

# REDUCING RADIATION EXPOSURE TO CHILDREN FROM COMPUTED TOMOGRAPHY (CT) SCANS



## FREQUENTLY ASKED QUESTIONS

### 1. What is a CT scan?

CT scans use an X-ray device that rotates around the patient to create many individual pictures that can be used to build a three-dimensional (3-D) image of a body part. These 3-D pictures often provide more detailed information for diagnoses than can be obtained from other kinds of X-rays. Modern CT scanning is very fast and accurate. However, because CT scans are built up from multiple X-rays, they deliver higher doses of ionising radiation than single (plain) X-rays.

A form of CT called cone beam CT (CBCT) is also used in dental practice. CBCT uses less radiation than most medical CT scans, but more radiation than other types of oral health imaging (such as plain X-rays of the teeth). More information on CBCT is provided in Question 17.

### 2. Why would my child's doctor want my child to have a CT scan?

CT is a valuable diagnostic tool, providing doctors, dentists and other health professionals with non-invasive, fast and accurate information to help diagnose serious injury and illness, and inform treatment.

CT scans are useful in a wide range of clinical situations, including:

- in emergency situations when immediate imaging is required to provide a diagnosis
- when high-quality images of bone detail are required – for example, for complex fractures, or in planning for surgery when certain diagnoses need to be monitored or excluded.



### 3. What is ionising radiation?

Radiation is energy travelling as waves or particles. Radiation classified as 'ionising' has enough energy to cause changes in cells in the body.

We are all exposed to a small amount of ionising radiation every day from the air we breathe, the food we eat and buildings around us. In most parts of Australia, this natural background radiation<sup>1</sup> adds up to 1–2 millisieverts (mSv) per person per year.

<sup>1</sup> Natural background radiation is the term used to refer to the ionising radiation that we are unavoidably exposed to in our daily lives. Sources of natural background radiation give each of us a continuous, small dose of ionising radiation.

### 4. How much radiation do CT scans deliver?

A head CT scan exposes a child to approximately 2 mSv (millisieverts) of radiation, which is equivalent to more than one year of natural background radiation.<sup>1</sup> For comparison, a single chest X-ray delivers around 0.02 mSv, which is equivalent to approximately five days of natural background radiation. Other examples of radiation doses from various sources are shown in the following table:



**Table One: Typical radiation doses from various sources (for children 0–10 years)<sup>a</sup>**

Source of exposure	Effective dose (mSv) <sup>b</sup>
Average dose from natural background radiation per year (in Australia)	1.5
Extremities X-ray	0.005–0.05
Chest X-ray (2 views)	0.03–0.08
Head CT scan	1.5–2.5
Chest CT scan	1–3
Abdomen CT scan	4–10
Dental cone beam CT scan	0.1–0.2
Ultrasound	0
Magnetic resonance imaging (MRI)	0

a Children 0 to 10 years have been chosen because, after this age, the difference between child and adult dose is reduced.

b These figures are based on international sources and national data collected by the Australian Radiation Protection and Nuclear Safety Agency. Effective doses vary, depending on the gender, age and weight of the child, as well as the CT equipment and imaging settings used.

By improving dose optimisation at the time of the scan, lower effective doses can be achieved.

1 Natural background radiation is the term used to refer to the ionising radiation that we are unavoidably exposed to in our daily lives. Sources of natural background information give each of us a continuous, small dose of ionising radiation.

## 5. Why are children more at risk from radiation?

Exposure to ionising radiation is of potential concern for both adults and children because it can increase a person's risk of developing cancer. Children are at greater risk because their rapidly growing cells are more likely to be damaged by ionising radiation. Children also have longer to live than adults, so there is more time for the effects of any radiation damage to occur.



## 6. What is the risk of my child developing cancer from a CT scan?

Knowledge is still evolving about the extent of risk for children and young people. The risk varies with age, the size of the child and the part of the body scanned. Recent studies have provided varied estimates of the overall risk. For example:

- a 2013 Australian paediatric study estimated the risk at one extra case of cancer for every 1800 CT scans, about 10 years after exposure<sup>1</sup>
- a 2012 United Kingdom study estimated that, for every 10 000 head CT scans done before the age of 10, there was one extra case each of leukaemia and brain tumour, 10 years after the first exposure.<sup>2</sup>

These rates are small relative to the cancers that occasionally occur in childhood. Most of the cancers that occur after a CT scan in a child would have occurred without the scan. Nevertheless, it is important to be aware of the risk from CT scans so that parents, carers and doctors can decide how to balance any small and uncertain future risk against the medical benefits of having the scan.

A CT scan that is well justified on medical grounds will almost always result in more benefit than harm to most patients.

- 1 Mathews JD, Forsythe AV, Brady Z, Butler MW, Goergen SK, Byrnes GB, et al. Cancer risk in 680,000 people exposed to computed tomography scans in childhood or adolescence: data linkage study of 11 million Australians. *BMJ* 2013;346:2360.
- 2 Pearce MS, Salotti JA, Little MP, McHugh K, Lee C, Kim KP, et al. Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study. *Lancet* 2012;380:499–505.



## **7. My child has had a CT scan (or scans). Will this affect them in the future?**

CT scans have been linked to a small increase in the risk of cancer later in life (see Question 6). However, the risk of an individual child developing cancer as a result of a CT scan is low.<sup>1</sup>

The risk of a person developing cancer in their lifetime is also influenced by genetic factors and by exposure to other cancer-causing agents in the environment. CT scans are only one of the many risk factors associated with cancer, so there is no way to know whether any particular CT scan will affect an individual child in the future.

<sup>1</sup> Mathews JD, Forsythe AV, Brady Z, Butler MW, Goergen SK, Byrnes GB, et al. Cancer risk in 680,000 people exposed to computed tomography scans in childhood or adolescence: data linkage study of 11 million Australians. *BMJ* 2013;346:2360.

## **8. If my child has had a CT scan, do I need to take them back to the doctor to be tested for cancer?**

No. Routine medical follow-up is not required for radiation exposure from CT scans. However, if you have concerns about your child's health generally, you should seek medical advice.

## **9. What should I do if the doctor says my child should have a CT scan?**

Talk to your child's doctor about the benefits of the scan and its potential risks. If your child is in an emergency situation, it may be difficult to ask questions. A doctor is more likely to request a CT scan in a serious emergency situation because it is usually the quickest and most accurate way to see inside the body.

If your child's condition does not require urgent attention, there may be more opportunity to discuss the benefits and risks of a proposed scan; any previous imaging your child has had; and alternative



procedures that do not use ionising radiation, such as magnetic resonance imaging (MRI) (see Question 12) or ultrasound. If a diagnosis is not required urgently, the doctor might consider a 'wait and see' approach.

Although the risk of cancers resulting from CT scans is small, radiation doses from CT scans should be kept as low as possible and alternative procedures that do not use ionising radiation should be considered, where appropriate. If your child has to have a scan, ask the imaging service whether they will 'kid-size' the radiation dose.

The diagnostic imaging service is required to obtain the consent of a parent or guardian to conduct any medical imaging procedure on a child. This consent may be verbal or written. There is no requirement for your child's doctor to obtain your consent for ordering the CT scan, but a child's legal guardian is able to decide whether to follow through with the recommendation for a CT scan. The brochure [What you need to know about CT scans for children](#) will answer some of the questions you may have about CT scans, and suggest some questions to ask your child's doctor or the person doing the scan.

## **10. Should my child's doctor consider the number of CT scans my child has had before?**

If the benefits of an imaging test are considered to exceed its risks, it is considered a warranted test and should proceed, regardless of whether the child has had previous medical imaging.<sup>1-3</sup>

Every individual CT scan needs to be justified on its own merits, regardless of any past or potential future scans your child may have. While the risk of cancer appears to increase with additional scans<sup>4</sup>, if a scan is well justified on clinical grounds, then it needs to be done.



If you visit the doctor or dentist and there is a possibility of new scans for your child, you should bring any past medical imaging films with you. Previous medical imaging can allow your doctor to track the progress of your child's health issue, or resolve another medical question, possibly making further medical imaging unnecessary.

- 1 Durand, DJ, Dixon RL and Morin RL. Utilization strategies for cumulative dose estimates: a review and rational assessment. *Journal of the American College of Radiology* 2012;9(7):480–485.
- 2 Eisenberg JD, Lewin SO and Pandharipande PV. The fisherman's cards: how to address past and future radiation exposures in clinical decision making. *AJR: American Journal of Roentgenology* 2014;202(2):362–367.
- 3 Walsh C and Murphy D. Should the justification of medical exposures take account of radiation risks from previous examinations? *British Journal of Radiology* 2014;87(1037):20130682.
- 4 National Research Council. Health risks from exposure to low levels of ionizing radiation, BEIR VII Phase 2. Washington, DC: National Academies Press, 2006, [www.nap.edu/catalog/11340/health-risks-from-exposure-to-low-levels-of-ionizing-radiation](http://www.nap.edu/catalog/11340/health-risks-from-exposure-to-low-levels-of-ionizing-radiation).

## 11. What are the alternatives to a CT scan?

Although the risk of cancer resulting from CT scans is small, radiation doses from CT scans should be kept as low as possible. Sometimes there is no alternative to a CT scan, particularly if urgent decisions need to be made about your child's care. In other situations, alternative procedures that do not use ionising radiation, such as magnetic resonance imaging (MRI) (see Question 12) or ultrasound, may be appropriate. The doctor will consider the availability of these other procedures in your area. If circumstances allow, a doctor might choose a 'wait-and-see' approach, where your child's condition will be monitored for change.

Your child's doctor should work with you, and a radiologist, to determine whether imaging is required and, if so, which type is most suitable. Let the doctor know if a previous imaging scan is available because this might give them the information they need, so that a new scan is not required. Ask questions if you are unsure about anything. Make sure you [understand the options](#) so that you are informed to make the best decision for your child.



## **12. What is magnetic resonance imaging (MRI), and what are the benefits and risks of having MRI?**

MRI uses magnets and radio waves to produce signals that are processed by a computer to create pictures of the inside of the body. MRI does not produce ionising radiation. However, it may not be appropriate for all patients, conditions or circumstances. MRI generally takes longer to obtain an image, requiring the patient to stay very still for 10 minutes, to more than 1 hour, depending on the imaging needed. It also requires the child to be scanned in a more confined space and can be quite noisy. As a result, particularly for children, MRI may require sedation or anaesthesia, which carry other risks.

## **13. What is being done to reduce the risks from CT scans?**

The best way to reduce risks is to use CT only when it is appropriate, and to use the lowest amount of radiation needed to obtain the required image for each CT scan.

Many imaging services have protocols and scanners that reduce or 'kid-size' the radiation dose. Imaging professionals and the equipment they use aim to minimise the radiation exposure from any one imaging test. It is always okay to ask your child's doctor or imaging staff if your child's dose will be kid-sized.

You should discuss any additional questions with the doctor or dentist referring your child for CT, or with the person conducting the scan.

## **14. Should other parts of my child's body be covered during the scan?**

Every scan should be limited to the area of the body of interest. Improvements in CT technology, including techniques to reduce the radiation dose, mean that the use of physical shields (e.g. aprons, thyroid collars) for patients having CT scans is no longer routine.





If you are with your child in the CT room during the scan, the radiographer (the person performing the scan) will give you protective clothing (such as a lead apron). Tell the radiographer if you or your child may be pregnant.

If you have any concerns or questions, ask the radiographer before the scan.

## **15. How can I help prepare my child for a CT scan?**

CT scans are generally quick, but if your child moves or cannot hold their breath if required, it can blur the images so that a scan may need to be repeated. Taking along a favourite toy is often a comfort to younger children.

Many hospitals also have information on their websites on how to get your child ready for their CT scan. Some employ [child life therapists](#), who are trained to help children prepare for medical procedures, including CT scans. Links to relevant web pages for major children's hospitals nationally are:

- [Royal Children's Hospital Melbourne](#)
- [Monash Children's Hospital](#), Melbourne
- [Sydney Children's Hospitals Network](#)
- [John Hunter Children's Hospital](#), Newcastle
- [Children's Health Queensland](#) (including Lady Cilento Children's Hospital, Brisbane)
- [Princess Margaret Hospital](#), Perth
- [Women's and Children's Hospital](#), Adelaide.



More resources to help you prepare your child for their CT scan, including a video of a child having a CT scan, and tablet apps and games, are available at [healthdirect.gov.au/ctscansforkids](https://healthdirect.gov.au/ctscansforkids).

## 16. Should I keep a record of my child's CT scans?

Yes, keep a record of the CT scans and other imaging your child has. A previous CT scan may provide valuable information for future diagnoses.

If your child was born in Australia, you may have been given a health record book that is taken to the child health clinic for immunisations or health checks. A book such as this can help you and your child's doctor or dentist keep track of the imaging that your child receives.

Most state and territory health departments provide these books in hard copy or electronically:

- Australian Capital Territory – [My ACT Personal Health Record](#)
- New South Wales – [My Personal Health Record](#)
- Northern Territory – no book available
- Queensland – [Personal Health Record](#)
- South Australia – [My Health and Development Record](#)
- Tasmania – Personal Health Record (hard copy only)
- Victoria – My Health and Development Record (hard copy only)
- Western Australia – All About Me, Child Health Book (hard copy only).



## 17. Why would my child's dentist want a CT scan of my child's mouth?

Many different types of X-ray images can be requested by dental practitioners to assist in diagnosis. These include cone beam computed tomography (CBCT) scans.

CBCT scans are taken by an X-ray device that rotates around the head to create many individual pictures of the child's jaw and teeth, and these individual images are used to build a three-dimensional (3-D) image. This 3-D image may provide diagnostically important information that is not present in other types of dental images, such as orthopantomograms.

CBCT is only appropriate to use when 3-D imaging is required. It is particularly useful for investigating teeth that have not grown in properly, and injury to the jaw and teeth. It is often used for clinical assessment before the placement of implants, and jaw and face surgery.

CBCT scans typically expose a child to less radiation than a conventional medical CT scan (see Question 4). However, the radiation dose from a standard CBCT scan is usually higher than from other types of dental imaging.

If you are concerned about the increased risk of cancer to your child from a CBCT scan, talk to your child's dentist about the benefits and potential risks.

The brochure [\*Cone beam CT scans in oral health care for children and young people\*](#) will answer some of the questions you may have about CBCT scans, and suggest some questions to ask your dentist. Always take previous scans to your child's dental appointments.



## 18. What should I do if my child's dentist requests a cone beam CT scan?

Radiology is a common diagnostic tool in oral health practice. Dental images, including cone beam CT (CBCT) scans, can improve diagnoses and dental care. They can help determine the best treatment option, avoid other tests or surgery, and improve health outcomes.

In general, CBCT should only be required for complicated cases or those involving serious conditions. CBCT should never be conducted on a routine basis or without the dentist first obtaining a thorough medical history and performing a clinical examination.<sup>1</sup>

As with medical CT scans, a CBCT scan needs to be clinically justified, and the benefit of the scan should always outweigh the potential risk. If a dentist requests a CBCT scan for your child, talk to the dentist about why it is necessary and if there are alternative imaging options. The brochure [Cone beam CT scans in oral health care for children and young people](#) will answer some of the questions you may have about CBCT scans, and suggest some questions to ask your dentist. Always take previous scans to your child's dental appointments.

1 Joint Position Statement of the American Association of Endodontists and the American Academy of Oral and Maxillofacial Radiology: use of cone-beam computed tomography in endodontics. 2010, [www.aomr.org/news/52024](http://www.aomr.org/news/52024).

## 19. What can be done to reduce the risks from cone beam CT scans?

To minimise the amount of radiation used to create a dental image, the settings on some cone beam CT (CBCT) scanners can be adjusted to accommodate a child's size. As with medical imaging procedures, you should ask for appropriate low-dose techniques to be used to minimise radiation exposure. However, the dose of radiation typically delivered by any CBCT machine is relatively low (see also Question 4).



Shielding is not typically used for dental patients having a CBCT scan. However, you should ask about shielding for yourself if you are going to stay with your child during the scan. Tell the person taking the scan if you or your child may be pregnant.

## **20. How can I find out more about CT scans for children?**

Further information can be found at [www.safetyandquality.gov.au/ctscansforkids](http://www.safetyandquality.gov.au/ctscansforkids) or [www.healthdirect.gov.au/ctscansforkids](http://www.healthdirect.gov.au/ctscansforkids).