Data Supplement – Projected National Cost Analysis

This appendix offers a brief description of the methods used to calculate the estimated national effect of using HINTS versus ABCD2 as a screening tool to drive use of magnetic resonance imaging (MRI) for stroke detection in acute vertigo/dizziness in the emergency department (ED).

e-Methods

Method of Cost Comparison of the Two Diagnostic Strategies

To compare the strategies as screening tests that might be used in the ED to determine whether

MRI would be performed as part of a two-stage diagnostic strategy,[1] we also compared

sensitivity and specificity for identifying a causal lesion by MRI (a "diagnostic" MRI). For these

calculations, the 3% of patients who could not undergo MRI but had unequivocal acute lesions

by CT were presumed to have "diagnostic" MRIs. We extrapolated these results to a national

level using results from two recent studies providing necessary estimates for total dizziness

visits (~4 million),[2] AVS fraction (~10% to 20%),[3] and proportion of AVS with stroke (~25%).[3]

We projected the number of MRIs that would be ordered if the decision to image were based

solely on ABCD2 ≥4 versus a 'central' pattern on HINTS at three thresholds. We then calculated

the expected number of non-diagnostic MRIs (i.e., anticipated to reveal neither a stroke nor

another central cause). We compared the strategies on missed stroke, missed central causes,

non-diagnostic MRIs, and costs. For costs of MRI, we used an average 2012 Medicare payment

of $1204 for a non-contrast stroke-protocol MRI that includes MRA of the head and neck.[4]

Impact of the Two Diagnostic Strategies

With 4 million dizziness visits[2] and ~10% to 20% presenting AVS,[3] there are 400,000-800,000

AVS presentations annually in US EDs, ~100,000 to 200,000 due to stroke (~25% of AVS).[3]

Combining these figures with results from Table 3 and the Online Appendix reveals that if

ABCD2 ≥4 were used routinely to select AVS patients for MRI, the projected national results would be 38,938 to 77,876 missed strokes and 112,000 to 224,000 non-diagnostic MRIs at a cost of $134.8 to 269.7 million. Using the head impulse test alone would yield 78.8% fewer missed strokes at 93.3% lower cost. Using HINTS would yield 92.3% fewer missed strokes at 88.8% lower cost. Using HINTS 'plus' would yield 98.1% fewer missed strokes (absolute difference vs. ABCD2 nationally 38,053 to 76,106) and 86.6% fewer non-diagnostic MRIs (absolute difference vs. ABCD2 nationally in scans 97,000 to 194,000 and costs of imaging $116.8 to 233.6 million).

References

1. Bossuyt PM, Irwig L, Craig J, Glasziou P. Comparative accuracy: assessing new tests against existing diagnostic pathways. Br Med J 2006;332:1089-92.

2. Saber-Tehrani AS, Coughlan D, Hsieh YH, et al. Rising annual costs of dizziness presentations to US emergency departments. Acad Emerg Med 2013;20:689-96.

3. Tarnutzer AA, Berkowitz AL, Robinson KA, Hsieh YH, Newman-Toker DE. Does my dizzy patient have a stroke? A systematic review of bedside diagnosis in acute vestibular syndrome. CMAJ 2011;183(9):E571-92.

4. Siemens Medical Solutions USA. 2012 Medicare Hospital Outpatient Prospective Payment Schedule Rates: Magnetic Resonance Imaging: Siemens Medical Solutions USA, Inc., 2012.

e-Table. ABCD2 ≥4 versus HIT, HINTS, and HINTS 'plus' for a diagnostic MRI in AVS

Test properties	ABCD2 ≥4 (5-item rule*) %;LR (95% CI)	HIT (1-step rule*) %;LR (95% CI)	HINTS (3-step rule*) %;LR (95% CI)	HINTS 'plus' (4-step rule*) %;LR (95% CI)
DIAGNOSTIC MRI† (n=120 diagnostic, n=70 non-diagnostic)				
Sensitivity for diagnostic MRI	58.3% (49.4%-66.9%)	90.8% (84.6%- 95.1%)	96.7% (92.2%-98.9%)	99.2% (96.0%-100.0%)
Specificity for diagnostic MRI	60.0% (48.2%-71.0%)	95.7% (88.8%-98.9%)	92.9% (84.9%-97.3%)	91.4% (83.0%-96.5%)
LR+ for diagnostic MRI	1.46 (1.05-2.02)	21.2 (6.99-64.22)	13.5 (5.81-31.51)	11.6 (5.38-24.87)
LR- for diagnostic MRI	0.69 (0.52-0.92)	0.10 (0.05-1.17)	0.04 (0.01-0.09)	0.01 (0.00-0.06)
Reduction non-diagnostic MRI‡	Reference Case	93.3%	88.8%	86.6%

LR+ = positive likelihood ratio; LR- = negative likelihood ratio; ABCD2 = age, blood pressure, clinical features, duration of symptoms, diabetes; HINTS = head impulse, nystagmus, test of skew; HINTS 'plus' = HINTS plus new hearing loss detected by finger rubbing; HIT = head impulse test; AVS = acute vestibular syndrome; MRI = magnetic resonance imaging

* The ABCD2 rule requires 5 historical elements. The standard HINTS approach has 3 physical examination elements, the most predictive of which is the head impulse test (HIT). HINTS 'plus' adds the presence of new hearing loss by bedside finger rub as a predictor of a stroke syndrome.

† A 'diagnostic' MRI scan was defined as a final MRI (or CT with clear result) revealing a causal structural lesion responsible for the AVS presentation. These results differ from those in Table 3 because here non-diagnostic MRIs counted as rule failures, even if the localization was central (i.e., a central cause not evident on neuroimaging). This represents the economic perspective on the rule's utility. There were 120 diagnostic final MRIs (113 strokes, 7 other central structural) and 70 non-diagnostic MRIs (66 vestibular neuritis, 4 central [2 paraneoplastic, 1 Wernicke's, 1 carbamazepine]).

‡ These values represent the reduction in 'non-diagnostic' MRIs relative to ABCD2 that would be projected if HIT, HINTS, or HINTS plus were used to determine the diagnosis instead of ABCD2.