MI Cardiac Technology Buying Guide

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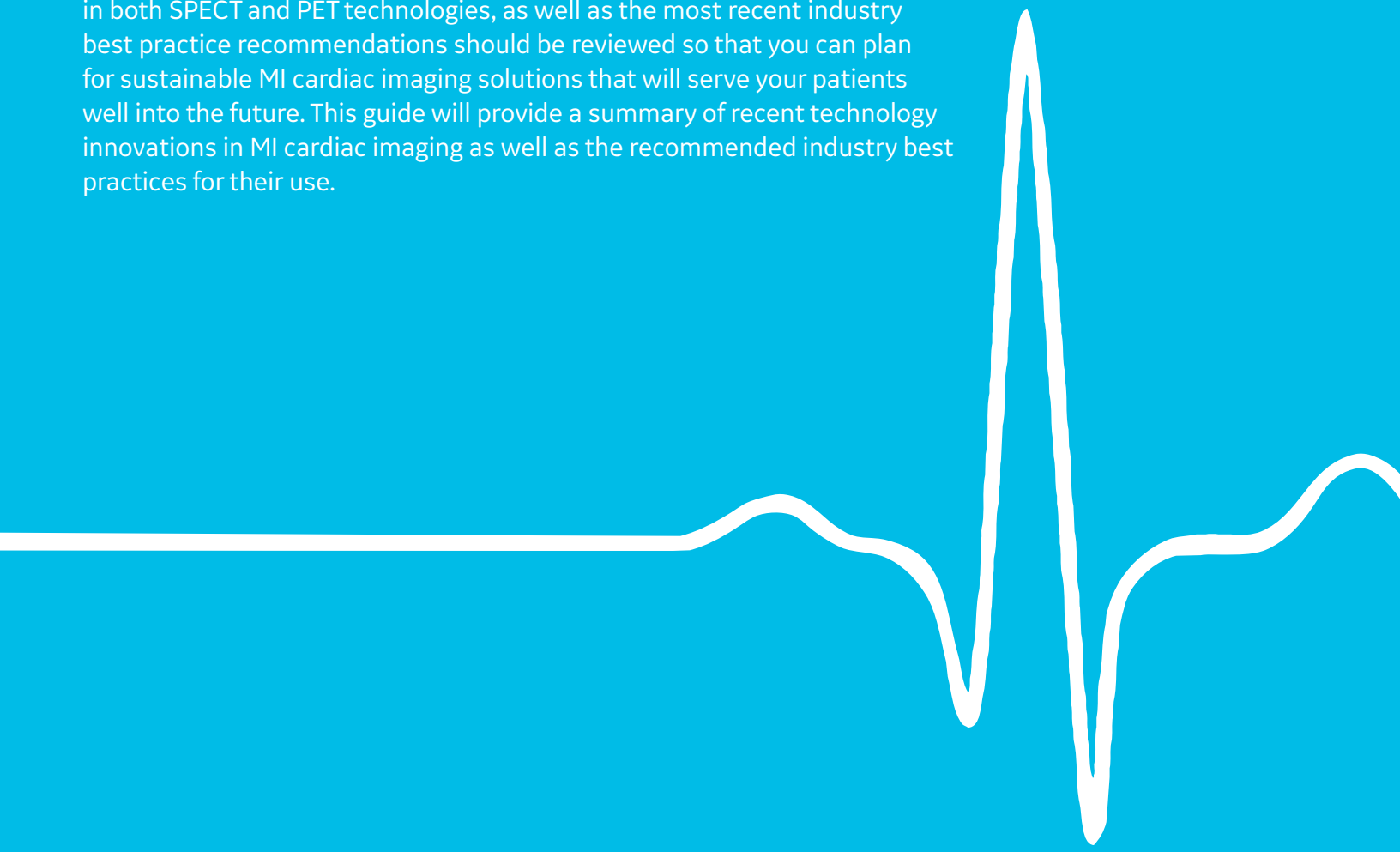
Introduction

For patients with suspected cardiac disease, molecular imaging (MI) continues to be one of the diagnostic industry standards trusted by clinicians.[1-5] From the original gamma camera and Single Photon Emission Computed Tomography (SPECT) to the latest in Positron Emission Tomography (PET), MI modalities are some of the leading non-invasive imaging techniques that can provide cardiac functional and flow data needed by clinicians for accurate diagnoses of heart disease.

SPECT and PET techniques used for myocardial perfusion imaging and quantification of myocardial blood flow measurements have begun to be widely incorporated into clinical practice. The additional diagnostic value of these measurements has been shown to improve identification of obstructive coronary artery disease.[2]

When planning to upgrade or expand cardiology imaging services, advances in both SPECT and PET technologies, as well as the most recent industry best practice recommendations should be reviewed so that you can plan for sustainable MI cardiac imaging solutions that will serve your patients well into the future. This guide will provide a summary of recent technology innovations in MI cardiac imaging as well as the recommended industry best practices for their use.



Key Criteria in MI Cardiac Technology

SPECT

For decades, nuclear cardiology imaging with SPECT has been commonly used for visualizing patients' myocardial perfusion. Cardiac SPECT imaging remains a valuable evaluation tool used by clinicians, and there have been recent advances in SPECT technology that should be fully understood when planning to replace outdated equipment or invest in expanded cardiology imaging services.

Technology

Standard SPECT imaging utilizes a dual-detector system with parallel-hole collimation and sodium-iodide (NaI) scintillation detectors mounted at 90 degrees to each other. Significant changes in the design of SPECT imaging technology have resulted in increased photon sensitivity. This is achieved either through the use of high-sensitivity collimation or multiple, solid state detectors made of Cadmium Zinc Telluride (CZT), or a combination of technologies. High sensitivity collimators allow more photons to reach the detector by focusing on the heart. Alternatively, other SPECT configurations use three parallel hole collimator cameras consisting of cesium-iodide (CsI) crystals/diode module detectors. Solid state configurations include CZT fanning detectors with parallel large hole collimators, or CZT detectors with pinhole collimation.

According to the American Society of Nuclear Cardiology (ASNC), the main advantage of CZT as a detector is that it has much better energy resolution than NaI scintillation and can be used to construct compact pixelated detector modules, where each pixel is smaller than the intrinsic resolution of a NaI scintillation camera. In its information paper on contemporary cardiac SPECT imaging, ASNC states that clinical CZT systems achieve energy resolution of better than 7 percent, compared to about 11 percent for a conventional scintillation camera.[3]

Image Reconstruction

Various software solutions are available to improve the resolution of reconstructed SPECT images with fewer counts. This allows clinicians to improve the patient's experience, either by reducing the required dose, or by shortening the exam time. Reconstruction software for SPECT typically involves correcting for photon attenuation, Compton scatter, and collimator resolution effects.

Attenuation Correction

SPECT imaging is often in need of attenuation correction or at least an understanding of the impact of attenuation to compensate how the study is read. Correcting for attenuation has been shown to improve overall test accuracy, imaging for larger patients with high BMI, as well as improve the imaging in stress-only studies.[3] Attenuation correction in SPECT requires a patient-specific map, which is most commonly achieved with the Computed Tomography (CT) scan on a SPECT/CT camera. Using SPECT alone, attenuation compensation is typically achieved through two position imaging, while the SPECT/CT can acquire or import a CT image for attenuation purposes. A higher performing CT option may also enable the system to perform some CT cardiac procedures such as calcium scoring and CT angiography, which may complement the information provided by SPECT.

According to ASNC, practices should consider attenuation correction hardware when replacing legacy SPECT instrumentation because of the potential to improve test accuracy and image quality.[3]

PET

Cardiac imaging using PET has undergone tremendous growth because of its ability to image cardiac function and blood flow non-invasively and with higher sensitivity and specificity than other imaging techniques. Improvements in image quality and diagnostic accuracy using PET, coupled with reproducible quantitation and shorter procedure times are contributing to the procedure growth in cardiology.

In a joint position statement, ASNC and the Society of Nuclear Medicine and Molecular Imaging (SNNMI) support that the properties of myocardial perfusion PET are sufficient to advance recommendations for its use in clinical practice.[6] These recommendations are general in intent and should not be interpreted as either inclusive or exclusive of specific clinical scenarios. However, they reflect the current understanding based on extensive clinical investigations as to when myocardial perfusion PET will provide best clinical value. Myocardial perfusion PET image quality, high diagnostic accuracy that is relatively independent of body habitus, ability to accurately risk stratify patients with a wide array of clinical presentations, short acquisition times, safety by virtue of low radiation exposure, and its unique ability to quantify myocardial blood flow are all significant and clinically important properties. The two professional societies encourage providers to consider this imaging option for appropriate clinical situations.

Technology

Like SPECT, PET products operate using a variety of scintillation crystal choices such as bismuth germanium oxide (BGO), gadolinium oxyorthosilicate (GSO), lutetium oxyorthosilicate (LSO), or lutetium-yttrium oxyorthosilicate (LYSO) coupled with either analog photomultiplier tubes or digital silicon photomulitpliers. While most discussions of these choices focus on their impact on oncology procedures, some may impact a system's sensitivity so compatibility with desired tracers and protocols should be considered. For example, flow imaging with some tracers may result in higher count rates which, because of detector decay time, can present imaging difficulty on some 3D-only scanners.

Attenuation Correction

Even more essential for PET studies, most PET scanners incorporate a CT scanner; in addition to being used for attenuation correction, higher performing systems may also enable some CT cardiac procedures to be performed.

Role of MI Cardiac Tracers

Radiopharmaceutical tracers used in SPECT and PET imaging have been developed to evaluate cardiovascular disease and visualize myocardial perfusion, metabolism, and inflammation.

Tracers used in SPECT imaging for myocardial perfusion imaging (MPI) include technetium-99m (^{99m}Tc) and thallium-201 (^{201}Tl).

Myocardial metabolism assessment with PET is typically imaged using fluorodeoxyglucose ([^{18}F]FDG). Other tracers such as Rubidium-82 (^{82}Rb) and Ammonia-13 ([^{13}N]NH_3) are commonly used for MPI with PET imaging.

New Growth Procedures in MI Cardiology

During the process of determining if an upgrade might be the best fit for your practice, fully understanding the practice advantages that state-of-the-art solutions can bring will benefit your cardiac services expansion plans. Some of the procedures that have experienced recent significant growth are:

Flow measurement—Cardiac imaging using PET allows absolute quantification of myocardial blood flow beyond the assessment of relative myocardial perfusion. Some newer multidetector solid state cardiac SPECT scanners now also offer flow measurement.

Amyloidosis—Cardiac SPECT & PET holds promise for non-invasive identification of amyloid subtypes, and monitoring disease burden, disease progression and potential response to therapy.

Endocarditis—With the significant increase in prosthetic heart valve replacement and cardiac implantable electronic devices, the risk for infection involving the endocardium also increases. Cardiac imaging with SPECT and PET techniques increases the chances of detecting these infections earlier, by identifying morphological changes before any structural changes become apparent.

How to Decide if You Need to Upgrade Your MI Cardiac Solution

Deciding to upgrade or expand your MI cardiac imaging services is a big decision, but it can also solve some of the challenges of your legacy systems. While there may never seem to be a perfect time to make significant changes to your day-to-day operations, there are a few areas to consider. The best way to determine if you are selecting the right cardiac MI solution for your needs is to understand some of the most helpful questions to ask; both internally and to each vendor.

Five areas tend to arise during the typical advancement discussion. Selecting and asking questions in this section can help to provide clarity to your buying process so that you feel informed and confident.

Improved Clinical Outcomes:
How will system “X” help me achieve an improvement in my diagnostic capabilities?
How will system “X” allow me to reduce patient dose consistently and monitor dose trends?
How important are new procedures (such as flow) to your practice? Will system “X” support them?
Will I notice a positive change in my diagnostic confidence? How?
Is it possible to realize both quality and quantity improvements with this system?

Patient satisfaction and volume:
Will I be able to improve patient access to cardiac MI exams?
Will system “X” help me attain my current and future patient satisfaction goals?
Will I be able to better serve the percentage of patients unhappy with cardiac MI exams?
Does this system allow me to provide better patient comfort and care?

Greater Operational Efficiency:
Can this system provide a path to overcome variation amongst technologists?
Will I be able to increase my patient throughput? How?
Am I currently optimizing the capacity of existing cardiac MI assets? How can system “X” help?

Improved Financial Outcomes:
Will system “X” allow me to develop new diagnostic services?
Can I expect to see an increase in my patient attraction and physician referral/retention rates?
Is it possible for system “X” to enable maximum reimbursement? How will it help with this?

Capital planning:
What do we anticipate our total cost of ownership to be and how does that fit our needs?
How long do I expect to retain system “X” and how will it benefit evolving patients and imaging?
Can I reduce my cost of capital with system “X” acquisition?

What MI Cardiac Equipment Options are Available?

Based on the needs of your practice, you will need to decide on having dedicated cardiac MI solutions, or general-purpose solutions with cardiac options.

- **Dedicated cardiac SPECT systems**—Small footprint CZT or NaI-based systems optimized for (and often limited to) cardiac applications only.
- **General-purpose SPECT and SPECT/CT systems with cardiac options**—Dual detector systems with parallel-hole collimation or alternate geometry dedicated-cardiac collimation and large field-of-view detectors that may be used in typical 90-degree or other vendor-specific cardiac configuration, or with detectors in other positions for general purpose imaging.
- **General-purpose PET/CT systems with cardiac options**—General purpose PET/CT systems typically include the necessary hardware to complete cardiology studies; however, comprehensive cardiology image reconstruction requires the use of additional software.

Manufacturers

GE Healthcare
Headquarters: Chicago, IL USA
Website: www.gehealthcare.com

Siemens Healthineers
Headquarters: Erlangen, Germany
Website: www.siemens-healthineers.com

Philips
Headquarters: Amsterdam, Netherlands
Website: www.usa.philips.com/healthcare

Digirad
Headquarters: Suwanee, GA, USA
Website: www.digirad.com

Spectrum Dynamics
Headquarters: Sarasota, FL, USA
Website: www.spectrum-dynamics.com

How to Evaluate a System for MI Cardiology

Installing a dedicated MI cardiac SPECT, SPECT/CT or PET/CT system can be a sizeable financial investment, so it's important to evaluate the best options for your needs. Uncovering the full project cost in contrast to the budget is an exploratory process that includes many variables.

What Variables Contribute to the Overall Cost?

While the list will be dependent on variables like a new system vs. an upgrade, etc., some of the common costs to be considered with a project will include:

- **Installation**
- **Training**
- **Energy consumption**
- **Downtime**
- **Service packages**
- **Construction**
- **Radiopharmaceutical usage**
- **Radiation safety**

How to Further Evaluate a System

A site visit can be a very useful experience when deciding which MI Cardiac system is right for you. Understanding what is important to observe and why has typically provided the most impactful visits. See the following five considerations for ensuring a successful experience:

- **Location**—Clinical site: Depending on what you are looking to observe, you may be able to leverage a clinical site close to your location. There you are able to observe typical daily operations. In the case where you might be looking to expand your cardiology imaging service, you might elect to see a clinical operation that is more comprehensive than you currently offer.
- **Stakeholders**—Determining who is best suited to evaluate a system during an experience visit is important. Not only will it help maintain efficiency in your decision-making process, but it can also help have a consistent message transfer if the key personnel from the various functions making a selection and working with the system are involved.
- **Start at the finish**—Successful site visits start with a detailed understanding of what is important to you and why. Making a list of the critical items you want to leave the experience understanding can be helpful. If hosted by a vendor, share visit expectations in advance to achieve a successful visit.
- **Duration**—Knowing how much time you need for discussion and questions can be difficult to predict. Barring the business-critical interruptions, the most successful experience visit starts with managing the allocated time. While there can always be follow-up after this time, setting a duration will help in planning the scanning time versus presentations, and more.
- **Topic weighting**—Prioritizations of the discussion topics will ensure the right people and processes are in place. For example, if understanding how faster scanning will increase patient satisfaction is one of your top interests, a simple ranking of these items can make sure they are addressed appropriately.

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https://www.gehealthcare.com/insights

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JB74709XX