

Latest highlight from literature review

Toney LK, et al. *The Economic Value of Hybrid Single-Photon Emission Computed Tomography with Computed Tomography Imaging in Pulmonary Embolism Diagnosis. Acad Emerg Med* 2017; 24: 1110–1123

Economic value of Hybrid SPECT/CT

In the United States, among 600,000 to 900,000 individuals suffer from acute pulmonary embolism (PE), a potentially fatal disease if untreated, that accounts for an estimated 200,000 to 300,000 hospital admissions¹.

PE diagnosis workflow includes clinical evaluation by laboratory testing (plasma D-dimer) and lung imaging. Ventilation-perfusion (V/Q) planar scintigraphy and computed tomography pulmonary angiography (CTPA) are depicted as the imaging modality of choice for diagnosing acute PE².

However, V/Q single photon emission computed tomography (SPECT) has superseded planar scintigraphy in clinical practice (particularly in Europe) and has emerged with much greater sensitivity, specificity and reproducibility than CTPA and planar V/Q scintigraphy³.

The Society of Nuclear Medicine details the advantage of using SPECT to obtain a three-dimensional evaluation of the lungs⁴ while the European Association of Nuclear Medicine guidelines clearly recommend V/Q SPECT as the preferred modality whenever possible⁵.

Fusing SPECT with computed tomography (SPECT/CT) enables the acquisition of V/Q SPECT and CT scans of the lung in a single imaging session providing functional and anatomic data results in more accurate localization and definition of scintigraphic findings, thus giving SPECT/CT added clinical value over SPECT or standalone CT imaging⁶.

References

1. Church AM et al. *Emerg Med Pract* 2012; 14(12):1-22
2. Konstantinides et al. *Eur Heart J* 2014; 35(45): 3145-3146
3. Stubbs M, et al. *Nucl Med Commun* 2017; 38(2): 135-140
4. Bajc M, et al. *Eur J Nucl Med Mol Imaging* 2009; 36: 1528-38
5. Parker JA, et al. *J Nucl Med Technol* 2012; 40: 57-65
6. Gutte H, et al. *J Nucl Med* 2009; 50:1987-92

Aim of the study

Given the current challenges in healthcare to contain costs while improving patient outcomes, this study attempts to quantify the potential economic value of V/Q SPECT/CT versus other imaging modalities (CTPA, planar V/Q and V/Q SPECT), in order to establish the diagnosis of suspected PE patients in an emergency room (ER) setting from a health plan payer's perspective.

Design of the study

Clinical endpoints and corresponding cost data were obtained by reviewing published literature (2005 to 2016) of patients with suspected PE in ER settings.

Outcomes included in the study were:

- Total cost burden
- Potentially wasteful excess costs
- Total lives lost

Major findings

Per annum and for every 1,000 imaging patients, switching to hybrid V/Q SPECT/CT would save:

	vs V/Q SPECT	vs CTPA
Total costs (USD)	\$400,000	\$600,000
Potentially wasteful excess cost (USD)	\$435,038	\$994,777

Reduction of potentially wasteful excess costs would be achieved mainly via reduction in PE hospitalization costs of the false positives.

The higher sensitivity and specificity of V/Q SPECT/CT, along with the absence of contrast-related complications may also help avoid loss of life compared to CTPA (up to 6 human lives).

V/Q SPECT/CT appears to confer superior economic value, primarily via improved sensitivity and specificity and low non-diagnostic rates. In turn, the improved diagnostic accuracy accords this modality the lowest ratio of expenses attributable to potentially avoidable complications, misdiagnosis and underdiagnosis.

Clinical value for TECHNEGAS

By bringing further evidence on the economic superiority of V/Q SPECT/CT along with improved diagnostic capabilities and easier availability, this paper supports Cyclomedica's recommendation to use V/Q SPECT/CT with Technegas as the first-line imaging modality for pulmonary embolism diagnosis.

Mid-year literature review

Large prospective studies are needed to warrant ventilation-perfusion (V/Q) single photon emission computed tomography (V/Q SPECT) with or without low dose CT (LDCT) as superior imaging modality for pulmonary embolism (PE) diagnosis

Because CTPA has several drawbacks, the nuclear medicine community mostly encourages V/Q SPECT use for diagnosing PE. However, according to the lack of numerous and large validation outcome studies, these recommendations remain an expert opinion. Therefore, the results of a randomized control trial that has just started in Europe will be of value to ensure that a diagnostic strategy based on clinical probability assessment, D-dimer measurement and V/Q SPECT is non-inferior to CTPA or planar V/Q in terms of diagnostic, exclusion safety, but also to detect a potential over-diagnosis using one of the strategies.

The introduction of integrated multimodality hy-

brid SPECT/CT cameras has enabled simultaneous acquisition of V/Q SPECT and CT scans of the lungs. The CT is usually performed as a low-dose CT scan without contrast enhancement. The combination of V/Q SPECT and CT scans has been described to improve the diagnostic performance of V/Q SPECT. LDCT allows the visualization of 'non-thromboembolic' abnormalities such as emphysema or pneumonia that may explain perfusion defects. CT images also allow anatomical correlation, for example for the detection of fissures. Nevertheless, formal validation of this hybrid technique in the management of patients with suspected PE is still needed.

Le Roux P, et al. *Thromb Res.* 2018; 163: 236-241

Just as radiology societies recommend computed tomography pulmonary angiography (CTPA) as the imaging test of choice in the diagnosis of PE, the European Association of Nuclear Medicine broadly recommends V/Q SPECT over CTPA wherever available. A prospective outcome study to assess V/Q SPECT superiority compared to CTPA is still needed. If confirmed, V/Q SPECT could become a very interesting alternative to CTPA, especially in patients in whom radiation is particularly a concern (young female patients, or in patients with contra-indication to CTPA).

Righini M, et al. *J Thromb Haemost.* 2017; 15: 1251-61

V/Q SPECT(/CT) for broad range of pulmonary diseases

With studies demonstrating an increased mortality in idiopathic pulmonary fibrosis (IPF) patients treated with warfarin, there is a need for a gold standard to investigate for PE in these patients. V/Q SPECT is one of the imaging modality used in clinical practice to assess for pulmonary embolism.

Jee AS, et al. *Respirology* 2017; 22: 1022-34

The clinical diagnosis of PE in patients with chronic obstructive pulmonary disease (COPD) is considered challenging because the symptoms of both PE and COPD are non-specific and quite alike. However, V/Q SPECT using Technegas can now diagnose both conditions fast and accurately. Therefore, COPD is not a contraindication to use V/Q SPECT with Technegas for PE diagnosis even in the most severe grade of COPD.

Nasr A, et al. *EC Pulmonology and Respiratory Medicine.* 2017; 4(3): 85-91

Regional ventilation measured by SPECT/CT using Technegas is reduced in asthma and becomes even more heterogeneous after bronchoconstriction.

Farrow CE, et al. *J Appl Physiol.* 2017; 123(5): 1188-1194

Clinical value for TECHNEGAS

Adding a low-dose CT component to the V/Q SPECT enables the detection of alternative diagnosis in patients suspected of having PE with a low radiation burden. Therefore, V/Q SPECT/CT using Technegas provides a comprehensive assessment of lung function and morphology in these patients.

What's happening with other imaging modalities?

Increasing use of CTPA with diminishing prevalence of pulmonary embolism has led to overdiagnosis of mostly subsegmental pulmonary embolism and unnecessary risks of radiation exposure and contrast medium induced nephropathy. To avoid these problems, validated diagnostic algorithms for suspected acute PE, using sequential testing, have been introduced. The main advantage of the YEARS algorithm in patients suspected of PE is the absolute 14% decrease of CTPA examinations in all ages and across several relevant subgroups.

van der Hulle T, et al. *Lancet.* 2017; 390: 289-297

This retrospective study demonstrates that using a low dose CTPA technique tailored to pregnancy, results in significant dose reductions (under 1msV), without a reduction in clinical image quality.

Halpenny D, et al. *Clin Imaging.* 2017 (44): 101-105