

## Incorporating Patient-Centered Outcomes in Cost-Effectiveness Analysis of Imaging in Renal Artery Stenosis

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**Background:** Alternatives to conventional angiography in evaluation of renovascular hypertension include MR angiography (MRA), CT angiography (CTA), captopril scintigraphy, and renal sonography. CTA and conventional angiography have been previously demonstrated to be cost-effective compared with MRA [15]. However, that study omitted the quality of life component from the cost-effectiveness analysis. Standard valuation analysis recommends incorporation of quality-of-life measurements, if available, in cost-effectiveness analyses [16]. Quality of life estimates adjust primarily for morbidity and mortality. Contributions to quality of life may also include the reassurance value of a test or the discomfort associated with undergoing a test, although these contributions are subordinate. Swan et al. [18] and Swan and Langlotz [19] have studied the short-term discomfort that the patient experiences during the performance of a given diagnostic examination. This discomfort has been termed short-term disutility and has been directly quantified in individuals undergoing both MR angiography and conventional angiography for peripheral vascular disease. We revisit the issue of cost-effectiveness of imaging in individuals suspected of renovascular hypertension.

**Objective:** To assess the contribution of patient-centered short-term disutilities and quality-of-life measures in cost-effectiveness analysis of CT angiography, MR angiography and conventional angiography in patients with medication-resistant hypertension.

**Materials and Methods:** A decision analytic model compared the life expectancy and incremental cost per life year using three initial diagnostic tests in a cohort of hypothetical individuals with medication-resistant hypertension over a range of renal artery stenosis (RAS) probabilities: CTA (sensitivity 96%, specificity 96%, cost \$865); MRA (98%, 94%, \$850); and conventional angiography (99%, 99%, \$2627). All imaging strategies were compared with a base case scenario mimicking the natural history of medication-resistant hypertension and to immediate enhanced medical therapy without prior imaging. Individuals without evidence of RAS on initial testing underwent conventional angiography if enhanced medical therapy failed to control hypertension. Individuals diagnosed with RAS by MRA or CTA required conventional angiography for definitive stent treatment (\$11223). Blood pressure response to renal artery stenting or enhanced medical therapy varied according to blood pressure, as did the incidence of myocardial infarctions and strokes resulting from hypertension. Patients who progressed to end stage renal disease (ESRD) received dialysis (\$60,000/year). Quality of life adjustments were made for patients with hypertension, ESRD, myocardial infarction and stroke. Short-term disutilities from undergoing an imaging test were included. The analysis accounted for direct costs, derived from Medicare reimbursements, and total costs, derived from the literature.

**Results:** All imaging strategies were cost-effective compared with enhanced medical therapy alone or to natural history. Accounting for direct costs, MR angiography was the preferred strategy, with conventional angiography as a cost-effective alternative to MR angiography. Accounting for total costs, conventional angiography dominated all other strategies. Adjusting for quality of life decreased the incremental cost-effectiveness ratios, making an already competitive strategy a more favorable alternative to the base case. Adjusting for test-related disutility did not significantly influence the cost-effectiveness of any of the imaging tests. Despite marked variation in the key clinical and cost variables, MR angiography remained the most cost-effective strategy.

The figure shows cost utility trade-off of evaluation and treatment strategies in medication-resistant hypertension. The natural history of medication-resistant hypertension represents the base case (BC) and results in the least costly strategy with the shortest quality-adjusted life expectancy (QALE). All alternative strategies increase QALE at increased expense. The slope of a line drawn between the base case and each of the other strategies estimates the relative cost-effectiveness of the alternatives. A steeper slope corresponds to a less cost-effective strategy, relative to the other alternative strategies. Thus, enhanced medical therapy without imaging (Med) is less cost-effective than any of the other strategies incorporating preliminary imaging. MR angiography (MRA) is the most cost-effective strategy compared with the base case and dominates medical therapy and CT angiography (CTA) strategies. Conventional angiography (CA) is a cost-effective alternative to MR angiography.

**Conclusion:** In the evaluation and treatment of medication-resistant hypertension, strategies that include preliminary imaging saved more lives than did the immediate institution of enhanced medical therapy at a lesser cost.

