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# The Applicability of the American College of Cardiology Appropriate Use Criteria for Myocardial Perfusion Scintigraphy in Australia

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## Background

The American College of Cardiology (ACC) Appropriate Use Criteria (AUC) for radionuclide myocardial perfusion scans (MPS) was developed to promote its rational use in the assessment of stable ischaemic heart disease (IHD). We sought to validate the applicability of this document in the Australian context.

## Methods

1009 consecutive patients who underwent MPS were retrospectively audited at a single major metropolitan hospital in Victoria, Australia. Appropriateness was assigned based on the 2013 ACC AUC, and common indications and predictors of positive scan results were examined.

## Results

The AUC was successfully applied (99.1%) retrospectively. A large proportion of scans were deemed appropriate (82.7%), whilst 7.8% were maybe appropriate. Positive detection rates in these groups were 17.0% and 17.9% respectively. Eighteen patients (1.8%) were unclassifiable, but had a detection rate of 44.4%. Positive predictors of an abnormal MPS result included prior history of coronary artery disease, typical angina, and following the conservative management of an acute coronary syndrome. Scans that were rarely appropriate had a detection rate of 0%.

## Conclusion

The retrospective application of the 2013 ACC AUC is feasible. Whilst the majority of the scans were appropriate, a group of unclassifiable patients was observed to have a high detection rate. Scans that were rarely appropriate could potentially be rationalised to reduce radiation risk.

## Keywords

Appropriate use criteria (AUC) • Myocardial perfusion scintigraphy (MPS) • Stable ischaemic heart disease • Coronary artery disease (CAD)

## Introduction

Myocardial perfusion scintigraphy (MPS) is a commonly used modality in the investigation of patients with known or suspected coronary artery disease. Appropriate use criteria (AUC) [1] were developed and revised by the American

College of Cardiology (ACC) with the aim to assist clinicians in test selection, to minimise cost and reduce radiation risk to patients in the investigation of stable ischaemic heart disease.

Since the publication of the AUC, several studies have sought to apply it to clinical practice to examine patterns of MPS use. Reported rates of inappropriate MPS scans

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ranged from 7 to 45% [2–5]. Furthermore, there were observations of abnormality detection rates as high as 89% even in “inappropriate” scans [6], which prompts for further evidence examining the applicability of the AUC. There is also a lack of Australian representation in the current literature. It is worth acknowledging, however, that the majority of studies thus far have applied the 2009 published AUC [7], and there has been a 2013 revision [1] since.

This study, therefore, sought to evaluate the usefulness of the 2013 ACC AUC for the retrospective audit of clinical practice, based on routine clinical information collected in a single major metropolitan centre in Victoria, Australia. Secondly, the detection rate of MPS for ischaemia based on appropriateness was examined, along with common indications for MPS. The clinical predictors of a positive MPS outcome were also explored.

## Methods

### Data Acquisition

This study was performed at The Northern Hospital, a major metropolitan hospital in Victoria, Australia. From 1st June 2015, 1009 consecutive patient episodes were collected retrospectively from scanned medical records, in an unidentified manner. Data elements were collected using a pre-existing worksheet, which included age, gender, cardiovascular risk factors such as smoking, diabetes mellitus, dyslipidaemia, hypertension, history of known coronary artery disease, as well as the indication and the outcome of the scans. Nine patients (0.9%) with incomplete or missing scanned documents were excluded, giving a final cohort of 1000 patients.

Myocardial perfusion images were obtained with dual-head solid-state cadmium zinc telluride (CZT) dedicated cardiac gamma camera (Discovery 530c, GE Medical Systems, Tirat Hacarmel, Israel). A one-day protocol was employed for patients <120 kg, where stress images were acquired four hours before the rest images. For patients >120 kg, a two-day stress/rest protocol was employed. 99m-technitium (Tc99m)-sestamibi is employed in this centre, and images were reported by either a nuclear medicine physician or a nuclear cardiologist, and results classified as either normal or abnormal (with fixed or reversible perfusion defects, or transient post-stress dilatation of the ventricle). Fixed defects were considered infarction when there was concurrent history of previous myocardial infarction, Q-waves on electrocardiography, or wall motion abnormality.

### Appropriate Use Criteria

The appropriate use criteria [1] were then applied retrospectively, categorising scan referrals into appropriate, maybe appropriate, rarely appropriate, and unclassifiable based on the AUC published by ACC. The modified Diamond and Forrester criteria, as recommended by ACC/AHA guidelines for estimating pre-test probability in stable ischaemic heart disease [8] were employed to classify patients

with chest pain or ischaemic equivalents. Dyspnoea was considered an ischaemic equivalent, as it may suggest an atypical symptom of angina, with important prognostic implications in cardiac stress testing [9]. For asymptomatic patients, a Framingham based score [10] was used to estimate risk of coronary artery disease (CAD) event or death in the next 10 years.

### MPS Outcome

The presence of a reversible perfusion defect, transient dilatation of the ventricle post-stress, or the presence of fixed perfusion defect in patients without prior history of myocardial infarction were regarded as positive scintigraphic results.

### Statistical Analysis

Descriptive statistics was presented as counts and percentage frequencies, mean  $\pm$  standard deviation (SD) or median with inter-quartile range (IQR) to summarise patient characteristics and outcomes. Categorical variables were evaluated using the Chi-square test or Fisher's Exact test on occasions of frequencies of less than 5. Continuous variables were analysed with logistic regression. Multivariate logistic regression was used to identify significant correlations, with only variables having a p-value of <0.1 on univariate analysis being included in the multivariate analysis. A two-tailed p-value of 0.05 was considered indicative of statistical significance. SPSS statistical analysis software for windows was used (version 22.0, IBM Corp, Armonk, NY, USA).

## Results

### Baseline Characteristics and Outcomes of MPS

One thousand patients were included in the final model for analysis. The majority of referrals were appropriate (82.7%), a minority were maybe and rarely appropriate (7.8% and 7.7% respectively), and 18 cases were unclassifiable (1.8%). Age (LR F(3,996) = 44.157,  $p < 0.01$ ), male sex ( $\chi^2(df = 3) = 10.7$ ,  $p = 0.01$ ), smoking history ( $\chi^2(df = 3) = 72.8$ ,  $p < 0.01$ ), hypertension ( $\chi^2(df = 3) = 11.1$ ,  $p = 0.01$ ), dyslipidaemia ( $\chi^2(df = 3) = 34.7$ ,  $p < 0.01$ ), family history of coronary artery disease ( $\chi^2(df = 3) = 15.2$ ,  $p = 0.02$ ), and known history of coronary artery disease ( $\chi^2(df = 3) = 58.3$ ,  $p < 0.01$ ) were significantly different between the groups (Table 1).

Post-hoc Bonferroni analysis revealed several notable patterns of statistical significance. Compared to their counterparts, patients with appropriate scans were more likely smokers, with known history of CAD and dyslipidaemia. Maybe appropriate classification was positively associated with male sex, but negatively associated with smoking, and family and personal history of CAD. Within the rarely appropriate category, patients were observed to be younger with a higher likelihood of family history of CAD, but less likely smokers, have dyslipidaemia or known personal history of

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