TITLE: Ventilation/Perfusion scintigraphy (using Technegas) versus Computed Tomography Pulmonary Angiography for the Diagnosis of Pulmonary Embolism in Hospitalized Patients: A Review of the Clinical and Cost-Effectiveness

DATE: 20 April 2011

CONTEXT AND POLICY ISSUES:

Pulmonary emboli is a relatively common pulmonary vascular disorder that increases in risk with age and among pregnant women.\(^1,2\) In the US, the annual incidence of pulmonary emboli is 69/100,000 people and leads to 5% to 10% of all hospital deaths.\(^3-6\) Despite the potentially fatal consequences of pulmonary emboli, diagnosis for this condition remains uncertain.\(^7,8\) In addition to clinical assessment and routine laboratory tests, such as blood gas and chest X-rays, the diagnosis of pulmonary emboli is performed using biochemical tests such as D-dimer levels, and imaging techniques such as ventilation-perfusion scintigraphy (V/Q scan), computed tomography pulmonary angiography (CTPA), and echocardiography.\(^9-11\) The ventilation studies of V/Q scan are in general performed using inhalation of 99m technetium-labelled aerosols of diethylene triamine pentaacetic acid (99m Tc-DTPA), or an ultrafine dispersion of 99m technetium-labelled carbon (Technegas). Technegas is considered to be the optimal option for ventilation studies because the small size of the particles allows good penetration. A head-to-head study that compared the V/Q scans using 99m Tc-DTPA and Technegas\(^12\) also showed that Technegas has a better peripheral penetration than 99m Tc-DTPA.

V/Q scans and CTPA recently have played an increasing role in the diagnosis of pulmonary emboli.\(^13-16\) The diagnostic performance (for example, sensitivity and specificity) of V/Q scan and CTPA for pulmonary emboli is uncertain, and they also face radiation exposure issues.\(^17,18\) Many studies that compared the accuracy of V/Q scan using gas other than Technegas with have reported that the two imaging methods have comparable diagnostic accuracy for pulmonary emboli.\(^19-21\)

Technegas is generated by TechnegasPlus Generator System – Ventilation Assistance Unit, a product of Cyclofarm, which was approved for use in Canada in 2006.\(^22\) This report is aimed to compare the clinical and cost-effectiveness of V/Q scan using Technegas with CTPA in the diagnosis of pulmonary embolism in hospitalized patients.

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RESEARCH QUESTIONS:

1) What is the comparative clinical effectiveness of ventilation/perfusion scan (using Technegas) versus computed tomography pulmonary angiogram for diagnosing pulmonary embolism in hospitalized patients?

2) What is the cost-effectiveness of ventilation/perfusion scan (using Technegas) versus computed tomography pulmonary angiogram for diagnosing pulmonary embolism in hospitalized patients?

KEY MESSAGE:

Data from one retrospective study that compared V/Q scan using Technegas to CTPA in pregnant women indicated that V/Q scan have a higher diagnostic accuracy than CTPA for pulmonary emboli. No evidence on the cost-effectiveness of V/Q scan versus CTPA for diagnosing pulmonary embolism in hospitalized patients was identified.

METHODS:

Literature search strategy

A limited literature search was conducted on key resources including PubMed, The Cochrane Library (2011, Issue 3), University of York Centre for Reviews and Dissemination (CRD) databases, Ovid EMBASE, Canadian and major international health technology agencies, as well as a focused Internet search. No filters were applied to limit the retrieval by study type. Where possible, retrieval was limited to the human population. The search was also limited to English language documents published between January 1, 2007 and March 23, 2011.

Selection criteria and method

One reviewer (CH) screened the titles and abstracts of the retrieved publications and examined the full-text publications for the final article selection. Selection criteria are outlined in Table 1.

<table>
<thead>
<tr>
<th>Table 1: Selection Criteria</th>
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<tbody>
<tr>
<td>Population</td>
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<tr>
<td>Intervention</td>
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<tr>
<td>Comparator</td>
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<tr>
<td>Outcomes</td>
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<tr>
<td>Study designs</td>
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</table>
Exclusion criteria

Articles were excluded if they did not satisfy the selection criteria in table 1, or if they were published before 2007, or they were duplicate publications of the same study.

Critical appraisal of individual studies

The quality of the included study was assessed using the quality of diagnostic accuracy studies (QUADAS) tool.23

SUMMARY OF EVIDENCE:

Quantity of research available

One-hundred and fifty-seven studies were identified by the literature search, and six were identified by the grey literature search. From these, 36 potentially relevant studies were selected for full-text screening, and one clinical trial was selected for inclusion. Appendix 1 describes the PRISMA flowchart of the included studies. The characteristics of the included study were summarized in Table 2. No economic evaluations were identified.

Table 2: Characteristics of Included Study

<table>
<thead>
<tr>
<th>First Author, Publication Year, Country</th>
<th>Study Design, Setting</th>
<th>Patient Characteristics, Sample Size (n)</th>
<th>Intervention</th>
<th>Comparator(s)</th>
<th>Clinical Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ridge, 2009, Ireland24</td>
<td>Retrospective study; hospital setting</td>
<td>n=50 pregnant women with suspected pulmonary embolism</td>
<td>Ventilation/perfusion scintigraphy using Technegas</td>
<td>Computed tomography pulmonary angiography</td>
<td>Diagnostic adequacy</td>
</tr>
</tbody>
</table>

Summary of findings

1. What is the comparative clinical effectiveness of ventilation/perfusion scan (using Technegas) versus computed tomography pulmonary angiogram for diagnosing pulmonary embolism in hospitalized patients?

The literature search identified one retrospective study that compared V/Q scan using Technegas to CTPA in pregnant women with suspected pulmonary embolism.24 Twenty-five pregnant women were in the V/Q scan cohort and 25 were in the CTPA group. Ventilation scan was performed using 99m-Tc carbon particles (Technegas, Cyclopharm), and CTPA was performed with multi-detector CT scanner (i.e., Somaton Sensation 64, Siemens Healthcare). Image analyses were done by consensus of two experienced radiologists. V/Q scan and CTPA were then classified as adequate or inadequate (i.e., whether the images were considered of diagnostic quality by the radiologists) for the diagnosis of pulmonary embolism. The results showed the rate of diagnostic inadequacy was lower for C/Q scan than for CTPA (4% vs 35.7%; p < 0.0058). The authors concluded
that V/Q scan was more reliable than CTPA in pregnant women. One possible explanation is that CTPA may have been affected by hemodynamic alterations during pregnancy, leading to poor pulmonary arterial opacification during CTPA.

2. What is the cost-effectiveness of ventilation/perfusion scan (using Technegas) versus computed tomography pulmonary angiogram for diagnosing pulmonary embolism in hospitalized patients?

The literature search did not identify any economic studies that compared the cost-effectiveness of V/Q scan using Technegas with CTPA.

Critical appraisal of individual studies

A summary of the quality appraisal of the included study using QUADAS is found in Appendix 2. Since the study sample was limited to pregnant women, it does not represent the entire population with suspected pulmonary emboli in clinical practice. Potential differences mentioned between the intervention and control groups or disagreements in the interpretation of the results were not reported.

LIMITATIONS

The literature search found one retrospective study that met the selection criteria. The study sample was limited to pregnant women and was not representative of the entire population at risk of pulmonary emboli in clinical practice. The number of subjects in the study limited the statistical power of the findings (n=50).

CONCLUSIONS AND IMPLICATIONS FOR DECISION OR POLICY MAKING:

The evidence on the clinical effectiveness of V/Q scan using Technegas compared with CTPA in the diagnosis of pulmonary emboli is insufficient. One retrospective study found that V/Q scan with Technegas is more reliable than CTPA in the diagnosis of pulmonary embolism in pregnant women. There is evidence in studies not included in this report that the diagnostic accuracy of V/Q scan using aerosols other than Technegas is comparable with CTPA, and that 99m technetium-labelled carbon (Technegas) provides better lung penetration than 99m technetium-labelled aerosols of diethylene triamine pentaacetic acid.
References


APPENDIX 1: Selection of Included Studies

157 citations identified from electronic literature search and screened

→ 127 citations excluded

30 potentially relevant articles retrieved for scrutiny (full text, if available)

→ 6 potentially relevant reports retrieved from other sources (grey literature, hand search)

36 potentially relevant reports

-35 reports excluded:
  -irrelevant intervention (3)
  -irrelevant comparator (1)
  -irrelevant outcomes (3)
  -irrelevant population (1)
  -other (review articles, editorials) (27)

1 report included in review
### APPENDIX 2: Critical Appraisal of Included Studies

<table>
<thead>
<tr>
<th>Item</th>
<th>Yes</th>
<th>No</th>
<th>Unclear</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Was the spectrum of patients representative of the patients who will receive the test in practice?</td>
<td>( )</td>
<td>(x)</td>
<td>( )</td>
</tr>
<tr>
<td>2. Were selection criteria clearly described?</td>
<td>(x)</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>3. Is the reference standard likely to correctly classify the target condition?</td>
<td>(x)</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>4. Is the time period between reference standard and index test short enough to be reasonably sure that the target condition did not change between the two tests?</td>
<td>(x)</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>5. Did the whole sample or a random selection of the sample, receive verification using a reference standard of diagnosis?</td>
<td>( )</td>
<td>( )</td>
<td>(x)</td>
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<tr>
<td>6. Did patients receive the same reference standard regardless of the index test result?</td>
<td>( )</td>
<td>( )</td>
<td>(x)</td>
</tr>
<tr>
<td>7. Was the reference standard independent of the index test (i.e. the index test did not form part of the reference standard)?</td>
<td>(x)</td>
<td>( )</td>
<td>( )</td>
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<tr>
<td>8. Was the execution of the index test described in sufficient detail to permit replication of the test?</td>
<td>(x)</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>9. Was the execution of the reference standard described in sufficient detail to permit its replication?</td>
<td>(x)</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>10. Were the index test results interpreted without knowledge of the results of the reference standard?</td>
<td>( )</td>
<td>( )</td>
<td>(x)</td>
</tr>
<tr>
<td>11. Were the reference standard results interpreted without knowledge of the results of the index test?</td>
<td>( )</td>
<td>( )</td>
<td>(x)</td>
</tr>
<tr>
<td>12. Were the same clinical data available when test results were interpreted as would be available when the test is used in practice?</td>
<td>(x)</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>13. Were uninterpretable/ intermediate test results reported?</td>
<td>(x)</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>14. Were withdrawals from the study explained?</td>
<td>(x)</td>
<td>( )</td>
<td>( )</td>
</tr>
</tbody>
</table>

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