

## REFERENCE GUIDE

# Amyloidosis Workflow

## BACKGROUND

Cardiac amyloidosis is a heart condition where protein abnormally builds up in the heart. This causes heart function to struggle, compensate by working harder -- ultimately resulting in heart failure. There are many causes for cardiac amyloidosis. It can be inherited, triggered by other diseases like cancer, or develop on its own. While amyloidosis is not curable, some types are treatable, such as AL (light chain), ATTR, and dialysis-related amyloidosis.

AL amyloidosis occurs when cells in the bone marrow malfunction and produce an excess of light chains. This can happen spontaneously or because of certain types of blood or immune system cancers. Diagnosis of this type of amyloidosis typically happens after age 50.

ATTR Transthyretin (often abbreviated TTR) is a protein that transports a thyroid hormone and vitamin A through the bloodstream. Misfolding of the TTR protein can result in the formation of abnormal protein aggregates called amyloid fibrils in various organs. In the heart, amyloid deposits lead to a condition called senile cardiac amyloidosis.

Corridor4DM provides an amyloidosis workflow to allow qualitative, semi-quantitative, and quantitative review of both planar and SPECT patient datasets to assist with identification of ATTR cardiac amyloidosis.

## DATASETS NEEDED

4DM's amyloidosis workflow automatically populates when a Nuclear Medicine (NM) Planar, ungated tomographic SPECT, or a reconstructed tomographic SPECT dataset(s) are loaded, that utilized either Tc-99m PYP or Tc-99m HDP. Both 1 hour and 3 hour protocols can be used, and should be noted for inclusion in the report. The radiopharmaceutical should be defined at the camera level. However, when needed, 4DM's NM Viewer or MI Processing screens provide an interface, the Dataset Information Window, to manually set the dataset radiopharmaceutical as Tc-99m PYP or Tc-99m HDP, in-order-to activate the amyloid workflow. We note that some countries have approved Tc-99m DPD for this workflow. In that situation, manually select Amyloidosis in the workflow selector.

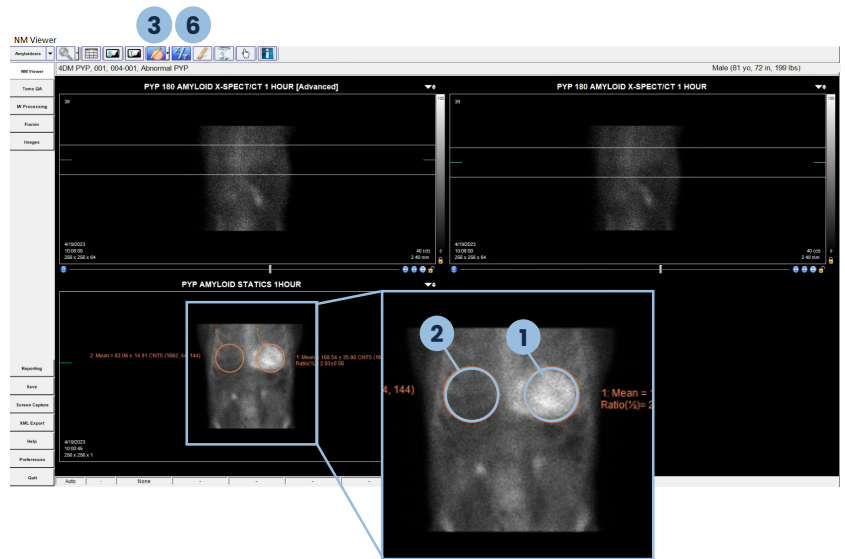
## HOW-TO-GUIDE

The default amyloidosis workflow layout in 4DM contains five screens for qualitative, semi-quantitative and quantitative review of the dataset. Each screen supports certain NM dataset types. The below sections outline the dataset types required, the purpose of the screen, and the workflow to quantify and grade amyloidosis.

## NM VIEWER

The NM Viewer screen enables the qualitative, semi-quantitative and quantitative review of Static (Ungated) Tomographic SPECT datasets. First, for qualitative review, visually compare the tracer uptake intensity between the heart **1** and the bone/rib **2**. Assess any uptake in or around the heart.

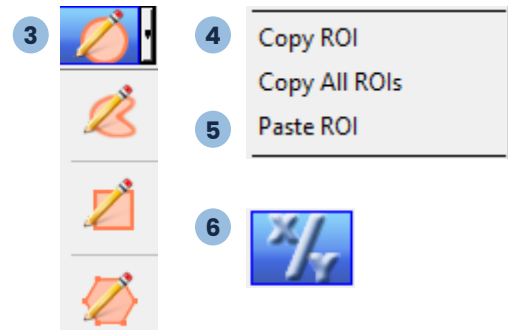
Second, estimate a semi-quantitative grade by visual review of the bone and heart uptake, then grading the uptake on a scale of 0-3 in relation to your assessment of heart to rib uptake. See the table below for guidelines.



The final step on this screen is by generating the heart-to-contralateral lung ratio (H/CL). Draw an ROI around the heart using the ROI tool, **3** right click on the ROI and select "Copy ROI" **4** then move the cursor to the chest area and "Paste ROI" **5** creating an identically sized ROI in the contra-lateral position that is symmetrically positioned to the heart ROI. Selecting the ratio tool **6** generates the H/CL as the ratio of uptake in the heart area to that of the lung area, displaying the H/CL ratio next to the heart ROI statistics. For the patient's report, the NM Viewer screen provides the semi-quantitative grading as well as the H/CL ratio.

## GUIDELINES WHEN USING TECHNETIUM:

Qualitative Assessment	Absent / focal / diffuse
Semi-quantitative grade	0 = no myocardial uptake
	1 = myocardial < rib uptake
	2 = myocardial = rib uptake
H / CL ratio	3 = myocardial > rib uptake
	> 1.6 = suggestive of TTR amyloidosis
	< 1.0 = not suggestive of TTR amyloidosis
	1.0 -- 1.6 = equivocal for TTR amyloidosis



Adopted from ASNC/AHA/ASE/EANM/HFSA/ISA/SCMR/SNMMI Expert Consensus Recommendations for Multimodality Imaging in Cardiac Amyloidosis

## TOMO QA

Visually review the raw planar SPECT data, in the same manner as a TOMO QA review of a myocardial perfusion study (MPI), looking for study artifacts, attenuation patient motion, and overall image quality.

## MI PROCESSING

For datasets that are negative, without any uptake in the heart (as evidenced by a semi-quantitative grade of zero, or an H/CL < 1), **the MI Processing screen is not necessary to complete the review of the amyloidosis workflow.** When the study dataset is positive, perform a typical review of the MI Processing screen, to verify the proper placement of the endocardial and epicardial surfaces. Refer to the MI Processing Help Sheet for guidance on QA steps in this screen.

## FUSION

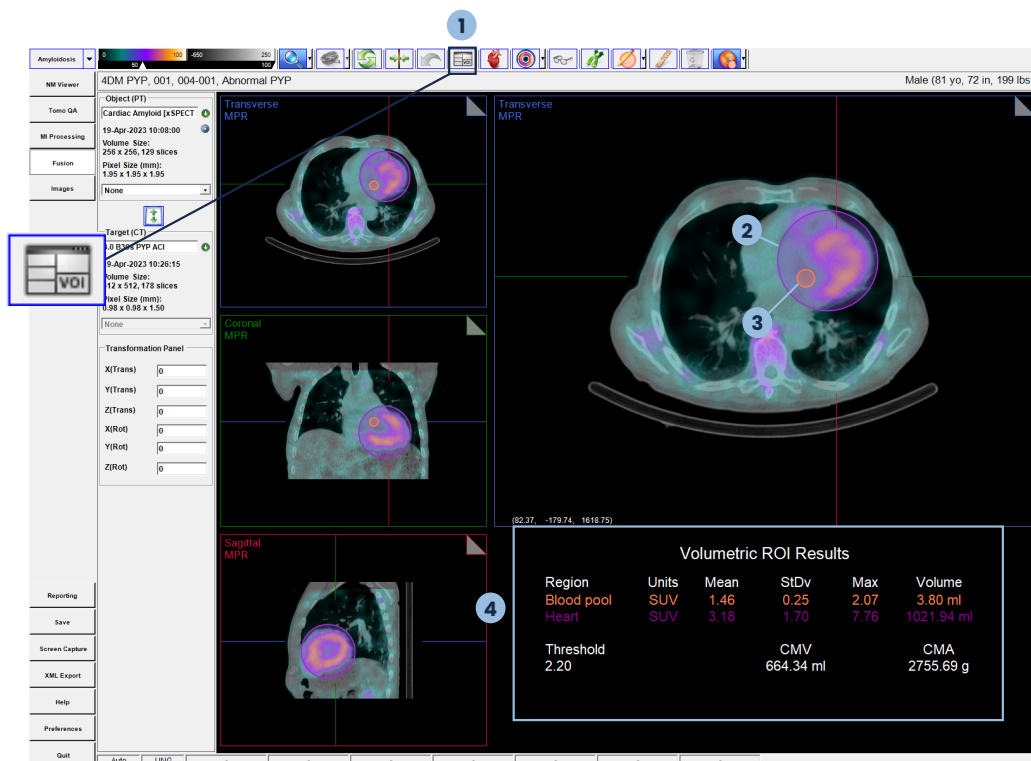
The Fusion screen in the amyloidosis workflow is only activated when a reconstructed tomographic SPECT dataset acquired with Tc-99m PYP or Tc-99m HDP is loaded. This screen enables viewing of both SPECT data and the diagnostic CT or attenuation map from a SPECT or hybrid-CT dataset. Such co-registered datasets are utilized to confirm that the heart uptake is myocardial uptake, not blood pool uptake.

To quantify blood pool to myocardial uptake, utilize the following steps:

The VOI display option **1** is the default for amyloidosis workflow studies. This option provides volumetric ROI's to compare blood pool to myocardial activity. Visually confirm that 4DM placed the heart volume of interest (VOI) **2** over the left ventricle (LV) or the entire myocardium, excluding any bone. Also confirm that the blood pool VOI **3** is placed in the LV outflow tract at the base of the heart.

If the VOI needs to be repositioned, left click and hold within the VOI, dragging with your mouse accordingly. To adjust the size of the heart VOI, hover over the heart VOI until a red dot appears. Left click and hold the red dot to adjust the size. The blood pool VOI is not resizable.

In the Volumetric ROI Result table **4** the max Cardiac Metabolic Volume (CMV) and max Cardiac Metabolic Activity (CMA) values help you assess the uptake in the myocardium. They provide an estimate of cardiac impact from tracer uptake in the heart at least 50% above blood pool activity. Though not established consensus guidelines, higher CMV and CMA values are believed to relate to higher amounts of amyloid in the heart. Likewise, CMV and CMA values of 0 indicate a normal study. As of October 2023, these values are not required for inclusion in the patient's report.



### IMAGES

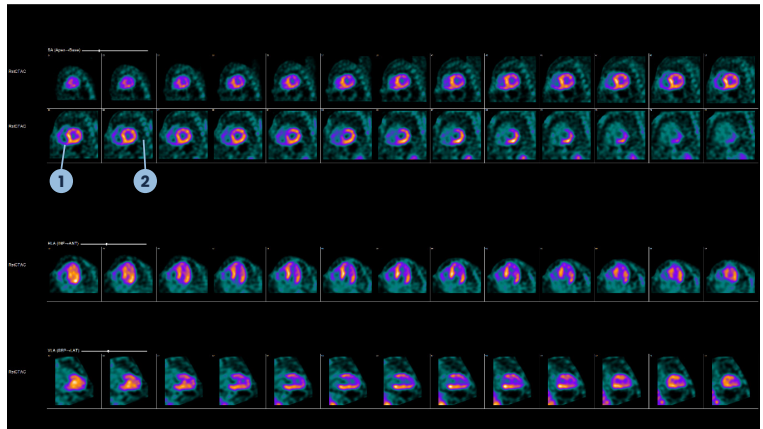
The Images screen is activated in the amyloidosis workflow when loading a reconstructed tomographic SPECT dataset. Use this screen to perform the qualitative evaluation – absent, focal, or diffuse – as well as to estimate a semi-quantitative grade. Review the images for cardiac uptake, extra cardiac activity, and regional differences of uptake (such that the brightness of the heart is inconsistent, indicating recent infarct) following the same process as for a SPECT MPI dataset. Uptake in the heart **1** brighter than that in the rib / bone **2**, is an indication of amyloidosis.

**NOTE:** For the patient’s report, your qualitative evaluation is best derived using the Images screen. Additionally, this visual review helps you estimate the semi-quantitative grade for the report.

### REPORTING

**Amyloid Rest** or **Amyloid Rest with CT** report templates are available in 4DM version v2024 and higher for manual completion at this time.

Volumetric Values	Description
Max	The max SUV value found per region.
Volume	The overall volume found in 3D ROI.
Threshold	Threshold is found by multiplying the mean blood pool SUV by 1.5.
CMV - Cardiac Metabolic Volume	Volume of activity above threshold within the Heart ROI in milliliters.
CMA - Cardiac Metabolic Activity	Activity in grams (g) calculated by multiplying your CMV value by the mean activity within the Heart VOI.



Report Templates	Workflow	Required Datasets									
		Stress Ung Gat Dyn	Rest Ung Gat Dyn	Delay Ung Gat	FDG Ung Gat	CT					
Amyloidosis (Rst)	Amyloidosis	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Amyloidosis with CT (Rst)	Amyloidosis	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

The templates include a section called Technetium Uptake for you to input your assessment.

**LV Perfusion**

LV Perfusion UI:  Traditional  Score maps  Dictation

LV Perfusion Summary:  Normal  Abnormal (  Ischemia  Infarction )  Uninterpretable

Defect

(1) There is diffuse intense PYP-Tc99m uptake (Grade 3) within the LV and RV myocardium consistent with ATTR amyloidosis.

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Consistent with

**Report: Finalized**

**IMAGING PROTOCOL:** Static Rest Tc-99m PYP with CT attenuation correction  
Rest imaging was performed with CT attenuation correction with the patient in the supine position approximately 78 minutes following the intravenous injection of 31.0 mCi of Tc-99m PYP. Stress imaging was not performed.

REST Study	
Date:	4/19/2023
Radionuclide:	Tc-99m PYP
Tracer Activity (mCi):	31.0
Injection Time:	08:50:00
Imaging Time:	10:08:00

**FINDINGS:**

Rest Images

Overall Study Quality:  Good  
Extra Cardiac Activity:  Normal  
Study Artifacts:  Motion artifact

**TECHNETIUM UPTAKE:**

Quantitative evaluation: absent / focal / diffuse

Semi-quantitative Grade: 0 / 1 / 2 / 3  
Grade 0: no myocardial uptake  
Grade 1: myocardial uptake < nb uptake  
Grade 2: myocardial uptake = nb uptake  
Grade 3: myocardial uptake > nb uptake

Quantitative heart/lung ratio: XX  
>1.8 is highly suggestive of TTR amyloidosis  
<1.0 is not suggestive of TTR amyloidosis  
1.0 - 1.6 is equivocal for TTR amyloidosis

**SUMMARY:**

(1) There is diffuse intense PYP-Tc99m uptake (Grade 3) within the LV and RV myocardium consistent with ATTR amyloidosis.

**CT FINDINGS AND INTERPRETATION:**

CT scan was performed with a Symbia Intevo 16 operating at 110.00 kV. The exposure was 25 eff.mAs. Contrast was not administered.

**REPORTING:**

The study interpretation occurred on 4/26/2023 13:30:13

**NOTE:** Manually update this table within the report preview to reflect the findings of your amyloid study review. Once the report is finalized and “sent as a PDF” these values display within the PDF report.

In the Interpretations tab of reporting, dictate or manually enter findings into the LV Perfusion section. Provide a description or interpretation of the findings observed. If a CT was acquired, use the CT Findings tab to dictate or manually enter any CT findings and interpretations.