Canberra.

American Heart Association (2005). *Coronary angiography* [Internet]. American Heart Association. Available from: http://www.americanheart.org/presenter.jhtml?identifier=11222 [Accessed 6th February 2006].

Chow, B. J., Hoffmann, U. & Nieman, K. (2005). 'Computed tomographic coronary angiography: an alternative to invasive coronary angiography', *Can J Cardiol,* 21 (11), 933-940.

Christian, T. F. (2005). 'Anatomy of an emerging diagnostic test: computed tomographic coronary angiography', *Circulation,* 112 (15), 2222-2225.

Cury, R. C., Pomerantsev, E. V. et al (2005). 'Comparison of the degree of coronary stenoses by multidetector computed tomography versus by quantitative coronary angiography', *Am J Cardiol,* 96 (6), 784-787.

Garcia, M. J. (2005). 'Noninvasive coronary angiography: hype or new paradigm?' *JAMA,* 293 (20), 2531-2533.

Health Care Providers (2006) *Health Statistics - Medicare* [Internet]. Available from: http://www.medicareaustralia.gov.au/providers/health_statistics/statistical_reporting/medicare.htm [Accessed 9th February 2006].

Herzog, C., Arning-Erb, M. et al (2006). 'Multi-detector row CT coronary angiography: influence of reconstruction technique and heart rate on image quality', *Radiology,* 238 (1), 75-86.

Hoffmann, M. H., Shi, H. et al (2005). 'Noninvasive coronary angiography with 16-detector row CT: effect of heart rate', *Radiology,* 234 (1), 86-97.

Kock, M. C., Adriaensen, M. E. et al (2005). 'DSA versus multi-detector row CT angiography in peripheral arterial disease: randomized controlled trial', *Radiology,* 237 (2), 727-737.

Maruyama, T., Yoshizumi, T. et al (2004). 'Comparison of visibility and diagnostic capability of noninvasive coronary angiography by eight-slice multidetector-row computed tomography versus conventional coronary angiography', *Am J Cardiol,* 93 (5), 537-542.

Ministry of Health (2004). *A Portrait of Health: Key results of the 2002/03 New Zealand Health Survey,* Ministry of Health, Wellington.

Mollet, N. R., Cademartiri, F. et al (2005). 'High-resolution spiral computed tomography coronary angiography in patients referred for diagnostic conventional coronary angiography', *Circulation,* 112 (15), 2318-2323.

Raff, G. L., Gallagher, M. J. et al (2005). 'Diagnostic accuracy of noninvasive coronary angiography using 64-slice spiral computed tomography', *J Am Coll Cardiol,* 46 (3), 552-557.

Schussler, J. M., Dockery, W. D. et al (2005). 'Computed tomographic coronary angiography: experience at Baylor University Medical Center/Baylor Jack and Jane Hamilton Heart and Vascular Hospital', *Proc (Bayl Univ Med Cent),* 18 (3), 228-233.

Schussler, J. M. & Grayburn, P. A. (2005). 'CT imaging of the coronary arteries', *Heart.*

LIST OF STUDIES INCLUDED

Total number of studies	5
Level II Diagnostic evidence	5

SEARCH CRITERIA TO BE USED:

Coronary Angiography/*methods
Coronary Disease/*radiography
Heart/*radiography
Tomography, X-Ray Computed/*methods

Image Processing, Computer-Assisted
*Imaging, Three-Dimensional
Peripheral Vascular Diseases/*radiography/therapy