

# DOES SAR MATTER?

William A. Faulkner, BS, RT (R) (MR) (CT), FSMRT

## What is SAR (Specific Absorption Rate)?

- SAR (Specific Absorption Rate) is a measure of the rate at which energy is absorbed by the body when exposed to a radiofrequency (RF) electromagnetic field. It is measured in units of Watts per kilogram of body weight.
- There are two SAR modes allowed for clinical operation of an MRI: Normal and First Level Controlled. For the head, both Normal operating mode and First Level Controlled are less than or equal to 3.2W/kg. Given the SureScan™ pacing, defibrillation (ICD) or cardiac resynchronization therapy defibrillation (CRT-D) systems have a head SAR limit of less than or equal to 3.2W/kg (both Normal and First Level Controlled for head SAR), the remainder of this document will be addressing whole body SAR.

For whole body SAR:

- **Normal operating mode:** Less than or equal to 2W/kg. In the normal operating mode, no physiologic stress is expected.
  - **First level controlled operating mode:** Greater than 2W/kg up to 4W/kg. In the first level controlled mode, some patients who are unable to tolerate a thermal challenge may experience physiologic stress. Examples include: elderly, frail, obese, diabetic etc.
  - **Second level controlled operating mode:** Greater than 4W/kg. Second level controlled mode is not utilized in clinical imaging and currently would require research protocols (IRB approval).
- For patients with a SureScan pacing, ICD or CRT-D system, the SAR limit is less than or equal to 2W/kg for whole body scans and less than or 3.2W/kg for head scans. Therefore, patients with a SureScan pacing, ICD or CRT-D system should be scanned in the **Normal Operating Mode**.

## What is “image quality”?

*“Image quality” is a somewhat subjective term. The question to ask is “can I provide a diagnostic study based on the clinical condition of a given patient?” As long as the image produced allows for proper diagnosis, the image quality has not been compromised.*

*Scanning at a reduced SAR level could result in reduced temporal resolution (i.e., reduces # phases per cycle). However, this does not mean that the study is non-diagnostic.*

*“As an MR technologist, I have often modified the protocol (including scanning at a lower SAR level) to meet the clinical needs of the patient. This does not mean they received a less than optimal study.”*

—Wm. Faulkner, BS, RT (R) (MR) (CT), FSMRT

## Does higher SAR produce a higher image quality?

- More power or higher SAR does not produce a better image. SAR is not directly related to image quality.
- All patients can be scanned in the Normal Operating Mode with no impact on image quality
- The main effect is that some scans (depending on the particular sequence) may take from a few seconds to a few minutes longer

## In what cases is it necessary to scan a whole body at an SAR above 2W/kg?

There is no instance known when a scan cannot be acquired without going into First Level Control Mode. In some instances, certain types of sequences may not have as short a scan time in Normal Operating Mode. This, however, does not mean they cannot be performed.

## How to stay within the 2W/kg SAR limit?

When selecting the Normal Operating Mode on some systems, the operator CANNOT exceed 2W/kg. On other systems, if the 2W/kg limit is reached, the system will prompt the operator to change certain parameters (TR, flip angle, # of slices) and provide the values for each which will keep the system in the Normal Operating Mode.

A knowledgeable and trained operator can easily stay at or below 2W/kg without negatively impacting image quality. The negative impact can be a slightly longer scan time.

## Are there other cases when the SAR is limited to 2W/kg?

At 2W/kg (normal operating mode) no physiologic stress is expected. Physiological stress can occur above 2W/kg (1st level controlled). There are many instances when normal mode should be maintained for patients who do not have a pacemaker, ICD or CRT-D system. The 2W/kg condition is not a big problem and should not be an issue. Basically, due to other clinical conditions or medications, patients with pacemakers, ICDs and CRT-D systems should be scanned at 2W/kg anyway.

*“Various underlying health conditions may affect an individual’s ability to tolerate a thermal challenge including cardiovascular disease, hypertension, diabetes, fever, old age, and obesity. In addition, medications including diuretics, beta blockers, calcium blockers, amphetamines, and sedatives can alter thermoregulatory responses to a heat load.”*

—Frank Shellock, PhD<sup>1</sup>

## What is the downside of an SAR limit at 2W/kg?

Slightly increased scan times in some instances.

## Why is there an SAR limit for SureScan pacing, ICD or CRT-D systems?

Testing was performed at 2W/kg and no physiologic stress is expected.

## Are radiologists and MR techs concerned about SAR limitation to 2W/kg?

"I feel certain I can scan all patients adequately at 2W/kg in almost every situation. Patients are more comfortable (less sweating) in the Normal mode. In my opinion, as an MR technologist, it is a non-issue." —Wm. Faulkner, BS, RT (R) (MR) (CT), FSMRT

### SUMMARY TABLE

	2W/kg	4W/kg
<b>Advantages</b>	No physiologic stress is expected. Patients are more comfortable in that they are able to easily dissipate heat resulting from exposure to RF.	Certain sequences will have shorter scan times.
<b>Disadvantages</b>	Some sequences in certain patients will have slightly longer scan times.	"Various underlying health conditions may affect an individual's ability to tolerate a thermal challenge." —Frank Shellock, PhD <sup>1</sup>

#### Reference

<sup>1</sup> Shellock FG, Schaefer DF. Radiofrequency Energy-Induced Heating during Magnetic Resonance Procedures: Laboratory and Clinical Experiences. In: Shellock FG, Bradley WG, eds. *Magnetic Resonance Procedures: Health Effects and Safety*. Boca Raton, FL: CRC Press; 2000:75-95.

#### Brief Statement

##### SureScan™ Pacing, Defibrillation, and Cardiac Resynchronization Therapy Defibrillation (CRT-D) Systems

The SureScan systems are MR Conditional, and as such are designed to allow patients to undergo MRI under the specified conditions for use. When programmed to On, the MRI SureScan feature allows the patient to be safely scanned while the device continues to provide appropriate pacing. A complete

SureScan system, which is a SureScan device with appropriate SureScan lead(s), is required for use in the MR environment. To verify that components are part of a SureScan system, visit <http://www.mrisurescan.com/>. Any other combination may result in a hazard to the patient during an MRI scan.

Products that appear on this website may not all be approved in your country. Please contact your local affiliate for further information.

See the MRI SureScan Technical Manual before performing an MRI Scan and Device Manual for detailed information regarding the implant procedure, indications, contraindications, warnings, precautions, and potential complications/adverse events.

Medtronic Canada  
99 Hereford Street  
Brampton, ON L6Y 0R3  
Canada  
Tel: 1(800) 217-1617

Toll-free: 1-800-505-4636  
(24-hour technical support for  
physicians and medical professionals)

UC201302397d EC © Medtronic  
2015. Minneapolis, MN. All Rights  
Reserved. Printed in USA. 12/2015