13 Hepatobiliary

This application allows you to perform gall bladder static analysis and gall bladder dynamic analysis. It has these methods:

- Gall Bladder: This displays a dynamic series of gallbladder images and calculates the gallbladder ejection fraction. It involves no further radionuclide injections. You can get results for these ROIs, which are also selectable as methods for Gall Bladder:
  - Gall Bladder (required)
  - BackGround
  - Hepatic Duct
  - Common Bile Duct
  - Duodenum
- GBEF Static Analysis: This calculates the percent emptied from the pre-stimulus Gallbladder static and up to 12 Post-stimulus statics
- Custom Display: This allows you to create a display tailored to your needs.

The methods are used to create these Preferences:

- Liver Spleen Display
- GBEF Static Analysis
- GB+Bkd+HD+CBD+DUO
- GB+Bkg+HD+CBD
- GB+Bkd+HD
- GallBladder + Bkg
- Gall Bladder

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

The patient data used for any of the Preferences with a dual phase can be bucketed to a multi-phase bucket. The dual phase can be seen in the review results workstep.

Hepatobility Tutorial

In this tutorial you will learn how to perform a hepatobiliary analysis. You will learn how to load gall bladder data, draw the necessary ROIs, and review the results and images.

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 Hepatobiliary** with Patient ID **Gallbladder Normal**.

3. Click on the arrow in the Analysis menu and select the NM Hepatobility application.

4. If the Preferences Data Manager is not open, open it now and select the Gallbladder + Bkg

   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. Click on the Gall Bladder dropdown list and select **Clear Bucket** at the bottom.

7. Notice that the Gall Bladder bucket has a red exclamation point. This indicates that it requires data.

8. Click on the Gall Bladder dropdown list again and select GBEF.

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

9. Click the Next Workstep button to proceed to the Define Regions workstep.

Philips

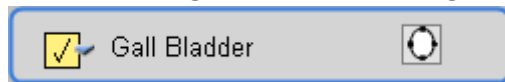## Define Regions and Input Parameter Information

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 application requires some inputs for its calculations. The Inputs viewer contains a table that can be written to. There can be either a checkmark or a pencil in the top right of the Inputs viewer. The pencil indicates that you can set parameters. After parameters are set, you save the information by clicking on the pencil, which turns into a checkmark, indicating that the information has been saved. To set more parameters, click the checkmark, which turns into the pencil.

1. If there is a checkmark in the Inputs viewer, click on it to change it to a pencil, which indicates that the table is writable.

2. Leave **Stimulus Info** set to CCKStimulus, but set the other parameters to these values by typing in the cells:

    - **Dosage of CCK (ug)**: 1.2

    - **Time CCK Infusion Begin (min)**: 0

    - **Duration of CCK infusion (min):** 30

3. Click the pencil icon in the upper right of the viewer to "write" the data to the table. The pencil changes to a checkmark, indicating that the data has been written successfully.

4. Adjust the slider at the bottom of the composite viewer so only frames 1-40 are used in the composite by dragging the right-hand slider to the left.

    By default, there is a bounding ellipse around the gall bladder in the Composite Image viewer (on the left). This defines the area in which autodetection occurs.

5. If necessary, adjust the contrast using the Image Control Bar in the Image Tools Data Manager.

6. Notice that the ellipse could be a little larger and tilted to the right slightly.

7. Use the handles on the ellipse (visible when you hover over it) to adjust it so it completely encloses the gall bladder.

8. Click **Detect Region/Undo Detect Region** (the white ellipse below):

    The ROI is drawn automatically.

9. Now follow the instruction to draw a background, using the pencil icon. If you need to adjust it, use the handles as you did on the ellipse.

If you are not satisfied with the ROIs, you can click the eraser and either use the pencil to redraw the ROI by hand or go back and edit the size or shape of the circle and use **Detect Region/Undo Detect Region** again.

10. Look at the cine viewer and notice that there is motion in the images that can affect the calculations beginning around frame 31.

    When this is the case, you can perform motion correction to improve the results.

11. Select the Motion Correction Data Manager in the Control Panel.

12. In the **Image** menu, select the GBEF image.

    To perform manual motion correction you must adjust the image in some frame. When you do this, all the images in subsequent frames are adjusted in exactly the same way. However, you can make multiple adjustments, keeping in mind that it is easiest if each adjustment is done in a frame that is later than the one of the previous adjustment. In other words, if frames 10, 20, and 30 needed adjusting, you should adjust frame 10 first, then frame 20, and frame 30 last.

13. Right-click in the viewer and select **Scroll.**

14. Drag in the upper left corner of the viewer until frame 29 is visible. The frame number is displayed in the lower right of the viewer.

15. Right-click again and select Pan.

16. Adjust the image in frame 33 so the position of the image in the ROI more resembles frame 29.

NOTICE

When you change the position of the image, its position in all subsequent frames shifts by the same amount.

17. Now scroll to subsequent frames and move the image as appropriate. Switch between **Scroll** and **Pan** to make adjustments to all necessary frames.

18. Click **Apply** in the Control Panel. Click on the Apply button. This returns you to the Define Regions workstep with the motion corrected data loaded in the cine viewer.

19. When you have finished adjusting, click the Next Workstep button to proceed to the Define Regions workstep:

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.

Philips

1. In the Time Activity curve in the Gall Bladder viewer, drag the timing markers to set the max count (green) and min count (red).

2. Review the adjusted results in the Results viewer.

3. Click Next Workstep to go to the Review workstep.
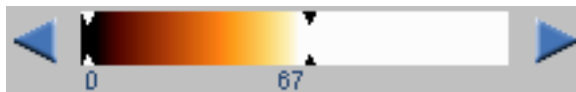
Review Images

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.

   This removes 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 Gallbladder

In the Define Regions workstep, a splash display is present for reference, and a Time Activity curve is drawn as soon as all required ROIs are present. Additionally, you may need to provide values for the following parameters in the Inputs viewer:

- Stimulus Info
- Dosage of CCK
- Time CCK Infusion Began
- Duration of CCK infusion
- Morphine Administered

In the Review Results workstep, you can use the timing markers in the Gall Bladder curve viewer to adjust the time range represented by the results values. By default, the green line indicates maximum counts, and the red line indicates minimum counts. Drag the timing markers to move them.

Results for Gallbladder

The Gallbladder Ejection Fraction application displays a dynamic series of gallbladder images and calculates the gallbladder ejection fraction. Depending on the preference selected, the results include a combination of the following:

- Cine loop with all ROIs
- The Ejection Fraction GBEF (%), based true counts, and on the timing markers in the time activity curve
- The Ejection Period GBEP (min) based on the timing markers in the time activity curve
- The Ejection Rate GBER (%/min) based on the timing markers in the time activity curve
- Maximum Counts based on the timing markers in the time activity curve
- Minimum Counts based on the timing markers in the time activity curve
- Dosage of CCK (or morphine, if selected)
- Time CCK (or morphine, if selected) Infusion Began
- Duration of CCK (or morphine, if selected) infusion
- Latent Period GBLP (min) time between injection and begin of emptying
- Morphine Administered
- Time Activity curve for background corrected Gall Bladder
- Time Activity curve for background corrected Hepatic Duct
- Time Activity curve for background corrected Common Bile Duct
- Time Activity curve for background corrected Duodenum
- Splash Display

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. See section "Review Results Workstep" on page 27 for details.

Preferences for GallBladder

To change the Preferences for this application:

1. Select the **Preferences** Data Manager.

2. Click **Open Preference Editor** at the bottom of the Preferences section (the second icon

).

3. Make changes in the preferences window using the information in the table below.

For details on editing Preferences, see section "Creating and Editing Preferences" on page 59.

You can save this parameter as Preferences:

Parameter	Default	Description
Review Compress FactoReview Compress Factor (Initial Biliary Compression)	0	Number of frames to compress for Biliary review data
Review Compress Factor (Gall Bladder)	0	Number of frames to compress for Gall Bladder review data
Stimulus Info	NoStimulus	This is the type of stimulus used in the study.
Decay Corrected Curv	Yes	This determines whether the Time Activity curve uses decay correction data.

Results for GBEF Static Analysis

If multiple Post Stimulus images are loaded:

- Counts and % Emptied values for PreStimulus
- Counts and % Emptied values for all Post Stimulus data

If one Post Stimulus image is loaded:

- PreStimulus counts
- PostStimulus counts
- Ejection Fraction value

Preferences for GBEF Static Analysis

To change the Preferences for this application:

1. Select the **Preferences** Data Manager.
2. Click **Open Preference Editor** at the bottom of the Preferences section (the second icon).
3. Make changes in the preferences window using the information in the table below.

For details on editing Preferences, see section "Creating and Editing Preferences" on page 59.

You can save this parameter as Preferences:

Parameter	Default	Description
Review Compress Factor	0	Number of frames to compress for review data

Review Layouts

Below are the layouts in the Review workstep:

- GBEF Dynamic Display
- GBEF Splash Display
- SC images
- Static Review
- Initial Biliary