

Diagnostic Imaging Pathways - Thoracic Aorta Blunt Trauma

Population Covered By The Guidance

This pathway provides guidance on the imaging of adult trauma patients at risk of aortic injury following blunt trauma.

Date reviewed: August 2013

Date of next review: August 2015






Published: August 2013

Quick User Guide

Move the mouse cursor over the **PINK** text boxes inside the flow chart to bring up a pop up box with salient points.

Clicking on the **PINK** text box will bring up the full text.

The relative radiation level (RRL) of each imaging investigation is displayed in the pop up box.

SYMBOL	RRL	EFFECTIVE DOSE RANGE
	None	0
	Minimal	< 1 millisieverts
	Low	1-5 mSv
	Medium	5-10 mSv
	High	>10 mSv

Pathway Diagram



Date reviewed: August 2013
 Please note that this pathway is subject to review and revision

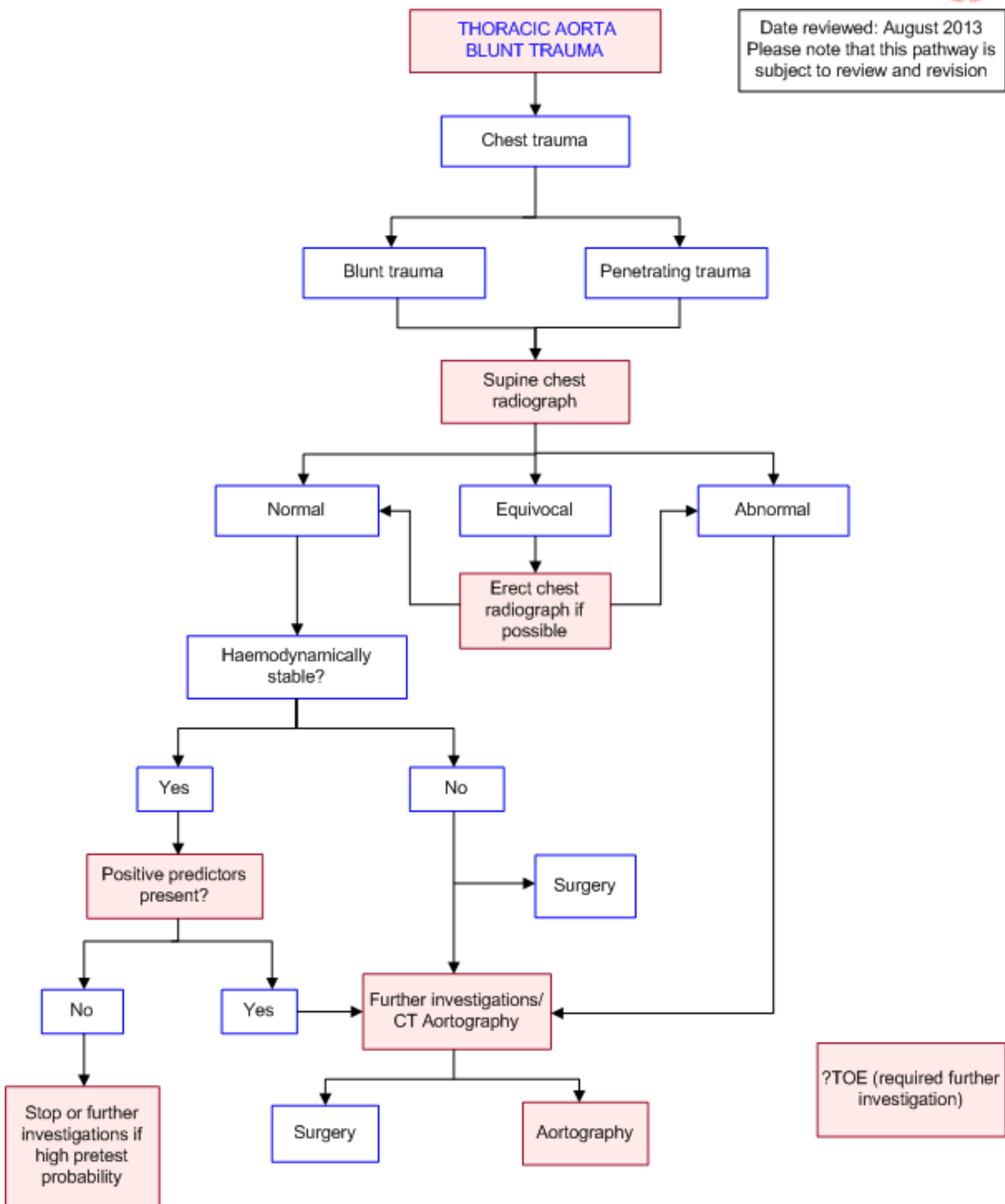


Image Gallery

Note: These images open in a new page

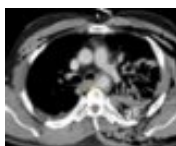
1



Blunt Thoracic Aortic Injury

Image 1 (Chest radiography): The classical radiographic signs of a traumatic disruption of the aorta are shown including a widened mediastinum, depressed left main bronchus and left apical cap.

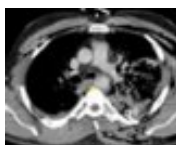
2a



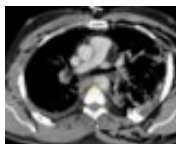
Blunt Thoracic Aortic Injury

Image 2a, 2b and 2c (CT Angiography): Evidence of an intimal flap and full-thickness rupture of the thoracic aorta at the level of the aortic isthmus (arrows). Subcutaneous emphysema is seen bilaterally with contusions to the left lung.

2b



2c

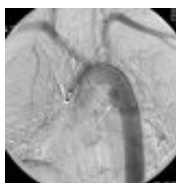


2d



Image 2d and 2e (Aortography): Aortic rupture is confirmed by evidence of delayed contrast flow in the region of the aortic isthmus (arrow) which is best seen in image 2e, where the area of injury retains contrast and appears darker compared to the rest of the aorta.

2e



Teaching Points

- Diagnosis depends on the level of clinical suspicion and imaging

- The initial screening tool for blunt thoracic trauma is a supine radiograph
- Patients who have an abnormal supine film (or normal erect chest radiograph with high clinical suspicion) and are haemodynamically stable should undergo CT of the mediastinum
- Absence of peri-aortic mediastinal haematoma and direct signs of aortic injury on CT has a very high negative predictive value for aortic trauma
- Those who have an abnormal supine film and who are cardiovascularly unstable, should be referred for an urgent surgical opinion
- An aortogram can be used for diagnostic and therapeutic purposes (e.g. stenting)
- The role of Transoesophageal Echocardiogram in the assessment of blunt thoracic trauma remains to be fully elucidated

Aortography

- Historically the "gold standard" in diagnosing acute traumatic aortic injuries, but multidetector CT has been shown to have a similar sensitivity and specificity in recent studies [1-4,17,21-23](#)
- Useful for establishing the diagnosis, defining the anatomy of the lesion, identifying additional sites of injury, and acute stenting of appropriate patients [1-4](#)
- Indicated in [1,3,4,10](#)
 - All clinically unstable patients suspected of having traumatic aortic injury
 - Clinically stable patients with an evidence of significant mediastinal haematoma on CT
- Allows complete evaluation of the thoracic aorta from the aortic root to the diaphragmatic hiatus and the brachiocephalic arteries and their branches [2,16](#)
- Disadvantages
 - Invasive procedure with a risk of complications
 - Use of iodinated contrast material
 - Time consuming

Computed Tomography (CT)

- Contrast-enhanced spiral CT has high (>96%) sensitivity and specificity for detecting direct and indirect signs of thoracic aorta injuries [7-10](#)
 - Direct signs of aortic injury include: intimal flaps, pseudotumours, intraluminal thrombi, contour abnormalities, pseudocoarctation of the aorta, and contrast material extravasation
 - Indirect signs of aortic injury includes mediastinal haemorrhage
- Brink et al (2010) have mentioned a few criteria for the selective use of CT chest in blunt chest trauma patients, based on available literature. However these need external prospective validation in different trauma population and settings [19](#)
- They showed that the independent predictors of the presence of any chest injuries (positive predictors) are [19](#)
 - Age >55 years
 - Abnormal physical examination chest
 - Abnormal physical examination of the thoracic spine
 - Altered sensorium
 - Abnormal conventional chest radiography
 - Abnormal thoracic spine radiograph
 - Abnormal radiograph of pelvis and abdominal ultrasonography
 - Base Excess less than -3 mmol/l
 - Haemoglobin less than 6 mmol/l

- The above independent predictors significantly contributed to the presence of chest injuries on CT in their study. The authors suggest that although their absence can be used as a guide against the use of a CT chest, their presence necessitates careful clinical judgement to decide which patient really needs CT
- Further investigations for clinically stable patients having normal chest radiograph should be dependent on pre-test probability. How to assess the pre-test probability is not well defined e.g. mechanism of injury does not co-relate [19](#) but speed of collision (> 60 mph) co-relates significantly with traumatic aortic injury [18](#)
- Clinically stable patients in whom suboptimal or equivocal chest radiographs fail to exclude mediastinal haematoma should have an erect posteroanterior radiograph. If the radiograph is abnormal, CT should be performed. If mediastinal blood or aortic contour abnormality is present, aortography is indicated [4,7,11](#)
- Allows triage of stable patients and prevents unnecessary aortography. If direct signs of aortic injury are present, the patient should proceed to surgery, however aortography may be performed for therapeutic reasons (e.g. stenting) [1,8,10,17](#)
- No further imaging is indicated in patients in whom there is no evidence of periaortic mediastinal haematoma or direct signs of aortic injury [1,10,20](#)
- The location of the mediastinal haematoma is significant, since a haematoma confined to the retrosternal area is of doubtful significance, whereas a para-aortic haematoma or one around the branches of the arch are significant and require further investigation [12](#)
- Post-IV-contrast CT may show direct signs of aortic injury [7,8](#)
- Advantages
 - Fast, non-invasive, safe test
 - Less expensive compared to aortography
 - Ability to distinguish mediastinal blood from other causes of mediastinal widening detected on initial chest radiographs eg artifacts of magnification, mediastinal fat, or anatomical variation
- Limitations
 - Motion artifacts
 - Artifacts caused by nasogastric and endotracheal tubes obscuring intimal defects of aorta
- Magnetic Resonance Angiography (MRA) has limited practicality and can be an alternative to Computed Tomography Angiography (CTA) when iodinated contrast is contraindicated

Predictors of Chest Injury

- Brink et al (2010) have mentioned a few criteria for the selective use of CT chest in blunt chest trauma patients, based on available literature. However these need external prospective validation in different trauma population and settings
- They showed that the independent predictors of the presence of any chest injuries (positive predictors) are [8](#)
 - Age >55 years
 - Abnormal physical examination chest
 - Abnormal physical examination of the thoracic spine
 - Altered sensorium
 - Abnormal conventional chest radiography
 - Abnormal thoracic spine radiograph
 - Abnormal radiograph of pelvis and abdominal ultrasonography
 - Base Excess less than -3 mmol/l
 - Haemoglobin less than 6 mmol/l
- The above independent predictors significantly contributed to the presence of chest injuries on CT

in their study. The authors suggest that although their absence can be used as a guide against the use of a CT chest, their presence necessitates careful clinical judgement to decide which patient really needs CT

- Further investigations for clinically stable patients having normal chest radiograph should be dependent on pre-test probability. How to assess the pre-test probability is not well defined e.g. mechanism of injury does not co-relate [8](#) but speed of collision (> 60 mph) co-relates significantly with traumatic aortic injury [11](#)

Mechanism of injury

- Mechanism of injury was not considered a positive predictor for the presence of a chest injury on CT in the recent study(2010) by Brink et al. [8](#) So in the absence of positive chest radiograph findings in stable patients with a low pretest probability (excluding motor vehicle accidents with speed >60 mph), a thoracic aortic injury can be excluded and thus a CT can be avoided. [11](#) The findings from the chest radiograph incorporated in the study were left paraspinous line displacement, obscured aortic knob, and mediastinal widening. It showed a negative predictive value of 99.6% in excluding thoracic aortic injury [11](#)

Thoracic Aorta Blunt Trauma

- Majority are fatal at the scene of the accident. Prompt diagnosis and treatment are essential on admission in survivors [1-4](#)
- >90% of injuries occur at the aortic isthmus. Most of the rest occur in proximal ascending aorta [1-4](#)
- Prompt diagnosis depends on the level of clinical suspicion and imaging [1-4](#)
- Usual mechanism of injuries: sudden deceleration or crush injuries to the chest causing shearing or bending forces to thoracic aorta [1-4](#)

Transoesophageal Echocardiogram (TOE)

- TOE is also an accurate modality for demonstration of aortic injury. [2,14,15,24](#) It can provide accurate diagnosis of aortic dissection with sensitivity and specificity of 99% and 98% respectively. [22](#) However further studies are required before TOE can be recommended as part of the imaging workup in patients with blunt chest trauma
- Advantages: can be performed at the patient bedside
- Limitations [2,13](#)
 - There may be blind areas of the aorta and branch vessels in some patients
 - Limited availability
- Disadvantages: semi-invasive procedure requiring sedation

Plain Radiography

- Initial screening study for evaluation of blunt thoracic trauma [1-5](#)
- Ungar et al, in a recent study, showed that certain chest radiograph findings including left paraspinous line displacement, obscured aortic knob, and mediastinal widening. had a negative predictive value of 99.6% in excluding thoracic aortic injury. [18](#) However these need external prospective validation in different trauma population and settings
- Some other radiographic findings in traumatic aortic rupture include [1,5](#)

1. Features directly related to the aortic injury: irregularity or blurring of the aortic knob contour, aortic knob enlargement
 2. Features related to the presence of a mediastinal haematoma: mediastinal widening, obscuration of aortic arch margin, deviation of trachea to the right, deviation of nasogastric tube to the right, depressed left main bronchus, loss of aorto-pulmonary window, widening of paraspinal stripes
 3. Other features: left apical cap, left haemothorax
- Most of the findings in aortic rupture are related to mediastinal haematoma rather to the aortic injury itself [1](#)
 - A combination of signs is more reliable than a single sign [5](#)

References

References are graded from Level I to V according to the Oxford Centre for Evidence-Based Medicine, Levels of Evidence. [Download the document](#)

- [1.](#) Wintermark M, Wicky S, Schnyder P. **Imaging of acute traumatic injuries of the thoracic aorta.** Eur Radiol. 2002;12:431-42. (Review article)
- [2.](#) Patel NH, Stephens KE, Mirvis SE, et al. **Imaging of acute thoracic aortic injury due to blunt trauma: a review.** Radiology. 1998;209:335-48. (Review article)
- [3.](#) Fishman JE. **Imaging of blunt aortic and great vessel trauma.** J Thorac Imaging. 2000;15:97-103. (Review article)
- [4.](#) Zinck SE, Primack SL. **Radiographic and CT findings in blunt chest trauma.** J Thorac Imaging. 2000;15:87-96. (Review article)
- [5.](#) Mirvis SE, Bidwell JK, Buddemeyer EU. **Value of chest radiography in excluding traumatic aortic rupture.** Radiology 1987;163:487-93. (Level III evidence)
- [6.](#) Woodring JH. **The normal mediastinum in blunt traumatic rupture of the thoracic aorta and brachiocephalic arteries.** J Emerg Med. 1990;8:467-76. (Level II/III evidence)
- [7.](#) Mirvis SE, Shanmuganathan K, Miller BH, et al. **Traumatic aortic injury: diagnosis with contrast enhanced thoracic CT: 5-year experience at a major trauma center.** Radiology. 1996;200:413-22. (Level II evidence) [View the reference](#)
- [8.](#) Scaglione M, Pinto A, Pinto F, et al. **Role of contrast-enhanced helical CT in the evaluation of acute thoracic aortic injuries after blunt chest trauma.** Eur Radiol. 2001;11:2444-8. (Level II evidence) [View the reference](#)
- [9.](#) Gavant ML, Mezel PG, Fabian T, et al. **Blunt traumatic aortic rupture: detection with Helical CT of the chest.** Radiology. 1995;197:125-33. (Level II evidence) [View the reference](#)
- [10.](#) Dyer DS, Moore EE, Mestek MF, et al. **Can chest CT be used to exclude aortic injury?** Radiology. 1999;213:195-202. (Level III evidence)
- [11.](#) Richardson P, Mirvis SE, Scorpio R, et al. **Value of CT in determining the need for angiography when findings of mediastinal hematoma on chest radiographs are equivocal.** AJR Am J Roentgenol. 1991;156:273-9. (Level II/III evidence)
- [12.](#) Wong YC, Wang LJ, Lim KE, et al. **Periaortic hematoma on helical CT of the chest: a criterion for predicting blunt thoracic aortic rupture.** AJR Am J Roentgenol. 1998;170:1523-5. (Level III evidence)
- [13.](#) Willens HJ, Kessler KM. **Transoesophageal echocardiography in the diagnosis of diseases of the thoracic aorta: Part II - atherosclerotic and traumatic diseases of the aorta.** Chest. 2000;117:233-43. (Review article)
- [14.](#) Goarin JP, Caloire P, Jacquens Y, et al. **Use of transoesophageal echocardiography for diagnosis of traumatic aortic injury.** Chest. 1997;112:71-80. (Level III evidence)
- [15.](#) Vignon P, Gueret P, Vedrinne J-M, et al. **Role of transoesophageal echocardiography in the**



- diagnosis and management of traumatic aortic disruption.** Circulation. 1995;92:2959-68. (Level II/III evidence)
16. Ahrar K, Smith DC, Bansal RC, et al. **Angiography in blunt thoracic aortic injury.** J Trauma. 1997;42:665-9. (Level III evidence)
 17. Cleverley JR, Barrie JR, Raymond GS, Primack SL, Mayo JR. **Direct findings of aortic injury on contrast-enhanced CT in surgically proven traumatic aortic injury: a multi-centre review.** Clin Radiol. 2002;57:281-86. (Level II evidence) [View the reference](#)
 18. Ungar TC, Wolf SJ, Haukoos JS et al. **Derivation of a clinical decision rule to exclude thoracic aortic imaging in patients with blunt chest trauma after motor vehicle collisions.** J Trauma. 2006;61:1150-5. (Level III evidence)
 19. Brink M, Deunk J, Dekker HM, Edwards MJR, Kool DR, van Vugt AB, et al. **Criteria for the selective use of chest computed tomography in blunt trauma patients.** Eur Radiol. 2010;20(4):818-28. (Level III evidence)
 20. Wicky S, Capasso P, Meuli R, Fischer A, von Segesser L, Schnyder P. **Spiral CT aortography: an efficient technique for the diagnosis of traumatic aortic injury.** Eur Radiol. 1998;8(5):828-33. (Level II evidence)
 21. Creasy J, Chiles C, Routh W, Dyer R. **Overview of traumatic injury of the thoracic aorta.** Radiographics. 1997;17(1):27-45. (Review article)
 22. Macura K, Szarf G, Fishman E, Bluemke D. **Role of computed tomography and magnetic resonance imaging in assessment of acute aortic syndromes.** Semin Ultrasound CT MR. 2003;24(4):232-54. (Review article)
 23. Nagy K, Fabian T, Rodman G, Fulda G, Rodriguez A, Mirvis S. **Guidelines for the diagnosis and management of blunt aortic injury: an EAST Practice Management Guidelines Work Group.** J Trauma. 2000;48(6):1128-43. (Level II evidence)
 24. Wicky S, Wintermark M, Schnyder P, Capasso P, Denys A **Imaging of blunt chest trauma.** Eur Radiol. 2000;10(10):1524-38. (Review article)

Information for Consumers

Information from this website	Information from the Royal Australian and New Zealand College of Radiologists' website
<p>Consent to Procedure or Treatment</p> <p>Radiation Risks of X-rays and Scans</p> <p>Angiography (Angiogram)</p> <p>Computed Tomography (CT)</p> <p>Chest Radiograph (X-ray)</p>	<p>Angiography</p> <p>Computed Tomography (CT)</p> <p>Iodine-Containing Contrast Medium</p> <p>Plain Radiography/X-rays</p> <p>Radiation Risk of Medical Imaging During Pregnancy</p> <p>Radiation Risk of Medical Imaging for Adults and Children</p>

Copyright

© Copyright 2015, Department of Health Western Australia. All Rights Reserved. This web site and its content has been prepared by The Department of Health, Western Australia. The information contained on this web site is protected by copyright.

Legal Notice

Please remember that this leaflet is intended as general information only. It is not definitive and The Department of Health, Western Australia can not accept any legal liability arising from its use. The information is kept as up to date and accurate as possible, but please be warned that it is always subject to change

File Formats

Some documents for download on this website are in a Portable Document Format (PDF). To read these files you might need to download Adobe Acrobat Reader.



[Legal Matters](#)