Cost effectiveness of stress only gated myocardial perfusion SPECT following normal stress scintigraphy findings

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Citation

M Holmes, J Wheat, G Currie. *Cost effectiveness of stress only gated myocardial perfusion SPECT following normal stress scintigraphy findings*. The Internet Journal of Nuclear Medicine. 2007 Volume 5 Number 1.

Abstract

In Australia, approximately 70000 myocardial perfusion SPECT studies are performed annually, costing in excess of $51 million. Eliminating the rest study in the presence of a normal stress study may potentially save millions of dollars annually.

Methodology: This study was a retrospective cost effectiveness analysis that examined the potential of eliminating the rest study when the initial gated stress study is normal in both perfusion and function. Decision tree analysis was performed to determine the cost effectiveness of this approach compared to the more traditional rest and stress procedure.

Results: 100% (174/174) of normal stress studies were associated with a normal rest study. Decision tree analysis demonstrated a potential saving of $3600000 annually without compromising patient management or outcomes.

Conclusion: Eliminating the rest image when the initial stress image is normal in both perfusion and function provides a positive cost benefit relationship without risking diagnostic integrity of the procedure. Additionally, eliminating the rest study reduces radiation exposure, reduces the time commitment of patients and potentially reduces waiting lists in busy department; increasing marginal profits.

INTRODUCTION

The rise in health care expenditure in Australia has seen the evolution of economic rationalism in health. While gated myocardial perfusion single photon emission computed tomography (SPECT) offers the benefit of both perfusion and functional assessment, it remains an expensive procedure. Cost effectiveness analysis is an analytical approach that integrates a tests economic value with its clinical effectiveness ([1]). The calculation of marginal or incremental cost effectiveness provides a rational means to balance health care quality and clinical value in terms of best outcomes at a reasonable cost ([1]). In this manner a cost effectiveness analysis relates the economic resources consumed in relation to the benefits attained ([1]).

Myocardial perfusion studies are the most commonly performed cardiac examination in clinical nuclear medicine practice. In Australia, approximately 700000 myocardial perfusion studies are performed annually ([2]).

Demonstration of normal perfusion and function in a stress study may eliminate the need for a corresponding rest study. Guerra et al. ([3]), Schroeder-Tanka et al. ([4]), Snapper et al. ([5]) and Worsley ([6]) have each investigated the use of stress only myocardial perfusion SPECT. None of these studies examined the potential economic benefits of this policy. Each demonstrated that a normal stress myocardial perfusion study corresponded to a normal rest study in 100% of patients (table 1) ([3,4,5,6]). This might be largely attributed to the use of ^{99m} Tc based radiopharmaceuticals where, in contrast to ^{201} Tl thallous chloride, reverse redistribution offers no diagnostic or prognostic value.

Figure 2

Figure 1: A composite diagnostic algorithm for rest and stress gated myocardial perfusion SPECT where A and B are defined as the alternative diagnostic strategies.

Study	Stress Only Normal	Stress-Rest Normal
Guerra et al. (*3*)	12	12
Snapper et al. (*5*)	22	22
Worsley et al. (*6*)	46	46
Schroeder-Tanka et al. (*4*)	94	94

The aim of this investigation was to evaluate the cost effectiveness of routine use of a two day stress / rest myocardial perfusion protocol where the rest study is only performed when the stress study demonstrates either a perfusion or functional abnormality.

METHODOLOGY

Decision tree analysis was utilised to model direct costs and the potential risks of procedures for the two diagnostic strategies. All diagnostic strategies were based on the diagnostic algorithm depicted in figure 1. The decision tree analysis was based on a hypothetical population of 2000 subjects presenting for scintigraphic evaluation of coronary artery disease (CAD). Each diagnostic strategy evaluated 1000 randomly allocated patients with homogenous variables. All transition probabilities and outcome rates were derived from previously cited data (Table 2). Costs were estimated based on the Commonwealth Medicare Benefits Schedule ($_2$).

Figure 3

Table 2: Summary of stress and rest data used on analysis.

Variable	Value
Mortality rate for normal study*	0.35% (*7,8*)
Mortality rate for abnormal study*	1.98% (*7,8*)
Myocardial Infarction rate for normal study*	0.63% (*7,8*)
Myocardial Infarction rate for abnormal study*	3.64% (*7,8*)
Normal stress	45.3% (*3-6,9-12*)
Abnormal stress	54.7% (*3-6,9-12*)
True Positive Stress	53.3% (*5*)
False Positive Stress	4.0% (*5*)
True Negative Stress	41.3% (*5*)
False Negative Stress	1.4% (*5*)
Normal Stress with abnormal rest	0% (*3-6*)
Normal Stress with normal rest	100% (*3-6*)
Abnormal Stress with normal rest	70.8% (*3-6*)
Abnormal Stress with abnormal rest	29.2% (*3-6*)
Coronary Angiography mortality rate	0.20% (*13*)
Coronary Angiography complication rate	2.42% (*13*)
Stress Only scintigraphy cost	$559.70 (*2*)
Rest and stress scintigraphy cost	$826.65 (*2*)
Coronary Angiography cost	$1,151.70 (*2*)

* within the first 12 months after diagnosis

Figure 4

Table 3: Summary of stress only data used for analysis (,).

Variable	Value
Significant Wall Motion & Wall Thickening	80.8%
No Significant Wall Motion & Wall Thickening	19.2%
Reversible defect with Significant Wall Motion and Wall Thickening	91%
Reversible defect with No Significant Wall Motion and Wall Thickening	9%
Fixed defect with Significant Wall Motion and Wall Thickening	25%
Fixed defect with No Significant Wall Motion and Wall Thickening	75%

Additionally, a decision tree analysis was performed on a hypothetical population of 1000 subjects presenting for scintigraphic evaluation of CAD using a stress-only strategy (figure 2). Variables were only acquired from data that included gated stress acquisition. Table 3 provides a summary of the key information utilised in the decision tree analysis and cost effectiveness analysis.

Figure 5

Figure 2: A composite diagnostic algorithm for stress only gated myocardial perfusion SPECT.

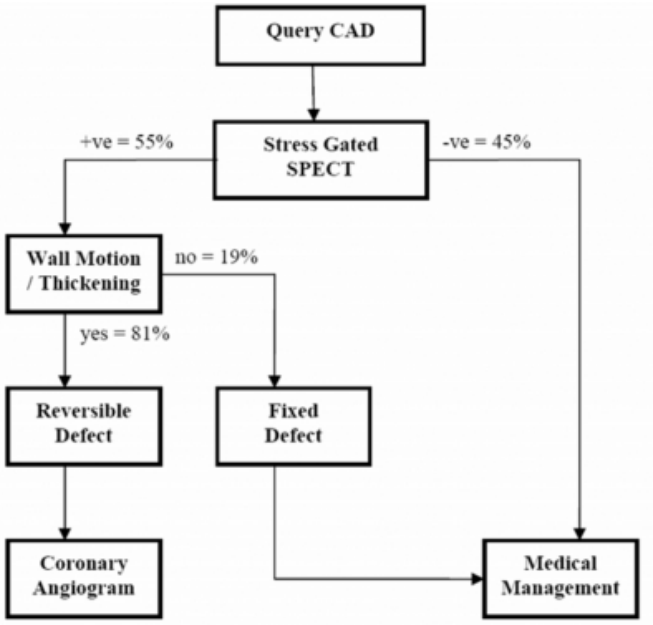
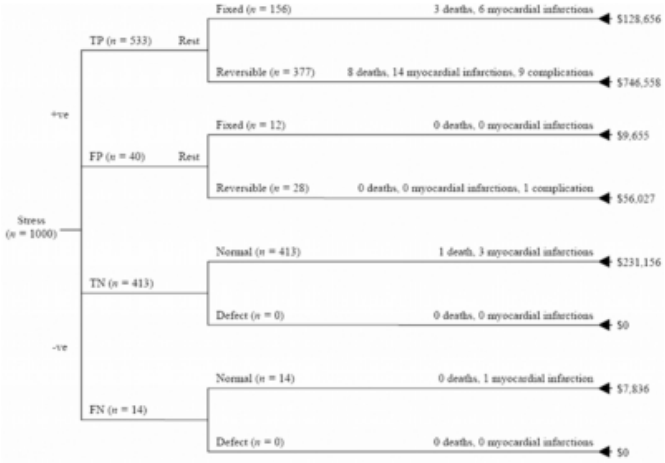


Figure 6

Figure 3: Decision tree analysis for rest only when stress is abnormal with a total of 12 deaths, 24 myocardial infarctions and costs of $1179889. True negatives (TN), false negatives (FN), true positives (TP) and false positives (FP).



RESULTS

The decision tress analysis for the cohort where rest studies were only performed if the stress study was abnormal (figure 3) demonstrated a total of 12 deaths, 24 myocardial infarctions, 10 complications and a total cost of $1179889. Three deaths and six myocardial infarctions were associated with true positive (TP) studies presenting with a fixed defect. Eight deaths, 14 myocardial infarctions and three complications were attributed to TP studies demonstrating a reversible defect and who underwent coronary angiography. One death and three myocardial infarctions were associated with the true negative (TN) group.

Decision tree analysis for the 1000 patients evaluated with both rest and stress myocardial perfusion SPECT (figure 4) demonstrated a total of 12 deaths, 24 myocardial infarctions, 10 complications and a cost of $1294004. Eight deaths, 14 myocardial infarctions and nine complications were attributed to performing coronary angiography on TP studies with a reversible defect. A further three deaths and six myocardial infarctions were associated with TP studies with a fixed defect. The TN cohort was associated with one death and three myocardial infarctions. While no reduction in deaths or complications was noted, the total costs were higher for the rest and stress cohort. The addition of the rest acquisition in 54.7% of patients increased the overall cost by $114115 ($114 per patient).

Decision tree analysis of the 1000 patients representing the stress only myocardial perfusion cohort (figure 5) demonstrated a total of 14 deaths, 23 myocardial infarctions, 11 complications and a cost of $1076605. Ten deaths, 15 myocardial infarctions and nine complications were attributed to patients who underwent coronary angiography for TP studies with a reversible defect. Three further deaths and four myocardial infarctions were associated with a fixed defect from a TP study. An increase of one death was noted compared to traditional rest and stress imaging. The total reduction in cost was $217399 ($217 per patient), primarily due to the elimination of the rest study for all patients.

Figure 7

Figure 4: Decision tree analysis for rest and stress with a total of 12 deaths, 24 myocardial infarctions and costs of $1294004.

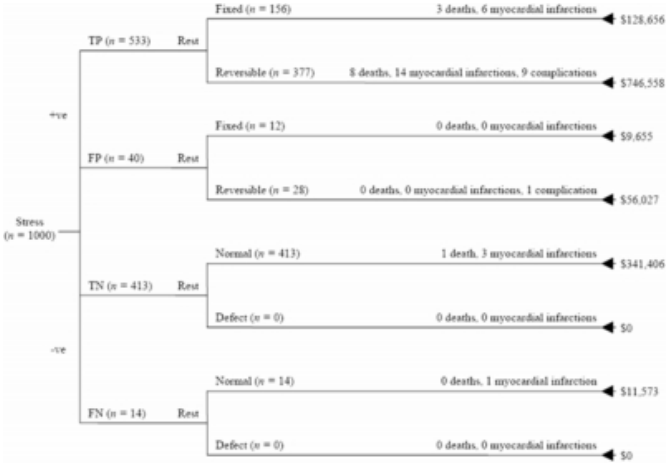
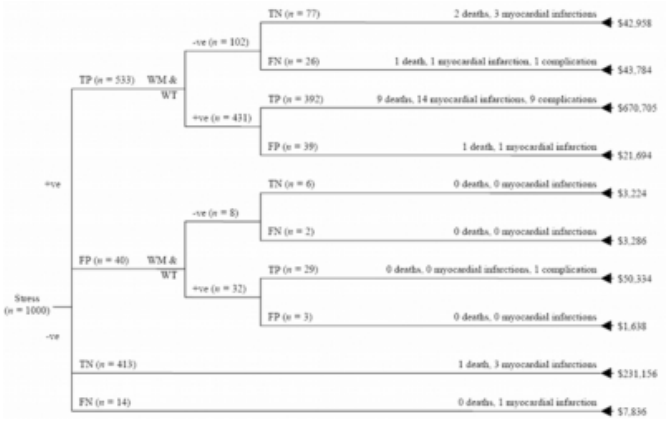


Figure 8

Figure 5: Decision tree analysis for stress only with a total of 14 deaths, 23 myocardial infarctions and costs of $1076605. Wall motion (WM) and wall thickening (WT) are represented.



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DISCUSSION

Significant myocardial wall motion and wall thickening in an area of decreased perfusion has been shown to indicate stress-induced ischaemia ($_{3,5}$). Myocardial infarction is characterised by significantly reduced myocardial wall motion and wall thickening in an area of decreased perfusion ($_{3,5}$). Stress-only imaging with gating, even in the presence of an abnormal stress study, has been proposed to eliminate the need for any resting studies ($_{3,5}$). Stress-only imaging was shown to increase deaths by 0.1% each (7000 Australians per year) offset by a potential saving of $217 per patient ($15.1 million annually across Australia) compared to traditional rest and stress imaging.

Eliminating the rest study when the stress study is normal in both perfusion and function, however, produced a cost reduction ($114 per patient or $8 million annually across Australia) without increasing deaths or cardiac events. This strategy is also consistent with the principles of ‘as low as reasonably achievable' (ALARA) with respect to both patient and staff dosimetry. There may also be a benefit to individual departments. The elimination of the rest study in a proportion of patient will allow higher throughput of myocardial perfusion patients; reducing waiting lists and potentially capturing additional patients lost to competition. In busy departments, this may indeed increase marginal profit because the stress component (minus the stress test component) attracts a $560 rebate and the rest component only $267.

CONCLUSION

Eliminating the myocardial perfusion rest study when the stress study is normal in both perfusion and function provides a cost effective approach to myocardial perfusion SPECT imaging. Patient outcomes are not adversely affected while significant health cost reductions might be produced. The extended benefits of appropriate elimination of the rest study includes reduced radiation exposure, reduced time commitment of the patient, reduced waiting lists and the potential to improve marginal profit. Patients demonstrating an abnormal gated stress study should be further evaluated at rest. A two day stress / rest protocol provides an optimal approach.

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References

1. Des Prez, RD, Gillespie, RL, Jaber, WA, Noble, GL, Shaw, LJ, Soman, P, Williams, KA and Wolsinky, DG 2005, 'Cost effectiveness of myocardial perfusion imaging: a summary of the currently available literature', J Nucl Cardiol, vol. 12, no. 6, pp. 750-759.
2. Medicare Australia 2006, 'Medicare Benefits Schedule Item Statistics', viewed 13 November 2006, http://www.medicareaustralia.gov.au/statistics/
3. Guerra, UP, Giacomuzzi, F, Gregorio, FD, Bax, JJ & Slavich, GA 1999, 'Gated Tc-99m sestamibi SPECT versus stress-rest SPECT in detecting coronary artery disease: correlation with coronary angiography in patients without myocardial infarction', Clin Nucl Med, vol. 24, no. 12, pp. 921-926.
4. Schroeder-Tanka, JM, Tiel-van Buul, MMC, van der Wall, EE, Rolker, W, Lie, KI & van Royen, EA 1997, 'Should imaging at stress always be followed by imaging at rest in Tc-99m MIBI SPECT?', Int J Cardiac Imag, vol. 13, pp. 323-329.
5. Snapper, HJ, Shea, NL, Konstam, MA, Oates, E & Udelson, JE 1997, 'Combined Analysis of resting wall thickening and stress perfusion with electrocardiographic-gated technetium 99m-labeled sestamibi single-photon emission computed tomography: Prediction of stress defect reversibility', J Nucl Cardiol, vol. 4, no. 1, pp. 3-10.
6. Worsley, DF, Fung, AY, Coupland, DB, Rexworthy, CG, Sexsmith, GP & Lentle, BC 1992, 'Comparison of stress-only vs. stress/rest technetium-99m methoxyisobutylisonitrile myocardial perfusion imaging', Euro J Nucl Med, vol. 19, pp. 441-444.
7. Hachamovitch, R, Berman, DS, Shaw, LJ, Kiat, H & Cohen, I 1998, 'Incremental prognostic value of myocardial perfusion single photon emission computed tomography for the prediction of cardiac death: differential stratification for risk of cardiac death and myocardial infarction', Circ, vol. 97, no. 6, pp. 535-543.
8. Hachamovitch, R, Hayes, SW, Friedman, JD, Cohen, I & Berman, DS 2004, 'Stress myocardial single-photon emission computed tomography is clinically effective and cost effective in risk stratification of patients with a high likelihood of coronary artery disease (CAD) but no known CAD', J American Coll Cardiol, vol. 43, no. 2, pp. 200-208.
9. Bateman, TM, Heller, GV, McGhie, AI, Friedman, JD, Case, JA, Brynegleson, JR, Hertenstein, GK, Moutray, KL, Reid, K & Cullom, SJ 2006, 'Diagnostic accuracy of rest/stress Rb-82 myocardial perfusion PET: comparison with ECG gated Tc-99m sestamibi SPECT', J Nucl Cardiol, vol. 13, no. 1, pp. 24-33.
10. Berman, DS, Kang, XK, Nishina, H, Slomka, PJ, Shaw, LJ, Hayes, SW, Cohen, I, Friedman, JD, Gerlach, J & Germano, G 2006, 'Diagnostic accuracy of gated Tc-99m sestamibi stress myocardial perfusion SPECT with combined supine and prone acquisitions to detect coronary artery disease in obese and non obese patients', J Nucl Cardiol, vol. 13, no. 2, pp. 191-201.
11. Fleischmann, S, Koepfli, P, Wyss, CA, Jenni, R & Kaufmann, PA 2004, 'Gated 99mTc-tetrofosmin SPECT for discriminating infarct from artifact in fixed myocardial perfusion defects', J Nucl Med, vol. 45, no. 5, pp. 754-758.
12. Garber, AM & Solomon, NA 1999, 'Cost-effectiveness of alternate test strategies for diagnosis of coronary artery disease', Ann Nucl Med, vol. 130, no. 9, pp. 719-728.
13. Bates, DW, Miller, E, Bernstein, SJ, Haumptman, PJ &

Leape, LL 1997, 'Coronary angiography and angioplasty after acute myocardial infarction', Ann Intern Med, vol. 126, no. 7, pp. 539-550.

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