How to scan children with FAST CARE

For all SOMATOM Scanners equipped with FAST CARE *syngo* CT 2011

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General

With FAST CARE, Siemens SOMATOM Scanners offer a portfolio of features, tailored to the pediatric patient. With CARE Child, dedicated protocols, 70 kV scan modes and specific CARE Dose4D curves are available.

When imaging pediatric patients, special attention is needed on the one hand to meet the image quality requirements and on the other hand, to ensure lowest dose given that children are more sensitive to radiation than adults.

The most important steps in reducing dose for pediatric patients are:

- to be sure that a CT scan is the most appropriate diagnostic test for the clinical question at hand
- to scan only the regions that are indicated
- to optimize scan parameters to the diagnostic task

The dose for each individual scan should be carefully adjusted to achieve the necessary image quality. Scans with lower radiation dose may have higher image noise, but deliver diagnostic image quality.

For further general tips see “How to reduce dose in Pediatric CT imaging”.

Selecting protocols

As a starting point, Siemens provides default scan protocols for children, tailored to various body regions and procedures.

Child protocols include various features optimized for pediatric imaging, such as dedicated CARE Dose4D parameters, low tube voltage settings and special reconstruction kernels.

You may customize and save these protocols according to your imaging needs. Please ensure that your protocols are changed only by authorized personnel.

As a guideline we recommend using child protocols up to a weight of 55 kg (body imaging) or up to 6 years (head imaging). For body imaging children heavier than 55 kg should be scanned with an adult protocol, for head imaging children older than age 6 should be scanned with an adult protocol.

Your system can be configured to automatically select child protocols depending on the child's age. The value can be set in the Examination Configuration dialogue, please refer to the Operator Manual.

Proper patient centering is always important to dose and image quality. Double check and verify the patient's position with the laser beams as well as in the topogram to ensure that CARE Dose4D and CARE kV function optimally.


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CARE Dose4D

Siemens' child protocols use CARE Dose4D. CARE Dose4D adjusts the *tube current* automatically to the patient's size and anatomy to achieve the specified image quality at lowest possible dose.

The CARE Dose4D algorithm is based on three primary considerations: information on the patient's anatomy from the topogram, the user specified reference settings and configured settings depending on scan type.

You can specify a desired image quality by setting the **"Quality reference mAs"** value. Starting with software version *syngo*® CT 2011, this value is set for a reference patient weighing 75 kg for all scan protocols, including child protocols.

If unsure what to use, the child protocols already available on your system are a good starting point.

Once these prerequisites (Quality reference mAs, adjustment curves) have been set do not change them.

CARE Dose4D allows adjusting the modulation strength specifically for child protocols and for individual organ characteristics. Five different **configurations** are available: very weak, weak, average, strong and very strong.

CARE Dose4D configuration: mAs adaptation to patient size

Organ characteristics	Child	Adult slim	Adult obese
Brain	Average	Average	Average
Neck	Very weak	Average	Average
Shoulder	Very weak	Average	Average
Thorax	Very weak	Average	Average
Abdomen	Very weak	Average	Average
Pelvis	Very weak	Average	Average
Spine	Very weak	Average	Average
Osteo	Very weak	Average	Average
Head/Vascular Head	Average	Average	Average
Vascular Body	Very weak	Average	Average
Runoff	Very weak	Average	Average
Cardio	Very weak	Average	Average
Respiratory	Very weak	Average	Average

All configuration settings for CARE Dose4D can be adjusted in the menu Options → Configuration → Examination → Dose Tab Card

If all images of slim patients are too noisy, you can choose a weaker curve, meaning the decrease in dose is weaker allowing for less image noise. If all images of obese patients are too noisy, choose a stronger curve, meaning that the dose is increased a little further to avoid too high an image noise.

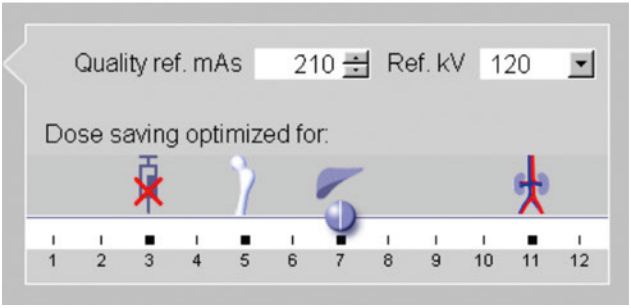
For further details refer to the Operator Manual. In addition please see “How to scan with CARE Dose4D” (*syngo* CT 2011).

CARE kV

Siemens' child protocols use CARE kV, a fully automated feature integrated into the CARE Dose4D workflow that adjusts *tube voltage* to the individual patient and the clinical question.

Similar to CARE Dose4D, a "Reference kV"-value has to be defined for each protocol. The **"Reference kV"** refers to a standard patient, weighing 75 kg. Specify values that you would use in such a standard patient for all protocols, including child protocols. If unsure what to use, the child protocols already available on your system are a good starting point.

Select the exam type (e.g. CT Angiography, non-contrast exam, etc) by setting the slider **"Dose saving optimized for"** in the Exam Card. For CT Angiography examinations the slider should be positioned at 11, for non-contrast enhanced scans at 3. For contrast enhanced scans of parenchymatous organs such as the liver, a setting in between (7) is recommended.



Once the reference settings are defined (Quality reference mAs, Reference kV, slider position) do not change them.

With **CARE Child** Siemens offers the option of scanning with 70 kV which will especially benefit the youngest patients. Thus, five different settings are available: 70 kV, 80 kV, 100 kV, 120 kV and 140 kV.

Note that lowest kV does not necessarily mean lowest dose. Depending on your patient and exam type, the system might choose a higher kV-setting to achieve the specified image quality at a lower dose.

Choosing lower kV-settings requires an increase in mAs to maintain image quality. However, even with such increased mAs-settings, the dose can be reduced. Monitor the $CTDI_{vol}$ value prior to scanning to estimate the actual exposure during the scan.

For further details refer to the Operator Manual. In addition please see "How to scan with CARE kV" (*syngo* CT 2011).

How to reduce dose

Avoid multiphase exams

Reduce the number of phases when appropriate. Campaigns such as Image Gently (www.imagegently.org) urge clinicians to use single phase scans whenever possible.

Use automated adaption of the tube current

Always use CARE Dose4D. It adjusts the exposure to the size and attenuation of the individual patient.

Use automated adaption of the tube voltage

CARE kV automatically adjusts the tube voltage tailored for each examination.

Especially for contrast enhanced scans, dose reductions are possible by using low kV-settings.

The following are examples on how CARE kV and CARE Dose4D optimize the parameters for the individual child.

Reference setting		**Actual settings with CARE Dose4D and CARE kV***	
Examination of the thorax		Examination of the thorax Patient: 7-year-old child, weight: 32 kg	
"Quality reference mAs"	90 mAs	Effective mAs	101 mAs
"Reference kV"	120 kV	kV	80 kV
		$CTDI_{vol}$	1.7 mGy

* CARE Dose4D on, CARE kV on, slider position "Dose saving optimized for": 7.

Reference setting		**Actual settings with CARE Dose4D and CARE kV***	
Examination of the abdomen		Examination of the abdomen Patient: 7-year-old child, weight: 25 kg	
"Quality reference mAs"	150 mAs	Effective mAs	236 mAs
"Reference kV"	120 kV	kV	80 kV
		$CTDI_{vol}$	3.9 mGy

* CARE Dose4D on, CARE kV on, slider position "Dose saving optimized for": 7.

Use lower dose where low contrast resolution is not required

Examples for scans that may not need optimal contrast resolution include lung and bone imaging as well as follow-up studies for shunt or tube placement.

How to reduce dose

Use organ based dose modulation

If radiation sensitive organs are exposed during the scan, e.g. breast tissue in thoracic exams, use X-CARE if available on your system. X-CARE provides organ specific dose savings without the disadvantages of in-plane shielding.

The use of in-plane shielding is not recommended. If you nevertheless decide to use in-plane shielding with your Siemens CT Scanner, it is important to ensure that shields are removed during topogram acquisition. Otherwise the system will increase the dose according to the additional attenuation in the scan area and the potentially positive effect is negated. Always follow the shield manufacturers' instructions for proper use and placement.

Use high-pitch scanning

If available, use high-pitch values for fast scanning, thereby potentially avoiding sedation and motion artifacts.

With pitch values of up to 3.4, even uncooperative children can be examined without sedation on the SOMATOM Definition Flash, thus saving time and reducing stress for the patient.

Use the appropriate reconstruction technique

Avoid sub-millimeter slices. Thicker slices, selection of a smoother kernel and wider windowing reduce image noise, thus help reduce dose.

Use advanced reconstruction techniques like Iterative Reconstruction, when available.

Dose reporting

Siemens provides all the necessary tools for efficient dose management and monitoring.

Dose is reported in terms of **$CTDI_{vol}$** and **DLP**, as required by IEC standards.

This represents the dose delivered to a reference phantom reported in a standard way for all scanners and does not reflect actual exposure to any given patient.

The $CTDI_{vol}$ is displayed prior to the exam and immediately reflects changes in scan parameters. Both $CTDI_{vol}$ and DLP are available after each individual exam through either the **Patient Protocol** page or the **DICOM Dose Structured Report** (DICOM Dose SR). Thus the information is saved and can be archived.

For all Siemens' protocols including child protocols, as defined by IEC, the $CTDI_{vol}$ is measured in the 32 cm phantom for all body exams and in the 16 cm phantom for all head exams.

The phantom size used can be seen in the Exam Card prior to the scan and in the Patient Protocol and the DICOM Dose SR.

	Scan	kV	mAs / ref.	CTDIvol* mGy	DLP mGycm
Patient Position H-SP					
Topogram	1	80	19 mA	0.02 L	0
FI_Thorax	2D	80	44	0.69 L	17
				*: L = 32cm. S = 16cm	

This is an example of a Patient Protocol page of a thorax CT examination of a child. The phantom size used can be seen.
L = Large: 32 cm phantom and S = Small: 16 cm phantom

IEC: International Electrotechnical Commission

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