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SPECT/CT and Quantitative Analysis Provide a Clear Assessment of PE and Lung Function

Pulmonary embolism (PE) is a blockage of an artery in the lung that originates commonly as a blood clot in the leg. It is estimated there are 17,000 new cases of venous thromboembolism (VTE) in Australia per year, and PE accounts for about 40% of these events.[1] Clinical symptoms of PE are non-specific and can be mild, and they have poor positive predictive value when used alone. But traditional imaging methods present their own challenges, such as exposure to ionizing radiation and relatively high incidences of ambiguous results.

In 2009, the European Association of Nuclear Medicine published new guidelines recommending the use of tomography (V/Q SPECT) as a first-line procedure in patients with suspected PE.[2] Breakthroughs in SPECT/CT technology improve the specificity of such exams.

Q.Lung from GE Healthcare helps physicians diagnose PE in a more effective way and provides meaningful and valuable pre-surgical assessments. It combines both anatomy and function with automatic and semi-automatic segmentation tools. This capability also helps accurately quantitate lobe perfusion relative to the rest of the lung anatomy. The result is a more accurate evaluation of predicted postoperative forced expiratory volume in one second (ppoFEV1) to confidently inform the outcome of lung or lobe resection surgery.

Addressing PE in Australia

Austin Health in Victoria, Australia, is comprised of the Austin Hospital, Heidelberg Repatriation Hospital and the Royal Talbot Rehabilitation Centre. It operates 980 beds across acute, sub-acute and mental health facilities, is an internationally recognized leader in clinical teaching and training, and is affiliated with eight universities.

Each year, Austin Health performs 900 ventilation perfusion lung scans, most of which are for assessment of either acute PE or for clot resolution.

There are many challenges in diagnosing these cases, especially for on-call ER physicians who need precise information to make clinical decisions. “Clinical information is often unreliable and a blood test is nonspecific,” says Aurora Poon, FRACP, nuclear medicine physician at Austin Health. “Patient motion during image acquisition may cause artifacts and might not represent PE. And not all V/Q mismatches are pulmonary emboli and incomplete occlusion of pulmonary artery may not cause perfusion defects.”

To address these cases accurately, Austin Health performs V/Q exams on the Discovery™ NM/CT 670 systems and recently started using Q.Lung software for all diagnostic workups for acute and chronic PE.

“SPECT/CT offers more accurate anatomical localization and additional anatomical abnormalities in the chest. For example, in one of our patients assessed for possible PE, ventilation and perfusion SPECT showed no PE but CT showed bilateral pleural effusion and pericardial effusion which may contribute to the patient’s symptoms,” she says.

“With the increase in sensitivity using SPECT, specificity is actually reduced. We probably pick up more small mismatched perfusion defects that would otherwise be called normal on planar imaging, so all SPECT images are read with reprojection planar images,” she says. “It improves the confidence in reporting apparent mismatch from artifacts or hilar vascular prominence especially when combined with low-dose CT.”

When determining whether to include a CT, Dr. Poon will review the planar images. If they look normal, she’ll quickly

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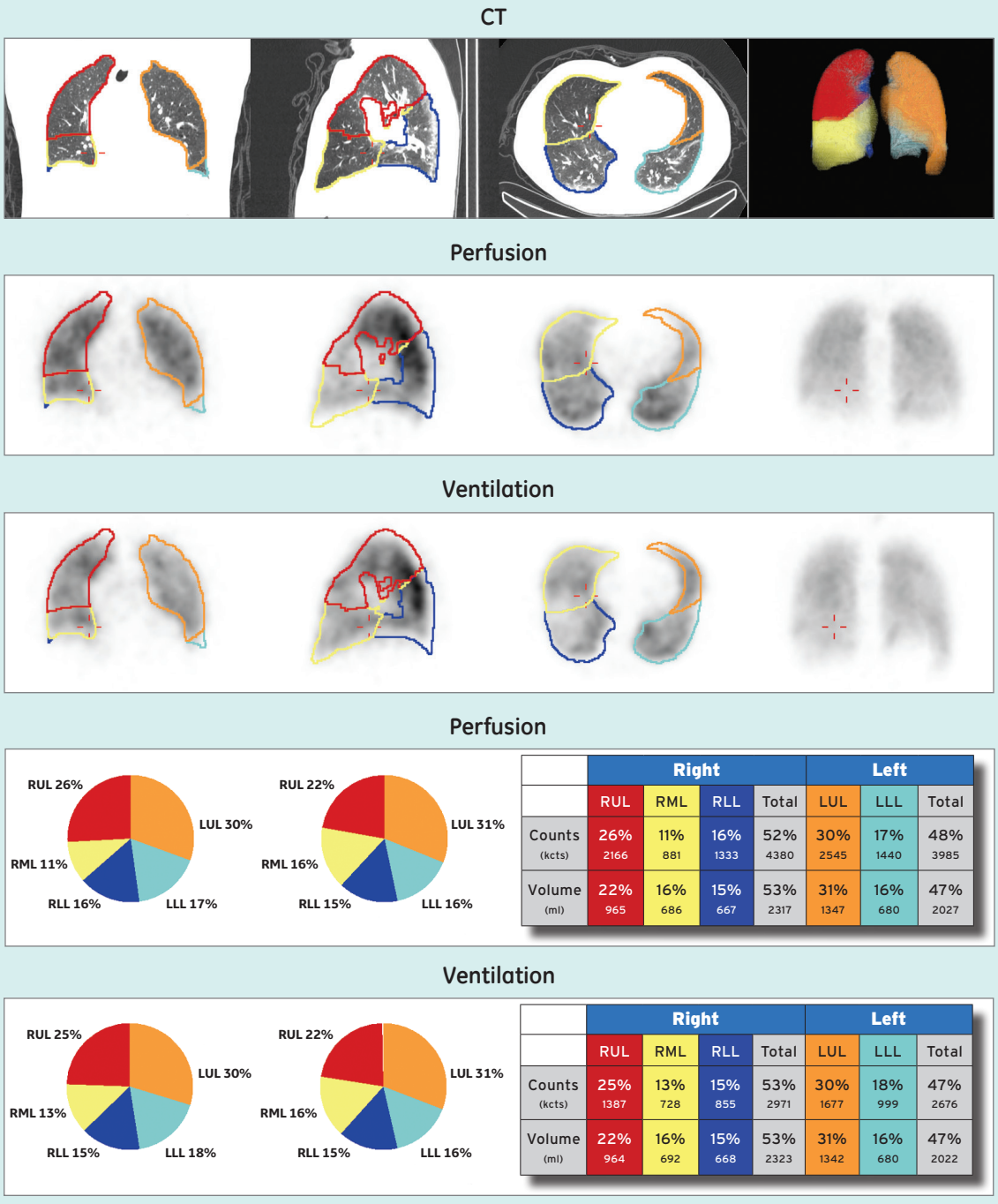

	Right				Left		
	RUL	RML	RLL	Total	LUL	LLL	Total
Counts (kcts)	26% 2166	11% 881	16% 1333	52% 4380	30% 2545	17% 1440	48% 3985
Volume (ml)	22% 965	16% 686	15% 667	53% 2317	31% 1347	16% 680	47% 2027

	Right				Left		
	RUL	RML	RLL	Total	LUL	LLL	Total
Counts (kcts)	25% 1387	13% 728	15% 855	53% 2971	30% 1677	18% 999	47% 2676
Volume (ml)	22% 964	16% 692	15% 668	53% 2323	31% 1342	16% 680	47% 2022

Figure 1. Accurate quantitation in a 13 sec/step, 15 min SPECT acquisition. Perfusion: 220 MBq of ^{99m}Tc MAA; 20-60 mAs, 120 kV, ASiR 50%. Ventilation: 40 MBq of ^{99m}Tc Technegas; 20-60 mAs, 120 kV, ASiR 50%.

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reference the processed SPECT images to make sure they are actually normal before declining the low-dose CT. She explains, "If the planar looks really abnormal—whether the ventilation and perfusion defects matched or mismatched—then I tend to choose to add the low-dose CT unless it is obviously just PE and nothing else. So, for the positive or very normal cases, I don't need CT but if that is not the case, we do a CT. The decision to perform a low-dose CT may also be influenced by other clinical information."

SPECT has made a significant difference in how images are read and interpreted. "Q.Lung can possibly help quantify the severity or extent of pulmonary vasculature involvement," she adds.

Increasing Referrals

In addition to using Q.Lung for PE patients, Austin Health also finds it useful for preoperative prediction of lung function. Ventilation and perfusion lung scans are not routinely performed prior to lung resection. They are only requested in patients with borderline lung function where distribution of pulmonary perfusion may help determine if the patient has sufficient pulmonary reserve and could help predict post-operative outcome.

In the assessment of differential lung function as pre-operative workup prior to lung resections, ventilation and perfusion studies are traditionally performed in planar acquisitions, which often deliver non-anatomical differential lung function. "Planar differential perfusion (and ventilation) is inaccurate and some SPECT quantitative software is labor intensive from the technologist or physician point of view," Dr. Poon says. Plus, the inaccuracy of the calculations limited the number of referrals Austin Health received, as well as the volume of patients they could work up.

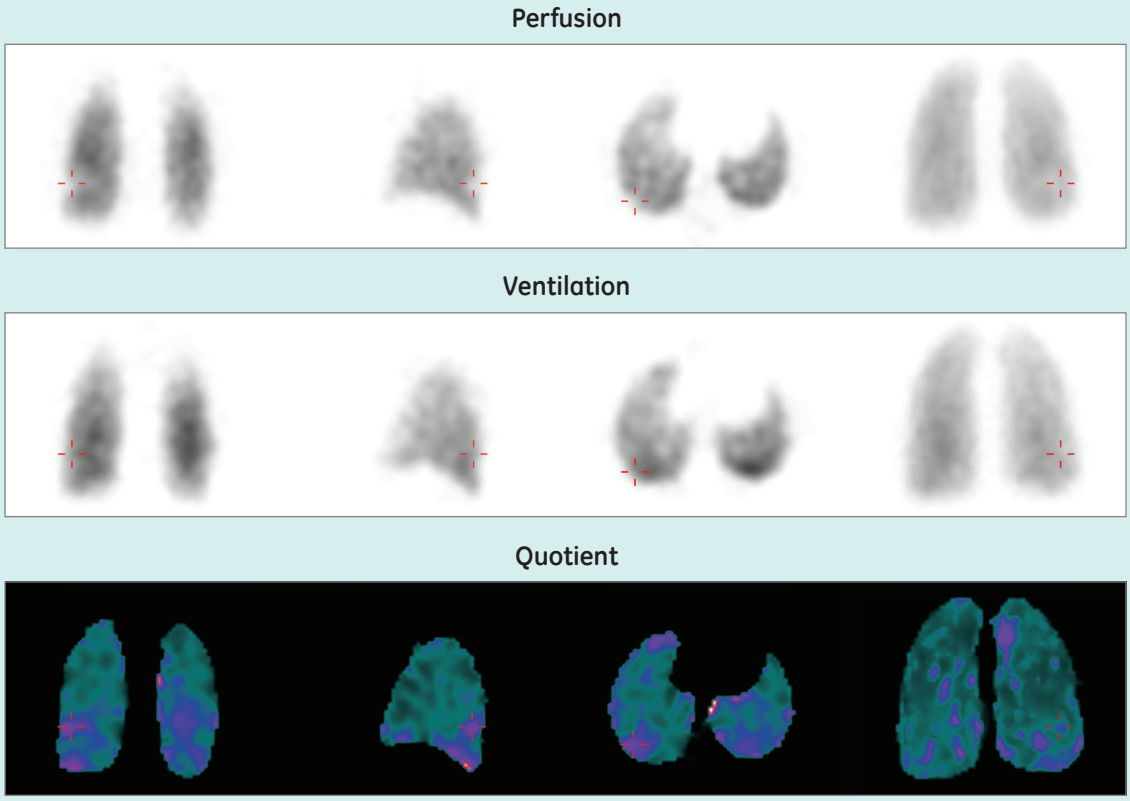

Figure 2. Quotient images depict a mismatch of the total volume at 3%.

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> *"... but with Q.Lung, I can perform the analysis as soon as the acquisitions are complete as it can be done in a relatively short timeframe."*
>
> *Dr. Aurora Poon*

Austin Health often uses SPECT/CT imaging for surgical work-up in lung resection cases. Historically, the practice would see sporadic referral for lung surgical resection; but, in the four months since their Discovery NM/CT 670 installation, they've seen eight patients referred for assessment of differential pulmonary ventilation/perfusion. Seven patients were pre-operative assessment and one was referred for the assessment of effect in phrenic nerve palsy. Dr. Poon expects this number to grow as referring physicians hear about their clinical capabilities.

"We have seen a few more referrals from external surgeons since the installation of the Discovery NM/CT 670 system," she says.

Her hospital is also located next to a maternity hospital, so they see a higher than usual number of pregnant patients with suspected PE.

"Also we have a large population of patients with poor renal function and post-renal transplant. If clinically warranted, they will be done at the earliest possible time. The emergency patients with low clinical likelihood may be sent home after an anticoagulant injection and then return the next day for a SPECT V/Q."

An efficient workflow

Dr. Poon says that Q.Lung is easy to use, and the total acquisition time is similar to other methods. However, the key benefit is that it requires less time for the nuclear medicine physician to analyze the imaging data and report the case. Before Q.Lung, a 3D pre-surgical workup for a lung resection took one to three hours, depending on complexity of the case and other factors. Now, with Q.Lung, she can complete them in much less time.

"I can do the simple cases in about 10 minutes or less. And even the more difficult cases I can complete in about 45 minutes," she says.

She used to perform these analyses at the end of the day, but now these can be reported as part of the routine workflow. "It interferes less with that workflow if done at the end of the day," she explains, "but with Q.Lung, I can perform the analysis as soon as the acquisitions are complete as it can be done in a relatively short timeframe."

Q.Lung is also improving Dr. Poon's efficiency in the pre-operative cases because previously she would have to draw a region on every single slice for each lung and each lobe of the lung separately.

"I could copy and paste the region of interest from one slice to the next and make adjustment for each slice, but I couldn't import the region from the perfusion study into the ventilation. I would have to do it all over again, which could make each subsequent region less accurate. Therefore, I tend to only perform differential pulmonary perfusion as the surgeons are more interested in this than the differential pulmonary ventilation," Dr. Poon explains.

For Dr. Poon, the addition of Q.Lung to their SPECT/CT imaging capabilities has led to faster processing and therefore shorter reporting times for differential pulmonary ventilation and perfusion assessment. Dr. Poon expects that referrals for pre-lung resection workup will continue to increase as more referring physicians learn about the clinical benefits of utilizing SPECT/CT and Q.Lung data for pre-surgical planning. ■

References

1. Available at: https://www.racgp.org.au/afp/2013/september/pulmonary-embolism/.
2. Bajc M, Neilly JB, Miniati M, et al. EANM guidelines for ventilation/perfusion scintigraphy. Eur J Nucl Med Mol Imaging (2009) 36:1356–1370.