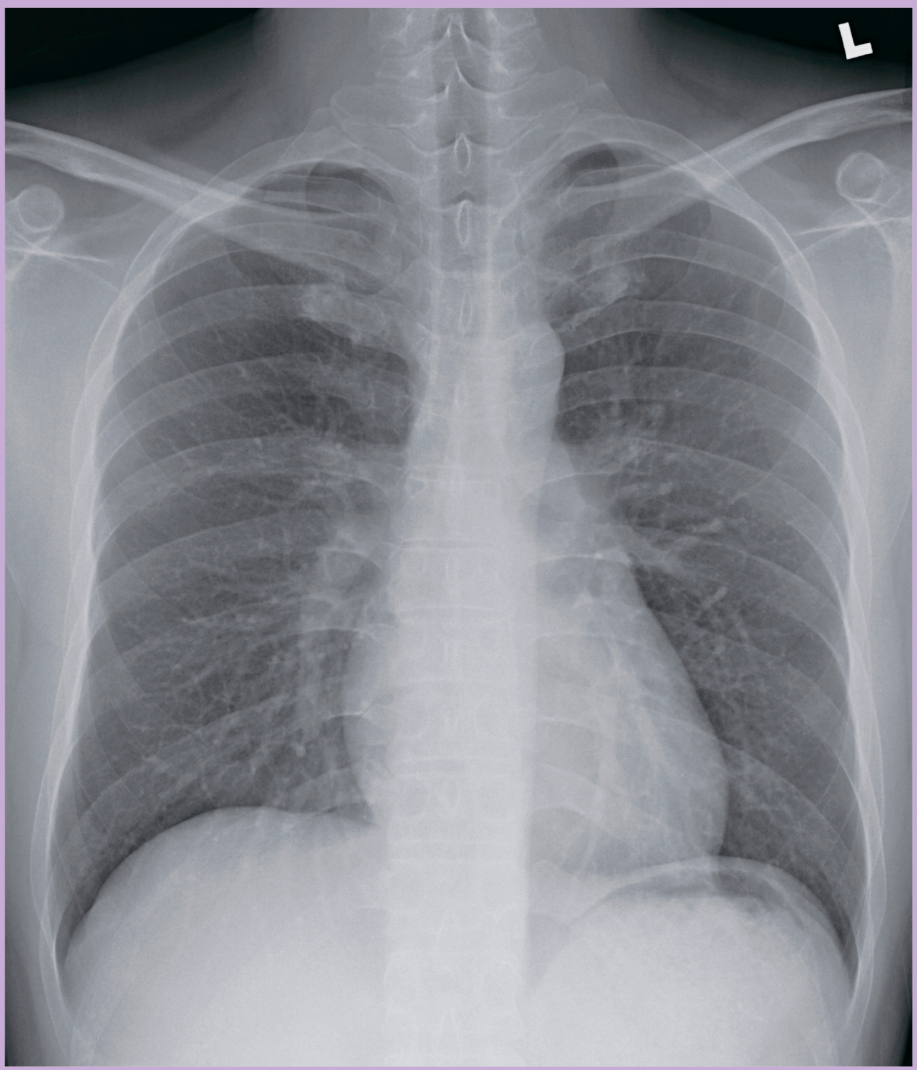
Chest Radiology



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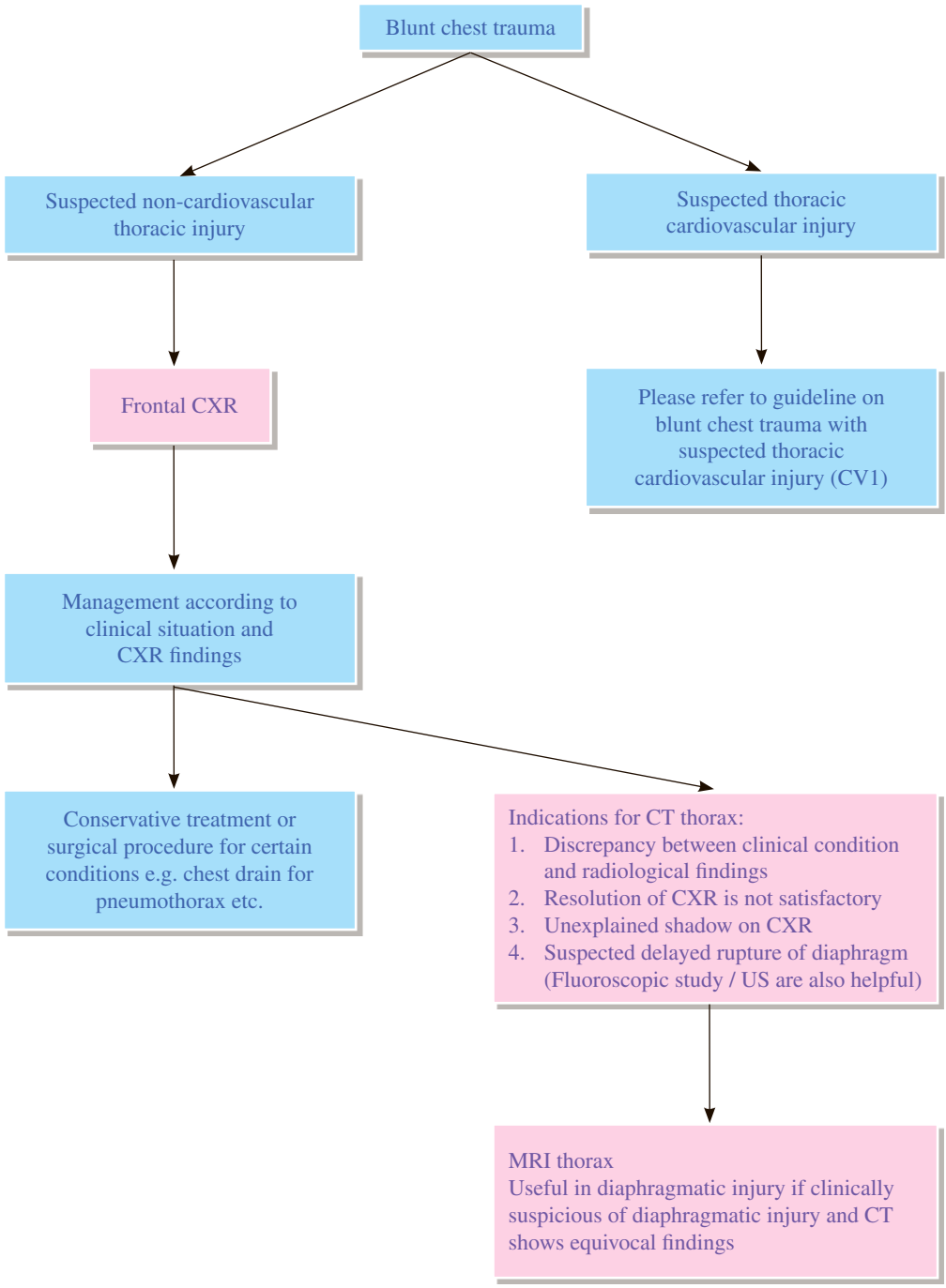
Blunt chest trauma
Suspected non-cardiovascular thoracic injury
Suspected thoracic cardiovascular injury
Frontal CXR
Please refer to guideline on blunt chest trauma with suspected thoracic cardiovascular injury (CV1)
Management according to clinical situation and CXR findings
Conservative treatment or surgical procedure for certain conditions e.g. chest drain for pneumothorax etc.
Indications for CT thorax:
1. Discrepancy between clinical condition and radiological findings
2. Resolution of CXR is not satisfactory
3. Unexplained shadow on CXR
4. Suspected delayed rupture of diaphragm (Fluoroscopic study / US are also helpful)
MRI thorax
Useful in diaphragmatic injury if clinically suspicious of diaphragmatic injury and CT shows equivocal findings

REMARKS

1 General

1.1 Clinical and radiological signs of significant lung injury are often absent on the initial evaluation. This is especially true for lung contusion for which the signs evolves over a period of 2 to 3 days.

1.2 There is no consistent relationship between evidence of external chest wall injury (either clinical or radiological signs) and the likelihood of serious underlying lung injury. This principle is especially important to remember when dealing with children, who because of their highly elastic chest walls can have serious lung injury even when there is no external sign of injury.

1.3 Radiographic studies greatly underestimate the true extent of lung and chest wall injury.

2 Plain radiograph

2.1 Chest X-ray (CXR) is the primary bedside imaging modality to evaluate the chest in post-traumatic patients.

2.2 CXR should preferably be taken in the erect posterior-anterior (PA) view. In case of major trauma, only supine anterior-posterior (AP) view may be possible.

2.3 Strict adherence to high standards of radiographic technique with respect to exposure factors, patient positioning and ventilation cycle is needed in order to obtain useful images.

3 CT

3.1 CT is the most sensitive and accurate imaging modality to evaluate the post-traumatic abdomen and chest.

3.2 CT is superior to CXR in imaging the chest wall, pulmonary parenchyma and mediastinum.

3.3 CT should be performed only if the patient's clinical condition is stable.

4 MRI

4.1 It is useful in assessing diaphragmatic integrity if there is clinical suspicion of diaphragmatic injury and CT shows equivocal findings.

4.2 MRI is most useful as a problem-solving tool and not as part of a standard trauma protocol, except in rare instances of significant thoracic spinal injury.

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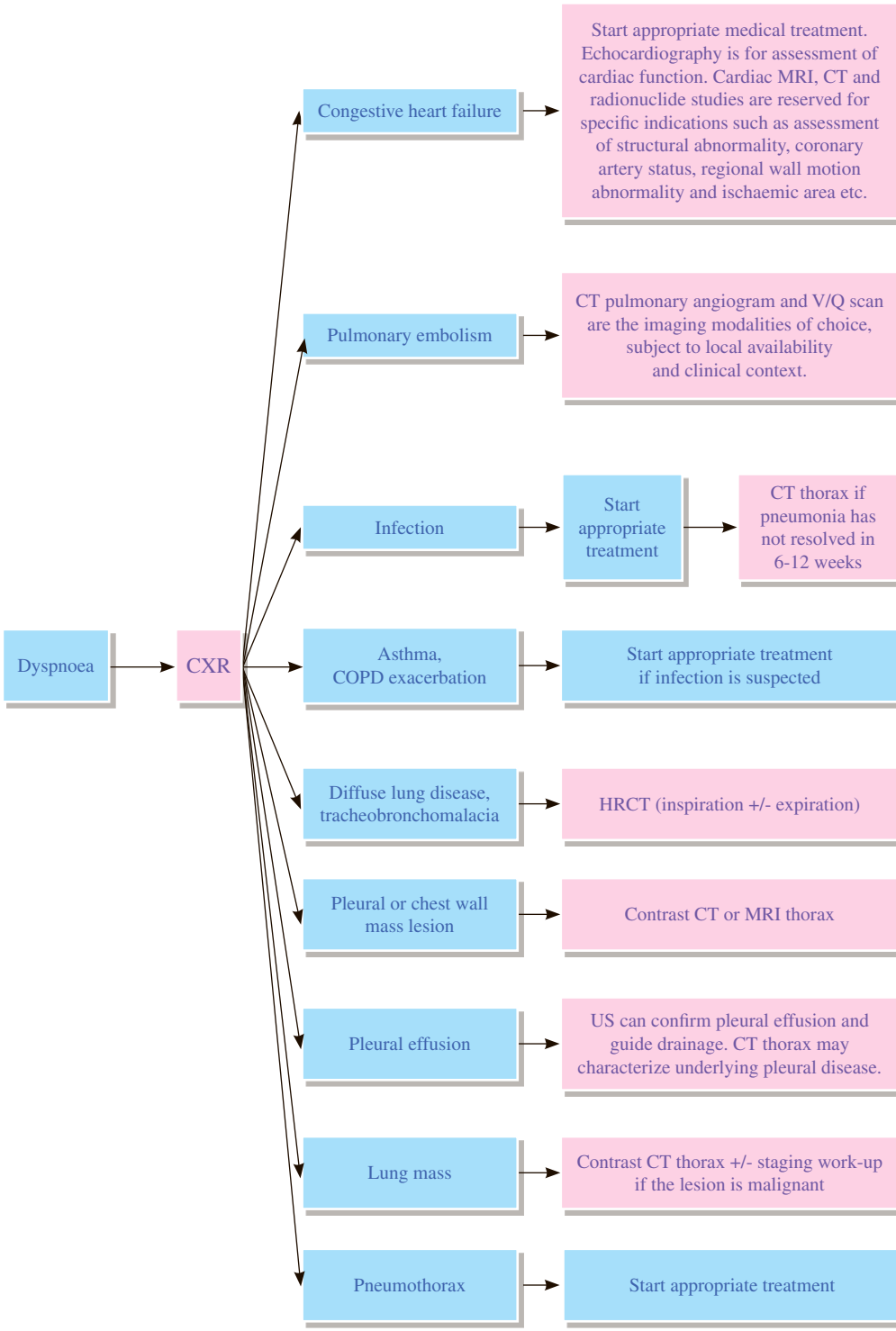
Dyspnoea
CXR
Congestive heart failure
Start appropriate medical treatment. Echocardiography is for assessment of cardiac function. Cardiac MRI, CT and radionuclide studies are reserved for specific indications such as assessment of structural abnormality, coronary artery status, regional wall motion abnormality and ischaemic area etc.
Pulmonary embolism
CT pulmonary angiogram and V/Q scan are the imaging modalities of choice, subject to local availability and clinical context.
Infection
Start appropriate treatment
CT thorax if pneumonia has not resolved in 6-12 weeks
Asthma, COPD exacerbation
Start appropriate treatment if infection is suspected
Diffuse lung disease, tracheobronchomalacia
HRCT (inspiration +/- expiration)
Pleural or chest wall mass lesion
Contrast CT or MRI thorax
Pleural effusion
US can confirm pleural effusion and guide drainage. CT thorax may characterize underlying pleural disease.
Lung mass
Contrast CT thorax +/- staging work-up if the lesion is malignant
Pneumothorax
Start appropriate treatment

REMARKS

1 Dyspnoea can be broadly classified into cardiac or pulmonary origins.

2 Chest X-ray (CXR) usually forms part of the initial workup for patients presenting with dyspnoea.

3 In two-thirds of the cases, CXR can help to make a diagnosis.

4 For patients with asthma or chronic obstructive pulmonary disease (COPD) exacerbation, a CXR is only needed under specific circumstances, e.g. when infection is suspected or if the condition does not respond to treatment.

5 High resolution CT (HRCT) is useful for diffuse lung disease, for example, interstitial lung disease, bronchiectasis, pneumoconiosis, sarcoidosis and emphysema. Expiratory HRCT can detect air trapping and tracheobronchomalacia.

6 Contrast CT thorax is needed when there is persistent consolidation, suspicion of pulmonary embolism, pulmonary or extrapulmonary mass.

7 MRI is usually reserved for evaluation of pleural disease or patients with chest wall mass.

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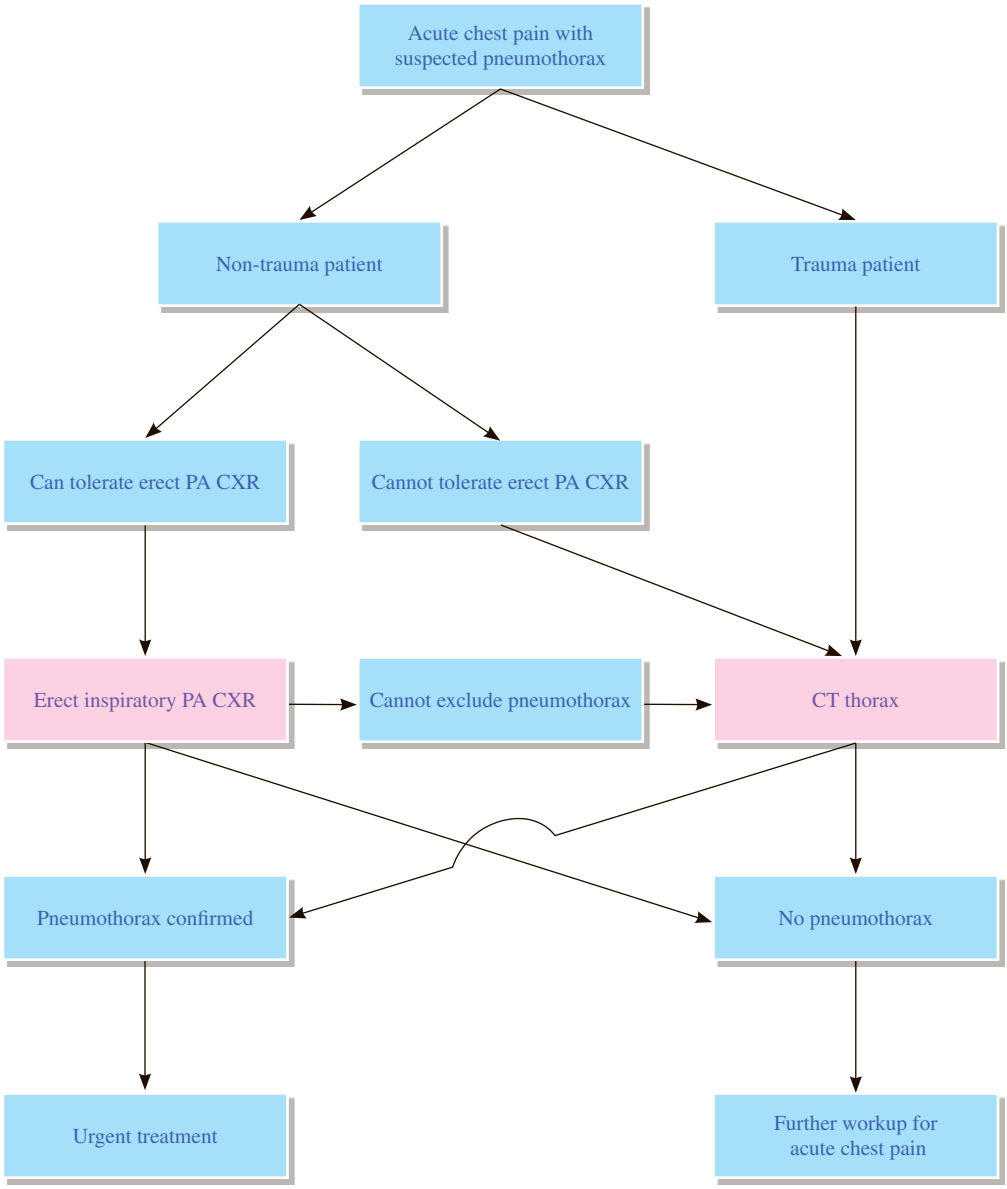
Acute chest pain with suspected pneumothorax
Non-trauma patient
Trauma patient
Can tolerate erect PA CXR
Cannot tolerate erect PA CXR
Erect inspiratory PA CXR
Cannot exclude pneumothorax
CT thorax
Pneumothorax confirmed
No pneumothorax
Urgent treatment
Further workup for acute chest pain

REMARKS

1 Plain radiograph

1.1 Posterior-anterior (PA) erect chest X-ray (CXR) in inspiration is recommended for the initial evaluation of suspected pneumothorax. In uncertain cases, such as in the presence of bullous lung disease, CT is preferred.

1.2 Lateral chest radiograph may provide additional information when a suspected pneumothorax is not confirmed on PA CXR but this is not routinely performed in everyday clinical practice.

1.3 Expiratory CXR is not thought to confer additional benefit in the routine assessment of pneumothorax.

1.4 Supine and lateral decubitus chest radiographs are mostly performed for trauma patients who cannot be safely positioned for erect PA view but these have been superseded by CT.

2 US

2.1 US only plays a subsidiary role in diagnosing pneumothorax and its efficacy highly depends on operator experience. US thus should not be a routine investigation.

3 CT

3.1 CT is the gold standard for detection of small pneumothoraces and for size estimation, and is recommended for uncertain or complex cases. It is also useful in detecting pneumothorax in the presence of bullous lung disease or surgical emphysema, and can also identify aberrant chest drain placement and other concomitant lung pathology.

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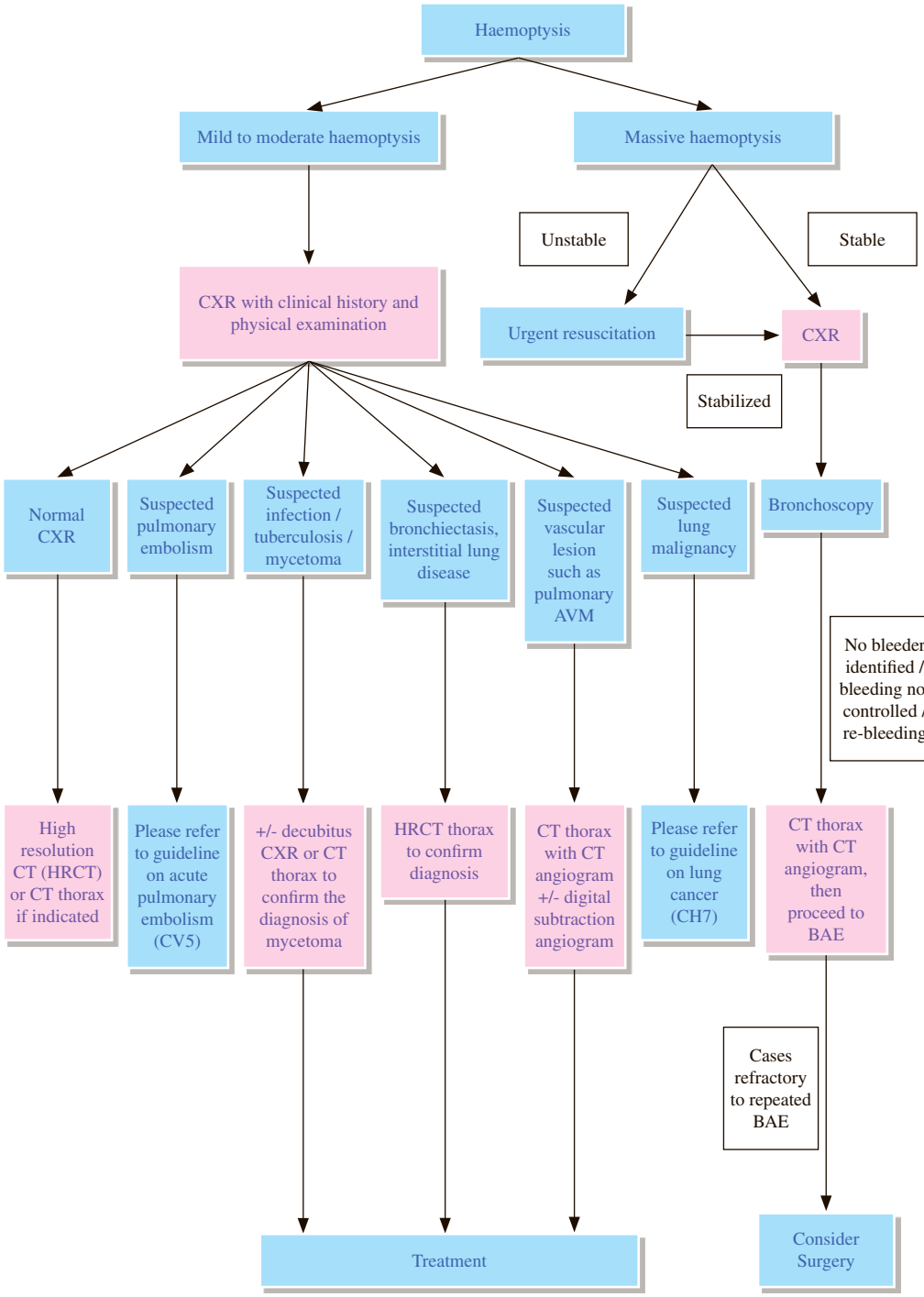
Haemoptysis
Mild to moderate haemoptysis
Massive haemoptysis
Unstable
Stable
CXR with clinical history and physical examination
Urgent resuscitation
CXR
Stabilized
Normal CXR
Suspected pulmonary embolism
Suspected infection / tuberculosis / mycetoma
Suspected bronchiectasis, interstitial lung disease
Suspected vascular lesion such as pulmonary AVM
Suspected lung malignancy
Bronchoscopy
No bleeder identified / bleeding not controlled / re-bleeding
High resolution CT (HRCT) or CT thorax if indicated
Please refer to guideline on acute pulmonary embolism (CV5)
+/- decubitus CXR or CT thorax to confirm the diagnosis of mycetoma
HRCT thorax to confirm diagnosis
CT thorax with CT angiogram +/- digital subtraction angiogram
Please refer to guideline on lung cancer (CH7)
CT thorax with CT angiogram, then proceed to BAE
Cases refractory to repeated BAE
Treatment
Consider Surgery

REMARKS

1 General

1.1 Haemoptysis is defined as the expectoration of blood that originates from the tracheobronchial tree or pulmonary parenchyma. The majority of cases are benign and are self-limiting episodes. However, its underlying aetiology must be evaluated. Common aetiologies include bronchitis, bronchiectasis, pneumonia, tuberculosis and malignancy.

1.2 The definition of massive haemoptysis varies in literature from 100 – 1000ml over 24 hours but the more widely used figure is expectoration of 300 – 600ml of blood over 24 hours. The source of bleeding is usually from erosion of systemic rather than pulmonary arteries. Notable exceptions are arteriovenous malformations (AVM) and pulmonary artery aneurysms. Bronchial artery embolization (BAE) has been shown to be an effective treatment to control massive haemoptysis. Most authors reserve surgery for cases refractory to repeated BAE.

1.3 The imaging modalities pertinent to the evaluation of non-massive haemoptysis include chest X-ray (CXR) and CT thorax.

2 Plain radiograph

2.1 CXR is efficacious in the initial evaluation.

3 CT and CT angiography

3.1 Contrast-enhanced CT is useful for localizing the bleeding site and diagnosing the underlying cause.

3.2 CT angiogram performed with MDCT allows non-invasive, rapid and detailed assessment of lung and thoracic vasculature. It is possible to delineate abnormal bronchial and non-bronchial arteries using a variety of reformatted images, which can serve as a roadmap to guide therapeutic embolization procedures. Hence, it should be performed prior to BAE if embolization is anticipated.

4 Angiography

4.1 Angiography is performed prior to treatment such as BAE, or for confirming the diagnosis and for the treatment of AVM.

4.2 BAE has been proven to be an effective treatment for massive and recurrent hemoptysis, either as first-line treatment or as an adjunct to elective surgery.

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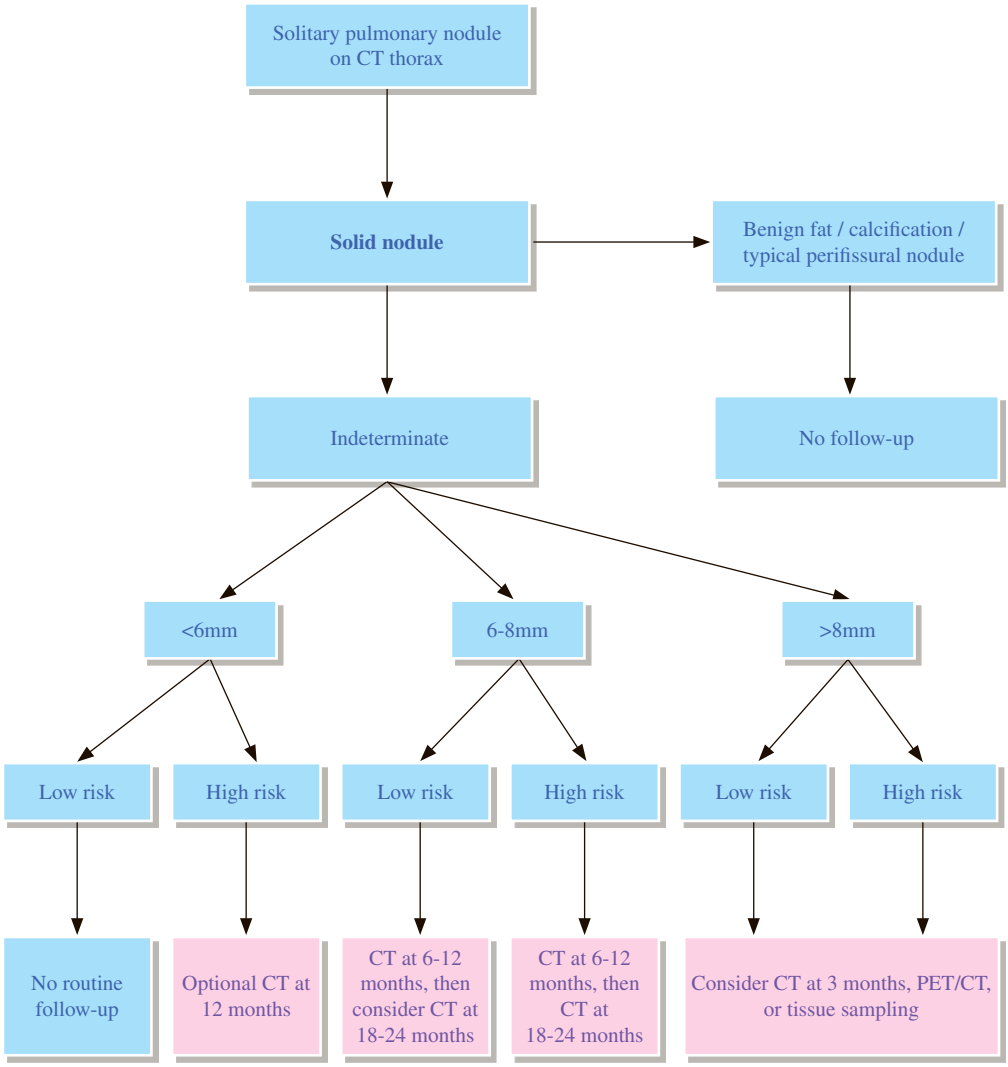
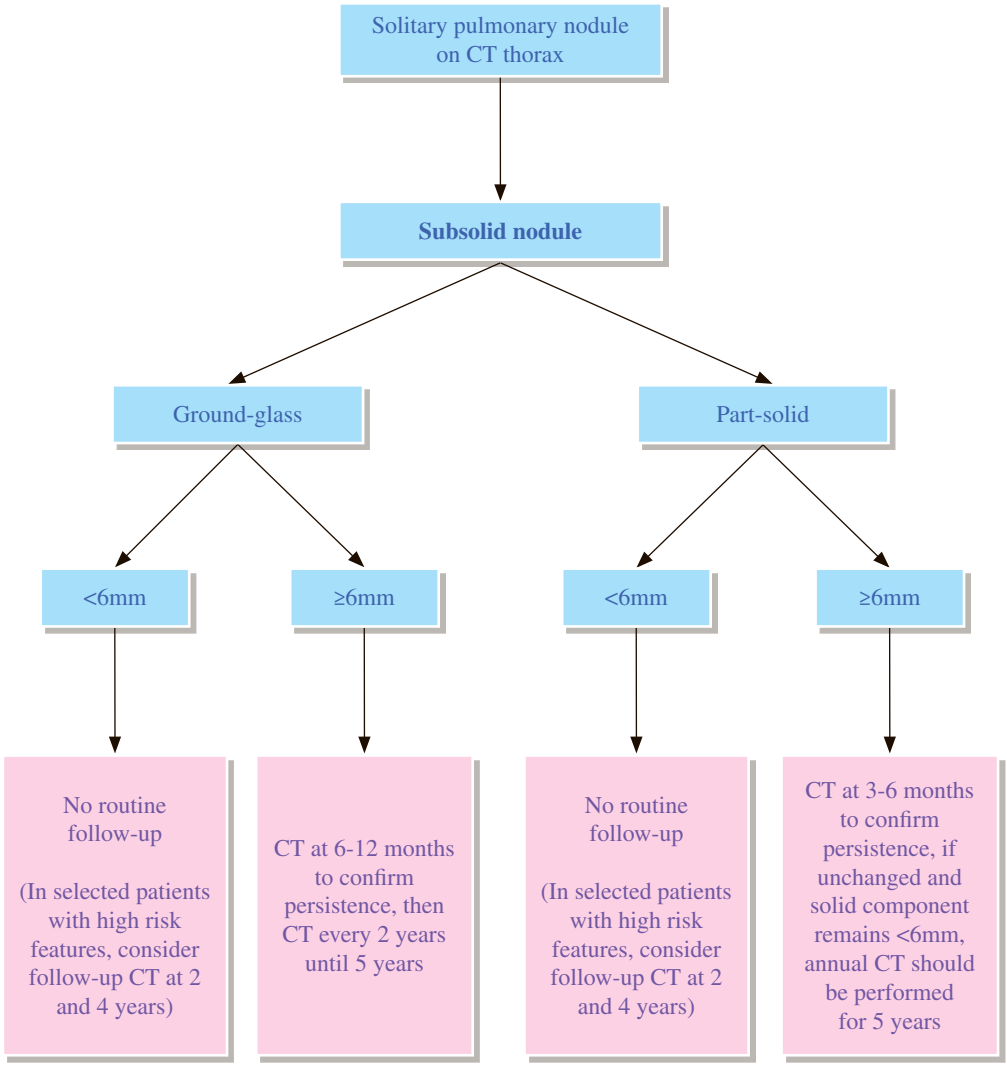

Solitary pulmonary nodule on CT thorax
Solid nodule
Benign fat / calcification / typical perifissural nodule
Indeterminate
No follow-up
<6mm
6-8mm
>8mm
Low risk
High risk
Low risk
High risk
Low risk
High risk
No routine follow-up
Optional CT at 12 months
CT at 6-12 months, then consider CT at 18-24 months
CT at 6-12 months, then CT at 18-24 months
Consider CT at 3 months, PET/CT, or tissue sampling


Solitary pulmonary nodule on CT thorax
Subsolid nodule
Ground-glass
Part-solid
<6mm
≥6mm
<6mm
≥6mm
No routine follow-up
(In selected patients with high risk features, consider follow-up CT at 2 and 4 years)
CT at 6-12 months to confirm persistence, then CT every 2 years until 5 years
No routine follow-up
(In selected patients with high risk features, consider follow-up CT at 2 and 4 years)
CT at 3-6 months to confirm persistence, if unchanged and solid component remains <6mm, annual CT should be performed for 5 years

REMARKS

1 General

1.1 Solitary pulmonary nodule is defined as a relatively spherical opacity of which the diameter is 3cm or smaller. It is completely surrounded by lung with no associated atelectasis or hilar adenopathy detected.

1.2 These guidelines apply to incidental solitary lung nodule in patients aged 35 or above. They do not apply to patients with known primary cancer, immunosuppression or lung cancer screening.

1.3 The minimum threshold size for recommending follow-up is based on an estimated cancer risk in a nodule on the order of 1% or greater.

1.4 Estimation of an individual patient's risk of developing lung cancer is multi-factorial, including the size and morphology of lung nodule, history of smoking, exposure to other carcinogens, location of lung nodule, presence of emphysema and fibrosis, family history of lung cancer, ethnic background, age and gender etc. Different risk prediction models are available. In general, high risk factors include older age, heavy smoking, larger nodule size, irregular/spiculated margins, and upper lobe location.

2 CT

2.1 Thin section scans are needed to enable accurate characterization and measurement of small lung nodules.

2.2 Low-dose thin-slice unenhanced scans are recommended for follow-up of lung nodules.

2.3 Measurement of a lung nodule should be based on the average of its long- and short-axis diameters, both of which should be obtained on the same transverse, coronal or sagittal reformatted images. The image which reveals the greatest diameter should be used. The measurement should be rounded to the nearest millimetre.

2.4 In practice, it is difficult to reliably define discrete solid components of part-solid nodules <6mm, therefore they are managed in a similar way that pure ground-glass lesions of equivalent size are treated.

2.5 Persistent part-solid nodules with solid component ≥6mm should be considered highly suspicious.

2.6 Contrary to growth in solid nodules which is based solely on size, in subsolid nodules, growth may manifest as an increase in size, an increase in attenuation, development of a solid component, or an increase in size of a solid component. In subsolid nodules, these imaging features of growth indicate an increased risk for malignancy.

2.7 Benign patterns of calcification in solitary lung nodules include dense central calcification, laminated calcification and diffuse calcification.

2.8 A typical perifissural nodule is attached to pulmonary fissure, homogenous, solid with smooth margin, and oval/lentiform/triangular in shape. Typical perifissural nodules are likely intrapulmonary lymph nodes.

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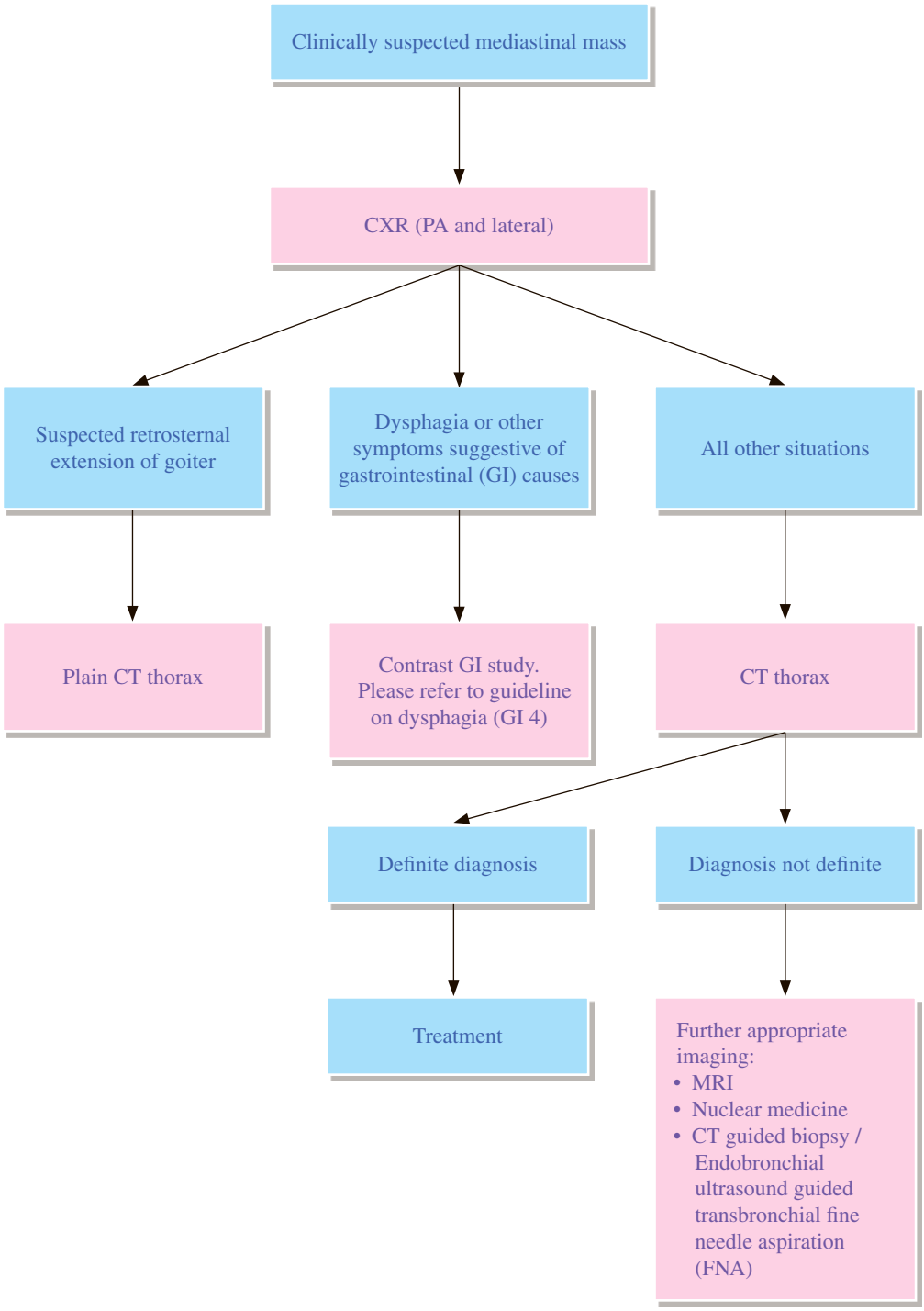
Clinically suspected mediastinal mass
CXR (PA and lateral)
Suspected retrosternal extension of goiter
Dysphagia or other symptoms suggestive of gastrointestinal (GI) causes
All other situations
Plain CT thorax
Contrast GI study. Please refer to guideline on dysphagia (GI 4)
CT thorax
Definite diagnosis
Diagnosis not definite
Treatment
Further appropriate imaging:
• MRI
• Nuclear medicine
• CT guided biopsy / Endobronchial ultrasound guided transbronchial fine needle aspiration (FNA)

REMARKS

1 Plain radiograph

1.1 Posterior-anterior (PA) and lateral chest radiographs are appropriate initial investigations although the chest films are almost never specific.

2 Nuclear medicine

2.1 Choice of nuclear medicine imaging modality depends on clinical suspicion.

2.2 Fluorodeoxyglucose (FDG) PET/CT is useful in assessing the metabolic activity of the mediastinal mass, and helpful in characterizing the lesion. It guides subsequent invasive investigations and is helpful in staging malignancy. It is also useful in monitoring treatment response in various malignancies.

2.3 Technetium-99m (Tc-99m) pertechnetate thyroid scintigraphy is useful for confirming presence of thyroid tissue if retrosternal goiter is suspected.

2.4 FDG PET/CT, Gallium-67 scintigraphy and white blood cell scintigraphy are useful in characterizing an infective mass or abscess in mediastinum.

3 CT

3.1 CT is the most versatile and valuable imaging modality for confirming or excluding, localizing and characterizing a mediastinal mass.

3.2 CT is usually adequate for diagnosis and further studies are not necessary.

3.3 CT also examines the lungs, which is critically important in patients who may have a thoracic neoplasm.

3.4 CT is the gold-standard imaging modality for the pre-operative evaluation of patients with retrosternal goiter. CT is essential to define the extent and position of a retrosternal goiter. Iodinated contrast medium should be avoided because it would interfere with subsequent radionuclide imaging.

3.5 Often the mass has non-specific characteristics and requires biopsy for definitive diagnosis.

4 MRI

4.1 If CT defines a mass but subtle relationships of the mass to the spine and neural foramina need to be evaluated, or if chest wall invasion needs to be evaluated in more detail, MRI would be useful.

4.2 MRI is also an appropriate alternative for patients who cannot tolerate the iodinated contrast medium needed for CT, and for children and pregnant women who should avoid exposure to ionizing radiation.

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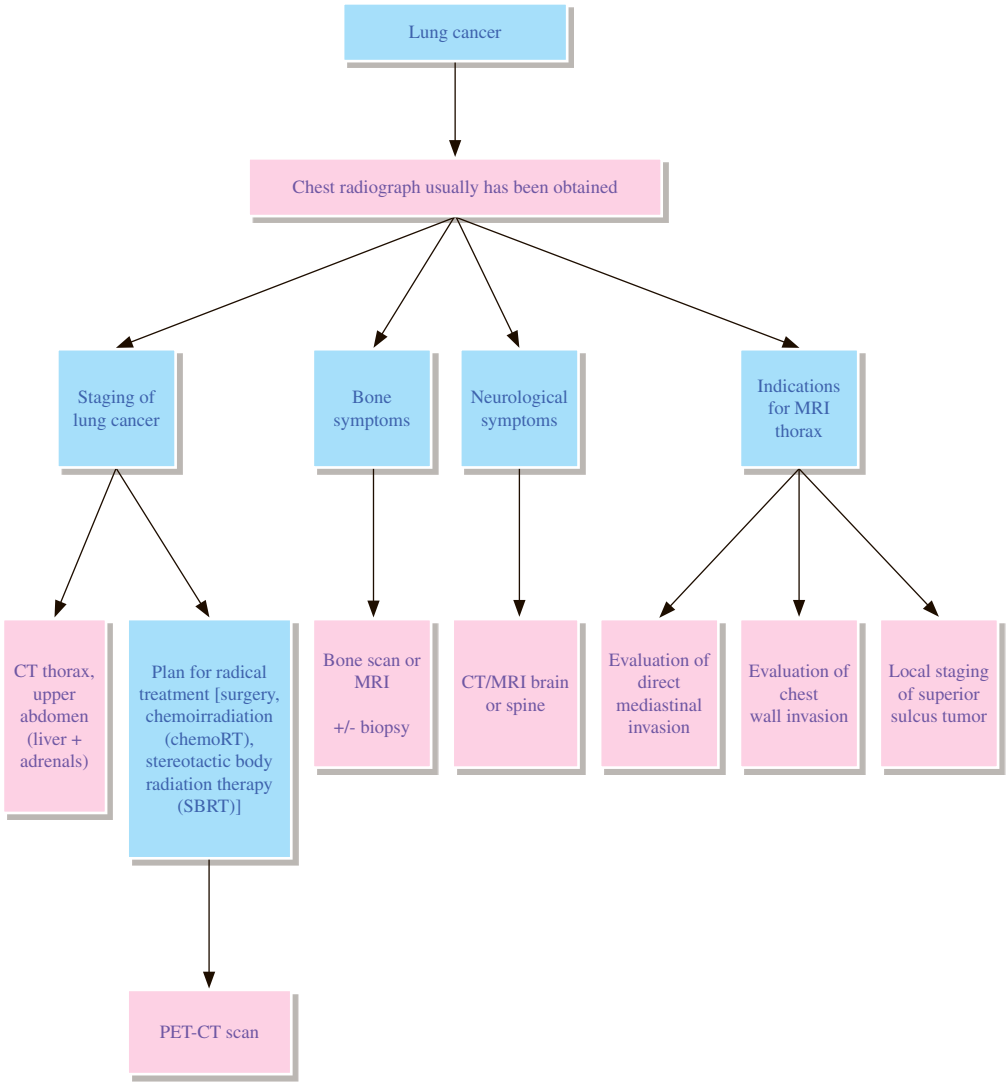
Lung cancer
Chest radiograph usually has been obtained
Staging of lung cancer
Bone symptoms
Neurological symptoms
Indications for MRI thorax
CT thorax, upper abdomen (liver + adrenals)
Plan for radical treatment [surgery, chemoirradiation (chemoRT), stereotactic body radiation therapy (SBRT)]
Bone scan or MRI
+/- biopsy
CT/MRI brain or spine
Evaluation of direct mediastinal invasion
Evaluation of chest wall invasion
Local staging of superior sulcus tumor
PET-CT scan

REMARKS

1 Plain radiograph

1.1 Many primary lung cancers are initially detected on chest radiograph.

1.2 In certain instances, the chest radiograph alone is sufficient for staging, e.g. when an obvious metastatic bone lesion is detected or when large bulky contralateral mediastinal lymph nodes are present.

1.3 Chest X-ray (CXR) can be used to monitor treatment response if CT is not available.

2 CT

2.1 CT is the main imaging modality of choice for evaluating patients with bronchogenic carcinoma.

2.2 CT has limitations in staging since there are no morphologic criteria to distinguish between benign and malignant lymph nodes, with low sensitivity and specificity in detecting nodal metastasis.

2.3 CT should include the adrenal glands.

2.4 CT has limited value in detecting chest wall and mediastinal invasion.

3 Fluorodeoxyglucose (FDG) PET-CT

3.1 Whole body FDG PET-CT is the preferred imaging modality for staging of non-small cell lung cancer in patients who are planned to be treated with curative intent.

3.2 FDG PET-CT has better sensitivity and specificity than CT alone in identification of nodal metastases with an overall sensitivity of 80–90% and specificity of 85–95%.

3.3 FDG PET-CT detects ~24% occult extrathoracic metastases in patients who are initially planned to undergo curative resection.

3.4 It decreases the number of futile thoracotomy by an additional 21%.

3.5 FDG PET-CT is an excellent tool for monitoring of treatment response.

4 Bone scan

4.1 Bone scintigraphy has high sensitivity (93.3%) for detecting osseous metastases.

4.2 Routine bone scintigraphy is not warranted, and is only reserved for symptomatic patients or those with biochemical abnormalities.

4.3 If whole body FDG PET has already been performed, additional bone scintigraphy is not necessary in most circumstances.

5 MRI

5.1 MRI is particularly useful in determining certain parameters of unresectability for superior sulcus cancer such as invasion into vertebral body, spinal canal, neural foramina, subclavian artery or brachial plexus.

5.2 MRI is useful in assessing chest wall and mediastinal invasion.

5.3 Using Cine MRI during free breathing, presence of sliding between the tumor and mediastinum or chest wall has been shown to be diagnostic of lack of invasion; the converse however may not necessarily indicate invasion since adhesion from local inflammatory changes may also restrict tumour motion.

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