



# FDG CARDIAC PET CT FOR MYOCARDIAL INFLAMMATION

## PATIENT PREPARATION & IMAGING

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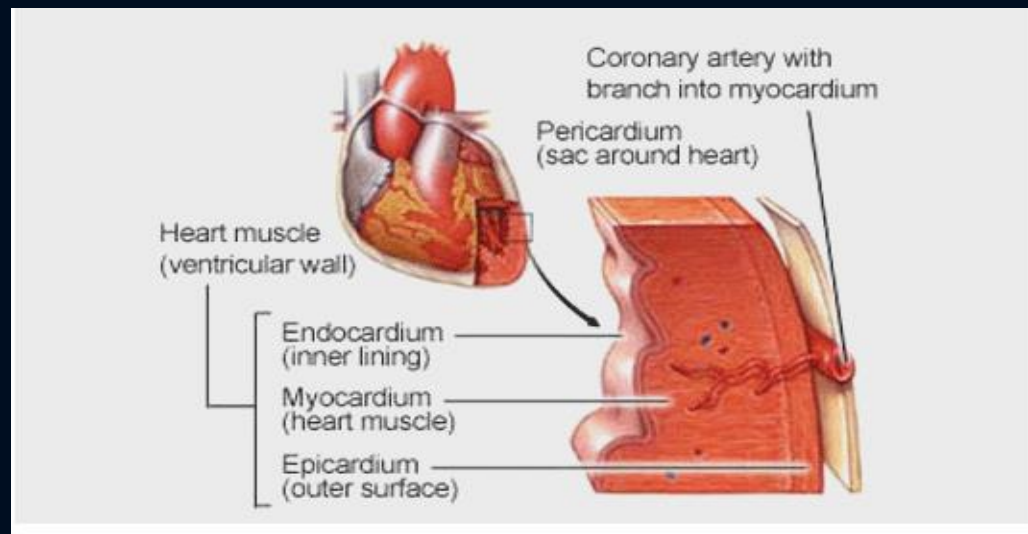
# INTRODUCTION

- $^{18}\text{F}$ -FDG Cardiac PET-CT is useful in identifying inflammation of the heart
- Clinical symptoms are usually non-specific
- $^{18}\text{F}$ -FDG PET-CT imaging provides complementary morphologic and metabolic information
- Cardiac inflammation is associated with high morbidity & mortality; making timely diagnosis crucial
- Glucose metabolism is increased in inflammatory cells
- **A major challenge is optimizing the ability to distinguish focal areas of pathological FDG uptake from normal physiologic myocardial uptake**
- Hence optimal patient preparation is crucial



# INFLAMMATORY CONDITIONS OF THE HEART

- Endocarditis
- Myocarditis
- Cardiac Sarcoidosis
- Pericarditis
- Vasculitis
- Inflammation of atherosclerotic plaques
- Cardiovascular implantable electronic device infections (CIED) and prosthetic valve infections







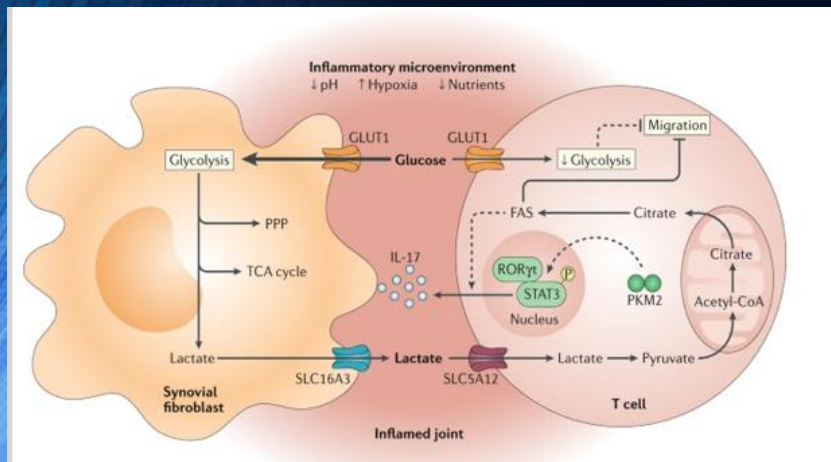
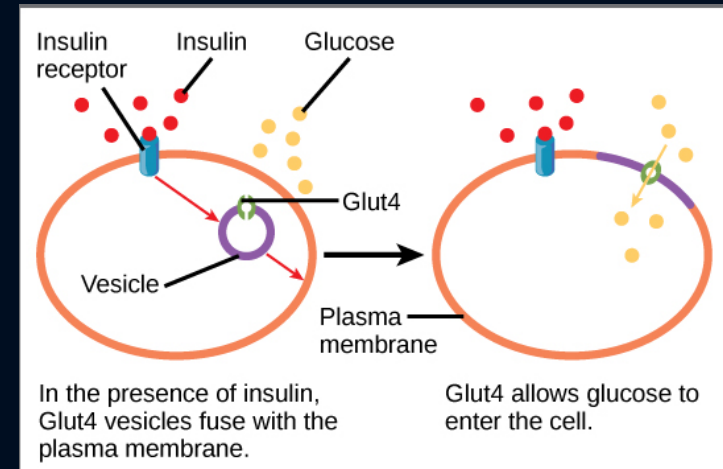
# MYOCARDIAL METABOLISM



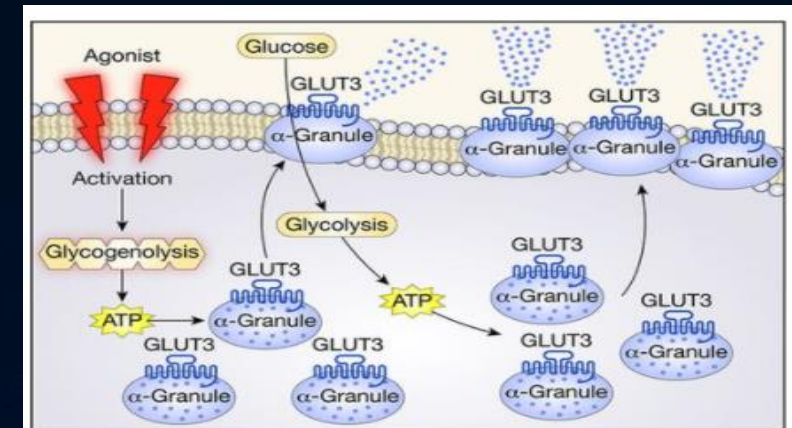
*In order to embark on Patient Preparation one has to understand Myocardial Metabolism*

Normal myocardium has a variable avidity for glucose, hence Pat Prep must promote free fatty acid metabolism & suppress physiologic glucose metabolism

Dietary carbohydrate intake triggers insulin secretion which activates glucose transporter GLUT4 in normal myocardium & allows glucose to enter the cells.



In the absence of carbohydrates & insulin, the myocardium uses free fatty acids for energy allowing glucose to enter the inflammatory cells via GLUT1 & GLUT3 glucose transporters.





# PATIENT PREPARATION

*(Review of published academic articles as well our experience at CUBIC PET-CT)*



- Assessment of myocardial inflammation on a background of physiological myocardial  $^{18}\text{F}$ -FDG uptake is challenging
- Proper patient preparation is critical for successful  $^{18}\text{F}$ -FDG PET-CT imaging for myocardial inflammation.
- Inflammatory cells have a high glycolytic activity.
- It is important to minimize normal physiological myocardial  $^{18}\text{F}$ -FDG uptake to optimize target to background ratio.

*Several Methods have been used to reduce physiological myocardial uptake & can be categorized as:*

*Dietary, Pharmacological & Behavioural \**



## REQUEST FORM

Patient preparation begins from the time the request form is received.

The following information on the request is important:

- A complete history inclusive of: Is the patient diabetic, does the patient have any intracardiac device and if so when was it placed, does the patient have poor left ventricular dysfunction/coronary artery disease & a complete list of medication the patient is on.
- Patients with recent intracardiac device placement or ablation have to wait 4–6 weeks for  $^{18}\text{F}$ -FDG PET-CT scan
- Left Ventricular dysfunction may have increased glucose uptake due to metabolic changes.
- Significant coronary artery disease can result in myocardial ischemia and consequently lead to abnormalities in both perfusion and  $^{18}\text{F}$ -FDG uptake.
- Glucocorticoids: Withdraw or delay therapy until after the PET-CT scan. If there is a risk of ischemic complications perform the PET-CT scan within 3 days after Glucocorticoid treatment.
- Diabetic Patients: No insulin or oral agents on day of the study.







## DIETARY METHOD

- SNMMI recommends a fat enriched diet with no carbohydrate 12-24 hrs prior to the scan & a 12-18 hr fast. The aim of the diet is to suppress normal myocardial glucose utilization and enhance myocardial fatty acid metabolism. It also reduces insulin release & promotes systemic lipolysis.
- Another recommendation is a High-Fat, High-protein, Very-Low Carbohydrate (HFHPVLC) diet ideally for at least 3 days
- Other reviewed data suggests that a High Fat No Carbohydrate (HFNC) diet should be implemented for one or two meals with a subsequent fast of at least 4 hours, although an even longer fast may be preferred for optimal suppression of myocardial glucose uptake. With this strategy, successful suppression has been demonstrated in up to 85–90% of patient populations in most studies.
- According to another article what is considered acceptable is fasting for 18 hrs or longer if patient cannot eat and has no enteral access or if patient has dietary restrictions preventing consumption of advised diet.





## PHARMACOLOGICAL

Together with behavioural & dietary preparation:

Intravenous unfractionated heparin approximately 15 mins prior to FDG injection, which promotes lipolysis and the availability of free fatty acids

Use of Calcium channel blockers as a means of improving myocardial suppression

## BEHAVIOURAL

Avoid strenuous exercise 12-24 hours prior to the examination







# HFHPVLC DIET

## FDG CARDIAC SARCOIDOSIS Patient Preparation

**High Fat, High Protein Very Low Carbohydrate Diet for 3 days before the study.** You are encouraged to drink large amounts of **plain water**.

Refer to recommended diet below. **Fast for a minimum of 12 hours** prior to the study.



<p><b>YOU MAY EAT</b></p>	<p>Fatty Meat &amp; Chicken &amp; Turkey with skin fried in oil or butter. Burger patties, Steak.            Tuna &amp; Sardine fish in oil, Salmon Mackerel.            Eggs prepared without milk or cheese.            Cabbage, Cauliflower, Broccoli, Spinach, Baby Marrow, Asparagus, Tomato, Avocado, Coconut.            Clear liquids such as water &amp; diet sodas.            Tea &amp; Coffee without milk &amp; sugar.</p>
<p><b>DO NOT EAT</b></p>	<p>Legumes, Beans, Nuts, Fruits &amp; Juices            Bread, Pap, Rice, Samp, Potatoes, Pasta, any Crumbed food.            Any baked goods            Sweetened, grilled, or Cured meats or Meat with carbohydrate-containing additives e.g. some sausages, Ham, Sweetened Bacon.            Dairy products (milk, cheese, etc.) aside from butter            Candy, Chewing Gum, Lozenges, Sugar, and Sweeteners            Alcoholic beverages, Soda, and Sports Drinks            Mayonnaise, Tomato Sauce, Tartar Sauce, Mustard, and any other Sauces</p>

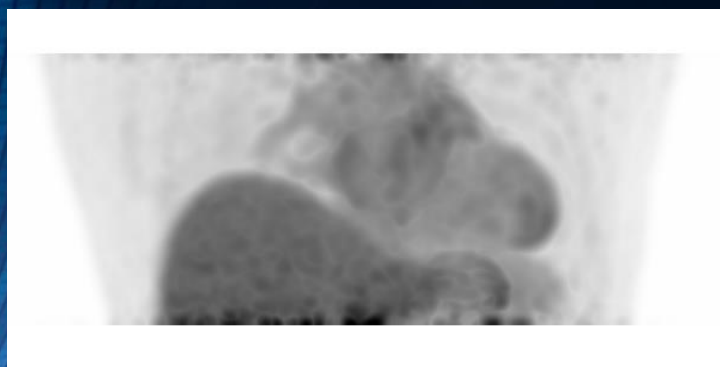


# HFHPVLC DIET



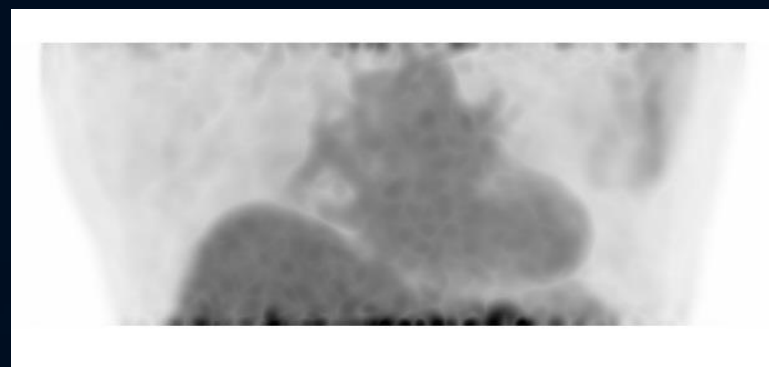
56 yr old male. Cardiac MRI showed Late Gadolinium Enhancement (RV&LV) in keeping with Sarcoidosis

To assess degree of disease



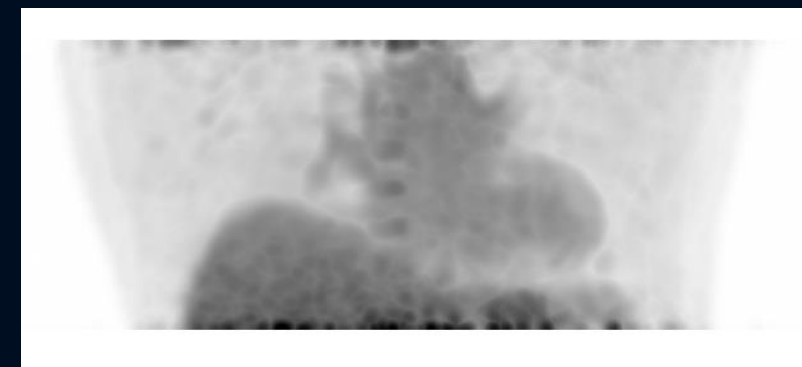
13 Jan 2020

To assess response to treatment



14 May 2020

To assess response to change in Rx



19 Jan 2021



## HFHPVLC DIET

Optifast Feeding Regimen for 2 days followed by a 12-18 hour fast

Optifast Feeding Regimen included:

4 shakes per day

1 soup per day

Soups & shakes are interchangeable

2 bars

1 portion dessert



Excellent target to background ratio





## Summary of Different Protocols courtesy of Seminars in Nuclear Medicine



Type of approach	Effects	Scheme
Pharmacologic approaches	Intravenous LMVH administration	Promotes lipolysis and availability of FFA
	Calcium channel blockade	Block Intracellular calcium which increase glucose uptake
Dietary approaches	Fasting, different duration	Reduces insulin release and promotes systemic lipolysis
	No carbohydrate diet + fasting	4-6 h
	Low carbohydrate diet	6-8 h
	Low carbohydrate diet + fasting	>12 h
	+ high fat beverage	12 h fast
	HFNC diet + fasting	24 h
	HFLC diet	At least 12 h fasting
	HFLC or HFNC diet + high-fat drink (vegetable oil) before $^{18}\text{F}$ FDG	24 h prior > 8 h fast
Mix regimens	Fasting + Pharmacologic	24 h
		2 meals + 4 h fast
		2 meals + 4 h fast
		18 h fast
		2 d + 12-14 h fast
		Heparin bolus after 6-14 h fast
		Low carbohydrate + 12-18 h fast + heparin
		HFLC + 12 h fast + verapamil
		HFLC + 48 h fast + heparin



## POST FDG INJECTION

Following FDG injection, patient continues to fast & not be physically active, the patient is given 250mls plain water 10 mins & 20 mins post injection. Patient must be comfortable and warm.



## IMAGING

PET-CT  $^{18}\text{F}$ -labelled 2-fluoro 2-deoxy-D glucose ( $^{18}\text{F}$ -FDG) in imaging inflammation and infection is increasing.

DOSE: 2.5-5.0 MBq/kg (175-350 MBq in a 70-kg standard adult)

UPTAKE TIME: Image acquisition generally starts after an uptake time of 45-60 minutes;

2 ACQUISITIONS: A single bed position of the Cardiac region, it is useful to record gated images and another field of acquisition, as in oncology, from skull base to mid thighs.

## FOLLOW UP STUDIES

Standardisation of dietary preparation & image acquisition parameters for follow up studies is crucial.



# CONCLUSION



- In the clinical setting,  $^{18}\text{F}$ -FDG PET-CT imaging is useful in evaluating cardiovascular inflammation.
- In most cases, its utilities include confirmation of clinical suspicion, determination of extent of the disorder, prognostication and evaluation of effectiveness of therapeutic intervention.
- The significance of proper patient preparation is absolutely crucial in obtaining optimum quality diagnostic images in PET-CT imaging for Cardiac Inflammation.
- Each institution must adopt a protocol and continuously monitor its effectiveness with a goal to achieve adequate myocardial suppression in greater than 80% of patients.





# REFERENCES



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2. Osborne MT et al;(2017) *Patient Preparation for Cardiac Flourine-18 Flourodeoxyglucose Positron Emission Tomography imaging of Inflammation*;Journal of Cardiology
3. Chareonthaitawee P et al (2018); *Joint SNMMI–ASNC Expert Consensus Document on the Role of 18F-FDG PET/CT in Cardiac Sarcoid Detection and Therapy Monitoring*; JNM
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