8 Lung

This application allows you to generate relative pulmonary uptake values for various pulmonary studies. Depending on the datasets you have loaded, you can perform analysis for perfusion only, ventilation only, or washout. Results are provided for upper, middle, and lower vertical segments in each lung. It has these methods:

- Perfusion Analysis
- Ventilation Analysis
- Washout Analysis
- Geometric Oblique Analysis

The methods are used to create these Preferences:

- Washout Analysis
- Ventilation Analysis
- Perfusion Analysis
- Perf Vent Analysis
- Perf Vent Side by Side Analysis
- Geometric Oblique Analysis

For information on loading requirements, and on calculations and algorithms used in this application, see the appropriate section in the *NM Application Suite Reference Manual*.

NOTICE

For the Time Activity Curves displayed in this application, the first point is the time for the end of the first frame. For example, if the first frame is 60 sec., the first point in the curve is not 0, but 60 (if seconds are the units; it would be 1 if the units were minutes). This reflects the fact that the frame completion is at the end of the time span.

NOTICE

When selecting multiple methods for analysis, you will typically have a separate page in the Define Regions and Review Results worksteps for each method selected. However, when using the Perf Vent Side by Side Analysis preference, there is a single page in the Define Regions and Review Results worksteps containing the combined information.

NOTICE

When selecting Washout Analysis preference, you can configure the following Parameters:

- Select Number of background regions to 1 or 2 (separate backgrounds for Left and Right lungs).
- Select to enable View fit curves.

Lung Tutorial

In this tutorial you will learn how to perform a lung perfusion/ventilation analysis. You will learn how to load the lung data, draw the necessary ROIs, and review the results and images. The Preference used for this tutorial analyzes both perfusion and ventilation data, each of which has its own page in the Define Regions and Review Results worksteps.

NOTICE

This tutorial is designed to use a particular sample patient that works well to illustrate certain features of the software. Nothing prevents you from substituting your own patient, but be aware that it may not load the same way or produce similar results. If you try to load your own data and it fails because of automatching, see section “Editing Auto Matches” on page 27.

If you would like to start this tutorial over at any time, just click **Restart** in the application. This reloads the data as it does in the first workstep, as long as the default Preference has not been changed.

Setup

1. In the IntelliSpace Portal Patient Directory’s Local Devices list, select the NM Demo Data folder.
2. From the list of patients, select Patient Name **NM Lung** with Patient ID **Lungs Quantification**.
3. Click on the arrow in the Analysis menu and select the NM Lung application.
4. Open the Preferences Data Manager and select the Perf Vent Analysis Preference by clicking on its **Apply Preference** icon ().

   The patient data automatches with the Preference by default, so you do not need to load data into buckets individually. When this happens, the application proceeds directly to the next workstep (Define Regions) automatically.

   If you wanted to load different data, you would have to go back to the Setup workstep. By way of example, we will do that next.
5. Click the Previous Workstep button to go back to the Setup workstep.
6. Open the Perfusion bucket by clicking on the double down arrows.
7. Click on the POST bucket dropdown list.
8. Scroll down to the bottom of the image list and select **Clear Bucket**.
9. Similarly, clear the ANT bucket.
10. Notice that the Perfusion bucket and its mandatory data buckets have red exclamation points. This indicates that they require data.
11. Click on the POST dropdown list again and select Perf POST. Then select Perf ANT from the ANT dropdown list.

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This clears the exclamation points and allows you to proceed to the next workstep.

12. Click the Next Workstep button to proceed to the Define Regions workstep:

NOTICE

For Side by Side Analysis, both perfusion and ventilation data are mandatory to be bucketed.

Define Regions

When the workstep loads, you can see that the Next Workstep button is grayed out:

This indicates that a requirement for the workstep has not been met. Different applications may have different requirements: drawing certain ROIs, setting parameters, etc. When all requirements have been met, the button becomes available.

This Preference requires you to specify an ROI for each lung. The basic process for drawing ROIs is very simple, but for instructional purposes we will make multiple attempts at this.

By default, two rectangular bounding boxes are positioned on the image, one for each lung.

1. Click Detect All Regions.

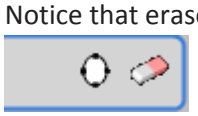
   This automatically draws the ROIs as isocontours. These ROIs are duplicated for the Ventilation page.

NOTICE

For the Perf Vent Side by Side Analysis Preference, the ROIs are not propagated or copied from perfusion to ventilation. It requires you specify an ROI for each lung for both perfusion and ventilation separately.

2. Click Detect All Regions again to undo the drawing.
3. Now adjust the rectangles so they are sized more appropriately for the image: hover the cursor over a line and drag the handles that appear.
4. Click Detect All Regions again.

   Notice that erasers appear in the Left and Right Lung Draw Regions:



5. Click the Right Lung eraser to delete the ROI.

The eraser icon changes to a pencil. This indicates that you can draw the ROI by hand. While you could draw using the default Freehand Contour tool, a box serves the purpose as well and is simpler to use.

6. Click the arrow on the Set ROI Type icon to display the menu.

7. Drag out a box to enclose the lung and adjust it using the handles.

NOTICE

After drawing the ROI, you can edit it. But if you do, the new ROI will not get propagated to the opposite side. To propagate ROIs you must use Restart to reload the data.

8. Select **Box** from the menu
9. Click the Ventilation Analysis protocol and confirm that the ROIs are correct for this image.

This page allows you to account for patient movement between perfusion and ventilation acquisition, for example. Any ROI editing on this page is not duplicated on the Perfusion page.

The regions detected will only propagate between methods specified within the preference if the ROI types match between the methods. For example, if the Perfusion Analysis method is configured in the preference to use a Box ROI and the Ventilation Analysis is configured to use a Smooth Polygon ROI, the original regions from the Perfusion Analysis will not be propagated to the Ventilation Analysis. You will be forced to complete the regions for the method in order to perform the analysis.

10. Notice that the Next Workstep button is now available. This indicates that there are no more ROIs to be drawn

11. Advance to the next workstep by clicking the Next Workstep button.

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Review Results

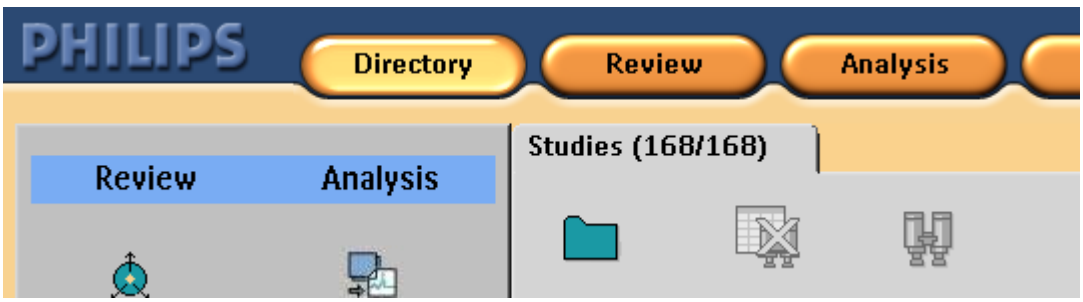
In this workstep, you can review the quantification results. For a list of the results displayed, see the “Results” section later in this chapter. You can also save the page as a Secondary Capture (as you can in any workstep). Secondary Captures can be either single-frame or multi-frame. Multi-frame allows you to embed a cine.

This Preference provides separate results for perfusion and ventilation. After reviewing the perfusion results, click on Ventilation Analysis (as you did in the Define Regions workstep) to review those results. You can create a Secondary Capture of each page.

Now create a Secondary Capture of the results:

1. If it is not already selected, click the Scroll button () and drag upward in the cine viewer to scroll to the first frame. The frame number is displayed in the lower right of the viewer.

2. In the Image Tools Manager, click the arrow on the **Save all images** button () and select **Secondary Capture**.
3. Type in a description for the Secondary Capture.
4. Check the **RGB** option.
5. Click **Save**.
6. Click on the orange IntelliSpace Portal **Directory** button at the top of the screen (the active button in the image below) to display the Patient Directory and notice that the saved image is listed in the Series list at the bottom, and also in the NM Images list (which is the tab next to Series).

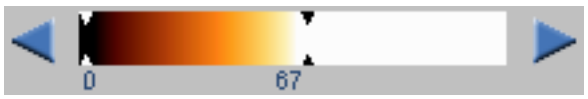


7. Return to the application by clicking on the orange IntelliSpace Portal **Analysis** button at the top.
8. Advance to the next workstep by clicking the Next Workstep button.

Review Images

This workstep provides multiple layouts to view the images. Click on each layout to view its contents. Layouts with a dark blue background are unavailable. You can also hide and show individual viewers:

1. Click the triangular Remove button in the upper left viewer to remove the viewer from the display area.

2. From the Global Image Tools, select the **Utilities** tab.
3. Click **Show Hidden Viewers** () to list currently hidden viewers.
4. Select the hidden viewer to redisplay it.
5. Use the Image Colorbar in the Image Tools Manager to adjust the background (white bar) and brightness (black bar).
6. Right-click on the Image Colorbar to open a menu that lets you select Colormap, Intensity, and Pixel Values:


When you are done, click **Exit** to exit to the Patient Directory. If you are prompted to save images, click **No** unless you want to save any new images.

Using Lung

This application draws a bounding box around each lung. To use automatic edge detection, first adjust each bounding box by dragging its control points. Then click **Detect All Regions**.

You can set the number of segments used for an ROI in two ways. In the Preferences Editor, select Organs and use the **Segment** selector for the Left or Right Lung. Alternatively, in the Define Regions workstep, right-click on an ROI and select **Number of Segments**.

NOTICE

If you have loaded both posterior and anterior images, you can redraw ROIs separately on each image. However, you must be sure to select the image first by clicking on it.

NOTICE

User can place the Background ROI under the Lungs.

When drawing ROIs for the Geometric Oblique Analysis method, use the following images for reference. The top image defines the lobes:

- LUL: Left Upper Lobe
- LLL: Left Lower Lobe
- RUL: Right Upper Lobe
- RML: Right Middle Lobe

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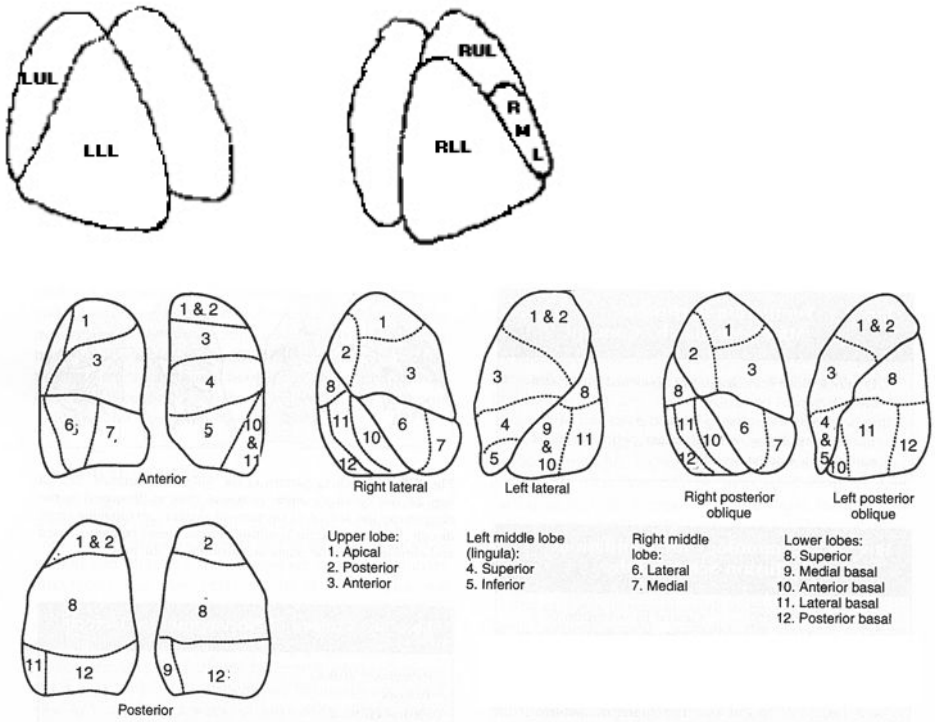
- RLL: Right Lower Lobe



Washout Results

In the Washout Analysis workstep, as soon as you draw the ROIs, you see the Results information:

- Cine with ROIs
- Static images
- T1/2 values for each segment in each lung
- Splash display with ROIs
- Time Activity curves for each segment in each lung
- Time Activity curve, with fit, for each segment in each lung
- Decay corrected Time Activity Curve with fit for each segment in each lung

If you do not see all the result images in the Review Results workstep, it may be that one or more viewers are hidden. If you suspect this, try using the **Show Hidden Viewers** tool in the **Utilities** Data Manager. For more information, see section “Review Results Workstep” on page 27.

Ventilation Results

- Posterior and Anterior images with ROIs

- 6 viewers for static images in other orientations
- Posterior: For each lung, counts by segment, in counts and as a percentage
- Anterior: For each lung, counts by segment, in counts and as a percentage
- Geometric Mean: For each lung, counts by segment, in counts and as a percentage

Perfusion Results

- Posterior and Anterior images with ROIs
- 6 viewers for static images in other orientations
- Posterior: For each lung, counts by segment, in counts and as a percentage
- Anterior: For each lung, counts by segment, in counts and as a percentage
- Geometric Mean: For each lung, counts by segment, in counts and as a percentage

If you do not see all the result images in the Review Results workstep, it may be that one or more viewers are hidden. If you suspect this, try using the **Show Hidden Viewers** tool in the **Utilities** Data Manager. For more information, see section “Review Results Workstep” on page 27.

Perf Vent Side by Side Analysis Results

- Ventilation Posterior and Anterior images with ROIs
- Perfusion Posterior and Anterior images with ROIs
- Ventilation Posterior: For each lung, counts by segment, in counts and as a percentage
- Ventilation Anterior: For each lung, counts by segment, in counts and as a percentage
- Ventilation Geometric Mean: For each lung, counts by segment, in counts and as a percentage
- Perfusion Posterior: For each lung, counts by segment, in counts and as a percentage
- Perfusion Anterior: For each lung, counts by segment, in counts and as a percentage
- Perfusion Geometric Mean: For each lung, counts by segment, in counts and as a percentage
- Six viewers for static images in other orientations for perfusion
- Six viewers for static images in other orientations for ventilation

Both the perfusion and ventilation results are displayed on a single page. If you do not see all the result images in the Review Results workstep, it may be that one or more viewers are hidden. If you suspect this, try using the **Show Hidden Viewers** tool in the Utilities Data Manager. For more information, see section “Review Results Workstep” on page 27.

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Geometric Oblique Results

- Posterior and Anterior images with ROIs
- Perfusion LPO and RPO images with ROIs
- Posterior: For each lung, counts by segment, in counts and as a percentage
- Anterior: For each lung, counts by segment, in counts and as a percentage
- Geometric Mean: For each lung, counts by segment, in counts and as a percentage
- Oblique: For each lung, counts by segment, in counts and as a percentage

Review Layouts

Below are the layouts in the Review workstep:

- Perfusion Ventilation Compare
- Perfusion Display
- Ventilation Display
- Washout Display
- Washout Perfusion Display
- SC images
- Custom Display

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