Ventilation/perfusion (V/Q) scintigraphy is a diagnostic investigation used in nuclear medicine to evaluate air flow (V) and blood perfusion (Q) in the lungs. It is most commonly used to detect or confirm pulmonary emboli (blood clots lodged in the capillaries, which cause blockages that restrict blood flow to some areas of the lung).

**How does it work?**

In V/Q scintigraphy, as explained by Gray (2005), images are acquired in two phases:

1. **After inhalation of a radioactive gas to assess ventilation of the airways;**
2. **After intravenous administration of a radioactive colloid to assess perfusion of blood in the capillary beds of the lungs.**

**First phase**

The test begins with the administration of a ventilation radiopharmaceutical, which can be in the form of a nebulised agent (inhaled into the lungs through a nebuliser) or a gas (inhaled into the lungs through a mask or mouthpiece). Images showing the air supply to the lungs are taken at various angles. Ventilation images are often acquired before perfusion images but, if using a radioactive gas, both types of images can be acquired at the same time.

**Second phase**

In the second phase, while the patient is still supine, a perfusion radiopharmaceutical is administered intravenously and lodges in the capillary beds. It cannot travel past blood clots occluding the vessels so, if there are areas that have taken up smaller amounts of radioactivity (or none at all), this indicates a high likelihood of pulmonary emboli.

Imaging takes place straight after the injection of the radiopharmaceutical and usually takes 5-20 minutes, depending on factors such as the activity of the chosen radiopharmaceutical. Perfusion images need to be taken from the same angles as ventilation images, so the two sets can be accurately compared.

If the perfusion radiopharmaceutical is not properly mixed before it is injected, there may be a clumping of particles that could cause an artefact (see part 2). This can sometimes result in images that are...
not usable for diagnostic purposes. Clumping artefacts are commonly observed in ventilation images acquired using the radioisotope technetium-99m ($^{99m}$Tc) (see part 1) combined with the chelating agent diethylenetriaminepentaacetic acid (DTPA). They are more likely to be present in patients with chronic obstructive pulmonary disease (COPD) (Ziessman et al, 2013).

Central lines should be avoided when injecting the radiopharmaceutical, as it may not have time to adequately mix with the blood in the pulmonary artery before reaching the lungs, which would cause poor distribution (Parker et al, 2012). Another necessary precaution is to avoid drawing blood back into the syringe and re-injecting it, as this may cause hot spots on the images.

Comparing the images
The two sets of images are compared. If the ventilation images (first set) do not show anything abnormal but the perfusion images (second set) do, this suggests pulmonary embolism. Defects that are indicative of pulmonary embolism are called ‘segmental’, referring to the anatomical segments of the lungs each supplied with a separate arterial branch; they often have a triangular shape (fig 1). If ventilation and perfusion images contain matching abnormal defects distributed in a patchy pattern, this is indicative of COPD.

“Legislation surrounding radiation protection states the importance of keeping radiation exposure of staff and patients as low as is reasonably achievable”

Preparing patients
V/Q imaging is commonly used to investigate potential pulmonary embolism in patients who are pregnant due to the lower radiation burden, compared with other investigation methods. Due to the nature of ionising radiation, pregnant women are often anxious about the dose of radiation the foetus might receive.

Patients undergoing nuclear medicine investigations sometimes assume radiation begins with the imaging process. This is not the case: radiation starts with the administration of the radiopharmaceutical. This should be very clearly explained to the patient before administration. If the patient is a pregnant woman, written consent is often required before administration to ensure she is aware of the risks to herself and the foetus (International Commission on Radiological Protection, 2000).

Pregnant women can undergo V/Q imaging relatively safely. The risk of the future baby developing cancer in childhood after the mother has undergone a V/Q scan is very low; it sits at approximately 1 in 280,000 people (Cook and Kyriou, 2005).

Radiation protection
Women who are breastfeeding can safely undergo V/Q imaging. However, they should express and discard their breast milk for 12 hours after intravenous injection of the radiopharmaceutical, as it will contain levels of radiation that are higher than normal (ICRP, 2000).

After V/Q imaging, patients should be encouraged to drink plenty and urinate often, unless contraindicated. This will help them clear the radioactive drug (which is excreted via the urinary tract) from their system more quickly and, for those who are pregnant, help reduce the dose of radiation received by the foetus because of concentration of radioactive urine in the patient’s bladder (ICRP, 2000).

If samples of blood, urine or faeces need to be collected from a patient in the 24 hours after V/Q imaging, nurses should take extra care and:
- Wear gloves, an apron and shoe coverings;
- Use absorbent pads to clean up any spillages.

If possible, it is advisable to either perform sample collection before the injection of the radioactive drug or postpone it until after 24 hours after the investigation.

Patients should not have close contact with young children or pregnant women—the two groups who are most at risk from radiation—for 24 hours after administration of the radiopharmaceutical. Ideally, staff members who are pregnant should not care for patients who have just had V/Q imaging, and all staff need to take extra care to reduce their own exposure to radiation. After 24 hours, standard staff rotas and care protocols can be resumed.

Conclusion
Legislation surrounding radiation protection states the importance of keeping radiation exposure of staff and patients as low as is reasonably achievable. Nursing staff should ensure they keep their distance from patients who have recently undergone a nuclear medicine procedure, and staff should ensure pregnant women and children keep their distance from the patient for 24 hours post investigation.

It is also important to reduce the time spent in close proximity with these patients wherever feasible—for example, taking samples of blood, urine or faeces should be avoided if possible. The handling of any of these fluids should be undertaken with care, and with the use of gloves and aprons. If there are any queries about specific nuclear medicine patient care, the local nuclear medicine department or medical physics expert can offer advice. NT

References