Among the many seemingly menial tasks frequently assigned to interns, junior residents, medical students, and nurses and physician’s assistants is following up on radiographs performed to assess placement of feeding tubes, central lines (including Swan-Ganz catheters), chest tubes, pacemaker leads, etc. Like many others of these “scut” tasks, though, evaluation of placement of tubes and lines is critical to insure patient safety and is sometimes less routine than expected. Immediate help from radiologists will not always be available, so you must be able to evaluate these x-rays for the critical information.

Our purpose is not to teach the techniques of placing these devices; that will come with hands-on teaching and experience. Instead, we will discuss the expected range of normal positions for these devices and the most significant and frequents complications associated with their placement.

**CENTRAL VENOUS CATHETERS**

Standard temporary and longer-term tunneled central lines are typically placed via the internal jugular, external jugular, or subclavian vein, while PICCs (peripherally inserted central catheter) are placed via an arm vein, typically the basilic. The preferred position of the tip is in the distal SVC, at the junction of the SVC and the right atrium, or within the proximal portion of the atrium. As long as there is not significant tubing within the atrium, induction of dysrythmias is not a risk. While placement of the tip in one of the smaller veins (brachiocephalic, subclavian, or jugular) is not ideal, it may suffice based on the catheter’s specific purpose and the individual patient. Some people have anomalous patterns of venous return. In these cases, a very unusual course of the catheter may be compatible with adequate function.
Complications: (1) Pneumothorax is the most common significant complication of central line placement, quoted as occurring in 3-5% of placements. Many of these pneumothoraces are small and require only observation. Look for a thin white line of pleura with gas (and no lung markings) peripheral to it. If a patient cannot sit upright and a supine film is equivocal, a lateral decubitus x-ray is very sensitive for pneumothorax detection.

(2) Intra-arterial placement is usually recognized immediately by pulsatile blood return and promptly corrected, but is occasionally overlooked clinically. Unusual catheter course may be evident on the x-ray.

(3) Vascular injury may cause development of a mediastinal hematoma or hemothorax (blood in the pleural space). An enlarging pleural effusion or mediastinal opacity/abnormal contour is a clue to this injury.

(4) Extravascular placement may also occur, again leading to hematoma or hemothorax.

(5) Catheters may kink or be pinched off, especially in the mid-portion of the subclavian vein, where there is a relative constriction caused by costoclavicular ligaments and fibrous tissue. Central lines can also induce thrombosis, which may lead to permanent occlusion of the vein.

(6) Catheters may break, with embolization of the distal fragments.

(7) Catheter malposition → turning up into the neck or out into the axilla, across the brachiocephalic vein to the other side, into the azygous vein, etc.

PULMONARY ARTERY CATHETERS (SWAN-GANZ®)

These are glorified central lines that have pressure transducers at the tips. If the tip is advanced into a small enough vessel, temporary inflation of the balloon allows measurement of the “pulmonary capillary wedge pressure,” which reflects the balance of fluid transfer across pulmonary capillaries, left atrial pressure, and left end-diastolic volume. Thus, these catheters are typically used to monitor the fluid status of critical patients while also allowing delivery of intravenous fluids/medications and blood draws.

The ideal position of a pulmonary artery catheter for the purposes of wedge pressures is within a segmental pulmonary arteriole. However, the catheter is usually not supposed to be actively wedging while a chest x-ray is being
taken, and the typical location when the catheter is normally functioning (not actively wedging) is within the main pulmonary arteries or proximal interlobar artery: radiographically, the tip should be no more than 2 cm beyond the central hilum. Of course, when wedge pressure measurements are not necessary, more proximal location is adequate.

**Complications:** The potential complications of central lines also apply to pulmonary artery catheters. Additional complications include:

1. **Arrhythmia/dysrhythmia:** It is quite common to induce a few irregular beats while navigating the catheter through the right ventricle. These almost always resolve once the tip is out into the pulmonary outflow tract, but occasionally will necessitate aborting the attempt if one is unable to successfully negotiate the catheter without significant dysrhythmia in a tenuous patient.
2. **Pulmonary embolus/infarction:** Catheters can create problems downstream by dislodging thrombus, vegetations, or plaque as they are passed; by creating their own thrombus; or by dissecting a pulmonary artery.
3. **Pulmonary artery perforation/pseudoaneurysm:** Vessel wall damage by the catheter is rare but potentially catastrophic. These patients become unstable after catheter placement, and chest x-ray will show a new opacity around or near the tip of the catheter, due to hemorrhage or pseudoaneurysm. Cardiorespiratory distress and even hemoptysis may ensue.

**INTRA-AORTIC BALLOON PUMPS**

These devices are used in cases of cardiogenic shock or recent cardiac surgery. They are placed, via a femoral artery, into the descending aorta. The balloon inflates during diastole, thereby increasing flow in the coronary arteries and improving cardiac perfusion.

The IABP has a small metal rectangle at its tip. This should be placed within the descending aorta, just distal to the left subclavian artery.

**Complications:**
1. Placement too proximally within the aorta may diminish flow to the arch vessels (read “brain”) or embolize them.
2. Placement too distally will reduce effectiveness, and may occlude visceral (SMA, renal) arteries.
(3) As with any arterial catheter, vessel dissection and distal embolization are always risks.

**PLEURAL DRAINAGE CATHETERS/CHEST TUBES**

These range from small catheters with a pigtail tip, commonly placed by radiologists and internists on the floor, to large-bore thoracostomy tubes meant to drain the pleural space with authority.

Obviously, these tubes must be in the pleural space to be effective. The large bore tubes allow more vigorous and effective suction and are less frequently occluded; they often can be effective even if not placed directly within the fluid or gas collection to be evacuated. The smaller drains, though, must be placed dependently to drain fluid and non-dependently to drain air. Of course, if a collection is loculated (e.g. empyema) local placement is required no matter the size of the drain.

**Complications:**
1. Placement of the tube within an interlobar fissure is fairly common. This is usually not harmful, but may render the chest tube ineffectual. Consider this if a pneumothorax will not resolve despite adequate suction.
2. Placement of the tube into the lung parenchyma can cause a focal contusion, pneumatocele (lung air-cyst), air leak, or even infection.
3. Intercostal nerve and vessel damage related to placement technique
4. Placement into the subpleural space: This is the potential space between the parietal pleura and the chest wall. The tube will not function.
5. Subdiaphragmatic placement: with possible diaphragm laceration as well as liver or spleen injury.
6. Incomplete placement of the tube within the pleural space: Tubes are often only partially inserted (or subsequently partially retracted), with one or more side-ports outside the pleural space. This will lead to persistent air leak.

**PACERS AND AICDs**
There are many different devices that fall under this category, and exact placement of leads may vary by device, patient, and operator, with luck playing a factor as well. Pacemakers often have two leads, one in the right ventricle apex and the other in the right atrial appendage. Pacers with a single RV lead are also common and occasionally one will see single RA leads. AICDs often have two electrodes over one wire. One electrode is in the RV, the other in the distal SVC or the brachiocephalic vein. Newer techniques for pacer lead placement, such as placement across the coronary sinus toward the left ventricle, continue to evolve and are beyond the scope of this discussion.

Complications: Since these are placed trans-venously, all the complications of central lines apply here. Of course, always look for pneumothorax especially. Other possibilities include: (1) Catheter dislodgement: If you have old films, always look for change in orientation of the leads, as this may not be obvious on the current film. (2) Line fragmentation: These leads are radio-opaque, so make sure there is no disruption (especially at the distal tip, near the control box, and at the insertion site). (3) Myocardial perforation with hemopericardium are, fortunately, rare.

ENDOTRACHEAL AND TRACHEOSTOMY TUBES

Placed for ventilatory support, these devices should have their tips in the thoracic trachea. In adults, the tip of an ETT should not be less than 2 cm above the tracheal carina and should not be above the thoracic inlet. If visible, the cuff balloon should be no wider than the adjacent tracheal caliber.

Complications: (1) Placement of the tube too low may lead to bronchial (as opposed to tracheal) intubation, more commonly right than left. This may cause collapse of the non-intubated lung (in pediatrics, this phenomenon occasionally is reversed, curiously). (2) High placement may lead to dislodgement. Also, a high ETT may have its cuff at the level of the glottis. If this position is maintained, it can be catastrophic for further phonation.
(3) Over-distention of the cuff may lead to scarring and tracheal stenosis. In fact, tracheal stenosis is a common complication of extended intubation, regardless of cuff use.

(4) Esophageal intubation by the ETT precludes adequate lung oxygenation. The tube often projects outside the tracheal air shadow on the AP chest x-ray, and the stomach is distended with gas.

(5) Tracheostomy placement can be complicated by hemorrhage, pneumomediastinum, and infection.

FEEDING TUBES

Small-bore nasoenteric feeding tubes are commonly placed by medical students, interns, and nurses in the hospital setting. Commonly called “Dobhoff® tubes,” after one of the common brand names, feeding tubes are designed to deliver nutritional supplements into the small intestine. The ideal placement is at or beyond the ligament of Treitz, which is a peritoneal reflection that suspends the bowel at the junction of the duodenum and jejunum. You will recall the duodenum is divided into four sections. The first, which is the only intraperitoneal portion, consists of the bulb and a small horizontal segment. The second is vertical, to the right of the spine and pancreas. The third is horizontal, passing just inferior to the superior mesenteric artery. The fourth is obliquely oriented, passing up and to the left toward the ligament of Treitz.

The basis for placement of these tubes near or beyond the duodeno-jejunal junction is the theory that material placed this far down the line will not be able to reflux back into the stomach; more proximal placement may result in enterogastric reflux and thus place the patient at risk for further reflux into the esophagus and thus aspiration. Truly adequate positioning depends on each patient’s aspiration risk, the urgency of starting tube feedings, and the preferences of the physicians involved.

Complications: The main complication is placement of the tube into the tracheobronchial tree. Because of this possibility, feedings should never begin before accurate placement is confirmed radiographically. If the tube is fairly proximal in the lung, it can simply be pulled and re-placed. If it is more peripheral, such that the tip is likely wedged in a small bronchiole, one should be aware of the real threat of pneumothorax after withdrawal. If you
think the tube is that far out, make sure a chest tube is nearby before removing the feeding tube. Of course, if you aren’t comfortable with bedside thoracostomy technique, have someone available who is.

Hints: (1) Do not be afraid to trace the course of the tube with your finger on the film/screen. This may help you determine the exact course of the tube. (2) The distal tip is not likely to be in the duodenum if it does not pass to the right of the spine. (3) If you are uncertain if a tube is coiled in the stomach or in bowel, you can either wait a few hours and repeat the film, or inject 10-20 cc gastrografin and shoot another x-ray. Gastric rugae are longitudinal, thick folds, whereas small bowel has transverse, thin folds called “valvulae conniventes.” pH testing may also be illuminating, as acidic gastric contents become more basic after bile and pancreatic secretions enter at the 2nd portion of the duodenum. (4) If placement is difficult, ask radiology or gastroenterology to place the tube with guidance.

NASOGASTRIC TUBES

You should familiarize yourself with the characteristic appearance of NG tubes on x-ray. The side port that is about 10 cm proximal to the distal tip intersects the radio-opaque stripe. Thus, you should see the side port most of the time. The side port and tip should both be in the stomach. Be aware that the esophagogastric junction is actually below the curve of the diaphragm on an x-ray by about 2-3 cm, so the side port should be below this level. X-rays are not typically necessary to confirm placement, as you can demonstrate intra-gastric placement by auscultating over the stomach while insufflating the NG tube with air. Nevertheless, you should always check its position on each film that shows it, to exclude changes in position.

Complications: (1) Again, misplacement in the tracheobronchial tree happens, but is almost always immediately apparent, as the larger size of the NG causes more irritation and respiratory difficulty. (2) Perforation of the stomach is extremely uncommon except in premature infants. (3) Esophageal perforation is also thankfully rare.
SELECTED REFERENCES
