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Study of Central Line Insertion and its Complications in the Department of Surgery, Hamidia Hospital Bhopal

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ABSTRACT

Central venous access is a common and essential procedure performed in many clinical settings for a variety of indications. Like any other procedure Central lines are not without risk, and there are a multitude of complications that are associated with their placement. Complications can present in an immediate or delayed manner and vary based on type of central venous access. These complications can cause a significant healthcare burden in cost, hospital days, and patient quality of life. Advances in imaging, access technique, and medical devices have reduced and altered the types of complications encountered in clinical practice; but most complications still center around vascular injury, infection, and misplacement. Recognition and management of central line complications is important when caring for patients with vascular access, but prevention is the ultimate goal. This research article discusses about the number of patient who had various complications of central line which has been observed in age group of 12 to 30yrs, 30 to 50 yrs, and 50 and above yrs in past one year in Hamidia Hospital Bhopal.

Key Words: *central venous, Central Line Insertion*

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INTRODUCTION

Numerous complications are associated with central venous catheter placement. The most common are listed in the table (table 1). The rate of mechanical complications is largely operator dependent and most (eg, pneumothorax) are detected at the time of catheter insertion [1]. Infectious and thrombotic complications usually occur later than mechanical complications.

Published rates of cannulation success and complications vary according to the anatomic site, the use of ultrasound guidance, and operator experience. As an example, one review described an overall complication rate of 15 percent [1], while an observational cohort study of 385 consecutive central venous catheter attempts over a six-month period reported mechanical complications in 33 percent of attempts [2]. Complications included failure to place the catheter (22 percent), arterial puncture (5 percent), catheter malposition (4 percent), pneumothorax (1 percent), subcutaneous hematoma (1 percent), hemothorax (less than 1 percent), and cardiac arrest (less than 1 percent). A later study examining the complications of central venous catheters by insertion site noted that 2.1 percent of patients had mechanical complications during insertion, 0.5 to 1.4 percent experienced bloodstream infections, and 0.5 to 1.4 percent developed deep vein thrombosis attributable to the central venous catheter [3]. The rate of mechanical complications is significantly decreased with the use of dynamic ultrasound-guided venous access. (See "Central venous access in adults: General principles", section on 'Use of ultrasound' and "Principles of ultrasound-guided venous access".)

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arterial puncture (5 percent), catheter malposition (4 percent), pneumothorax (1 percent), subcutaneous hematoma (1 percent), hemothorax (less than 1 percent), and cardiac arrest (less than 1 percent). A later study examining the complications of central venous catheters by insertion site noted that 2.1 percent of patients had mechanical complications during insertion, 0.5 to 1.4 percent experienced bloodstream infections, and 0.5 to 1.4 percent developed deep vein thrombosis attributable to the central venous catheter [3]. The rate of mechanical complications is significantly decreased with the use of dynamic ultrasound-guided venous access. (See "Central venous access in adults: General principles", section on 'Use of ultrasound' and "Principles of ultrasound-guided venous access".)
There can be placement related issues and catheter related infections

Definition of Central Venous Access

For these guidelines, central venous access is defined as placement of a catheter such that the catheter is inserted into a venous great vessel. The venous great vessels include the superior vena cava, inferior vena cava, brachiocephalic veins, internal jugular veins, subclavian veins, iliac veins, and common femoral veins.† Excluded are catheters that terminate in a systemic artery.

METHODOLOGY

Materials and Methods:

The present study conducted in patients visiting casualty, admitted in dept of general surgery, dept of orthopedics, dept of general medicines Gandhi medical college associated Hamidia, Hospital, Bhopal carried out in Department of General Surgery. The study included 164 number of patients who underwent resuscitation between January 2023 to January 2023. Patient characteristic and laboratory data were recorded in a predesigned proforma and all patients were observed for post procedure complication. Central line insertion was done with proper care and aseptic precautions which was observed for any complication mentioned below.

Total number of cases observed - 164

Age group[in yrs]	Total central line insertion
12 - 30	15
30 - 50	70
50 and above	79

Various complication observed and their number

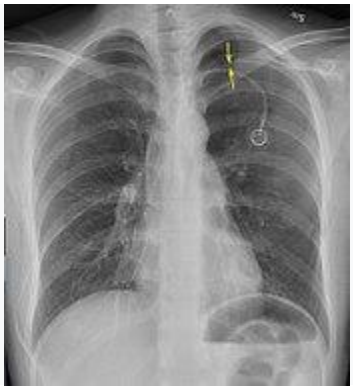
Complications	Nu. Of cases
Pneumothorax	02
Hemorrhage	02
Infection	07

PNEUMOTHORAX

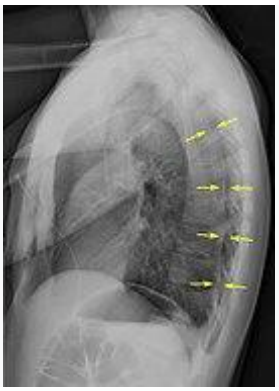
Total of 2 patient of pneumothorax which is an abnormal collection of air in the pleural space between the lung and the chest wall[4]. Symptoms typically include sudden onset of sharp, one-sided chest pain and shortness of breath[5]. In a minority of cases, a one-way valve is formed by an area of damaged tissue, and the amount of air in the space between chest wall and lungs increases; this is called a tension pneumothorax[4]. This can cause a steadily worsening oxygen shortage and low blood pressure. This leads to a type of shock called obstructive shock, which can be fatal unless reversed[4]. Very rarely, both lungs may be affected by a pneumothorax[4]. It is often called a "collapsed lung", although that term may also refer to atelectasis[6].

Chest X-ray

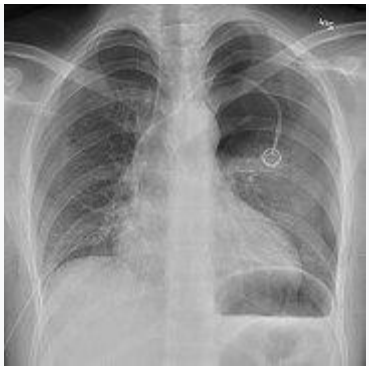
A plain chest radiograph, ideally with the X-ray beams being projected from the back (posteroanterior, or "PA"), and during maximal inspiration (holding one's breath), is the most appropriate first investigation. It is not believed that routinely taking images during expiration would confer any benefit. Still, they may be useful in the detection of a pneumothorax when clinical suspicion is high but yet an inspiratory radiograph appears normal. Also, if the PA X-ray does not show a pneumothorax but there is a strong suspicion of one, lateral X-rays (with beams projecting from the side) may be performed, but this is not routine practice[7][8].



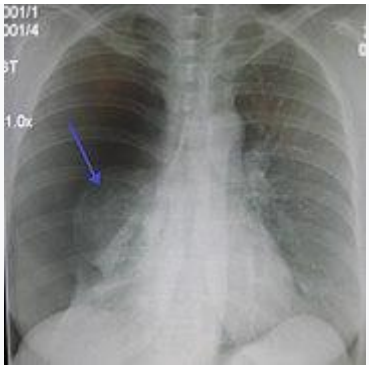
Anteroposterior inspired X-ray, showing subtle left-sided pneumothorax caused by port insertion



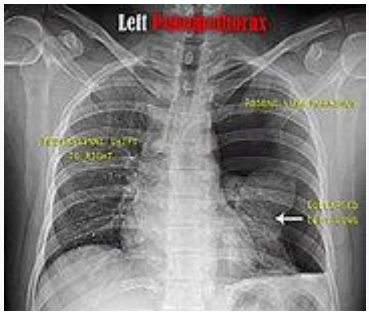
Lateral inspired X-ray at the same time, more clearly showing the pneumothorax posteriorly in this case



Anteroposterior expired X-ray at the same time, more clearly showing the pneumothorax in this case



Chest X-ray showing a pneumothorax on the right (left in the image), where the absence of lung markings indicates that there is free air inside the chest

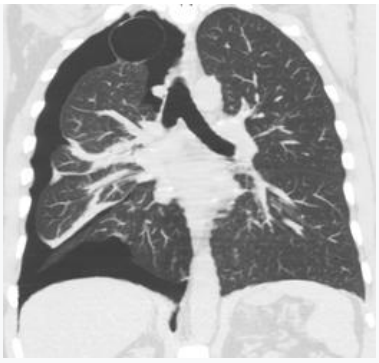


Chest X-ray showing the features of pneumothorax on the left side of the person (right in image)

It is not unusual for the mediastinum (the structure between the lungs that contains the heart, great blood vessels, and large airways) to be shifted away from the affected lung due to the pressure differences. This is *not* equivalent to a tension pneumothorax, which is determined mainly by the constellation of symptoms, hypoxia, and shock [9].

The size of the pneumothorax (i.e. the volume of air in the pleural space) can be determined with a reasonable degree of accuracy by measuring the distance between the chest wall and the lung. This is relevant to treatment, as smaller pneumothoraces may be managed differently. An air rim of 2 cm means that the pneumothorax occupies about 50% of the hemithorax[7]. British professional guidelines have traditionally stated that the measurement should be performed at the level of the hilum (where blood vessels and airways enter the lung) with 2 cm as the cutoff[7], while American guidelines state that the measurement should be done at the apex (top) of the lung with 3 cm differentiating between a "small" and a "large" pneumothorax. The latter method may overestimate the size of a pneumothorax if it is located mainly at the apex, which is a common occurrence[7]. The various methods correlate poorly but are the best easily available ways of estimating pneumothorax size[7]. CT scanning (see below) can provide a more accurate determination of the size of the pneumothorax, but its routine use in this setting is not recommended.

Computed tomography



CT with the identification of underlying lung lesion: an apical bulla on the right side

A CT scan is not necessary for the diagnosis of pneumothorax, but it can be useful in particular situations. In some lung diseases, especially emphysema, it is possible for abnormal lung areas such as bullae (large air-filled sacs) to have the same appearance as a pneumothorax on chest X-ray, and it may not be safe to apply any treatment before the distinction is made and before the exact location and size of the pneumothorax is determined[7]. In trauma, where it may not be possible to perform an upright film, chest radiography may miss up to a third of pneumothoraces, while CT remains very sensitive.

A further use of CT is in the identification of underlying lung lesions. In presumed primary pneumothorax, it may help to identify blebs or cystic lesions (in anticipation of treatment, see below), and in secondary pneumothorax, it can help to identify most of the causes listed above[7].

Ultrasound

Ultrasound is commonly used in the evaluation of people who have sustained physical trauma, for example with the FAST protocol. Ultrasound may be more sensitive than chest X-rays in the identification of pneumothorax after blunt trauma to the chest. Ultrasound may also provide a rapid diagnosis in other emergency situations, and allow the quantification of the size of the pneumothorax. Several particular features on ultrasonography of the chest can be used to confirm or exclude the diagnosis.

- Ultrasound showing a pneumothorax.
- Ultrasound showing a false lung point and not a pneumothorax.

Bleeding and hematomas

Expect minimal bleeding after catheter insertion. However, know that certain catheter types, insertion techniques, and laboratory values can make patients more prone to bleeding. When assisting with catheter insertion, control bleeding at the site before the final dressing is applied. If the insertion site continues to bleed or ooze blood, apply a sterile 2″ x 2″ gauze dressing under the transparent dressing; change the dressing every 24 to 48 hours. Follow your facility's policy on caring for and maintaining a gauze dressing.

If bleeding persists, consider using a pressure dressing or wrap. If your patient with a PICC has a wrap applied around the arm, monitor extremities for color, motion, and sensation according to facility policy. Document the time the pressure wrap was applied and the time it was removed. Sensation loss and numbness have occurred when pressure dressings were applied for more than 24 hours and the site, skin color, motion, and sensation weren't checked.

If bleeding persists beyond 24 to 48 hours after catheter insertion, assess for other possible causes. Determine if bleeding could stem from anticoagulant therapy, vigorous physical activity, sutures, or coagulopathy. Be aware that patients with an elevated International Normalized Ratio or sutures that were accidentally placed through small vessels may continue to bleed, as small pinholes within the catheter can cause oozing.

Infection

Healthcare-acquired infections (HAIs) are infections that arise 48 hours after admission, within 3 days after discharge, or within 30 days after surgery. Vascular catheter-associated infections and air embolism are two "never" events. Total 7 cases of infection were reported out of total central line insxertion. With long-term catheters (those indwelling more than 14 days), the major infection source is intraluminal colonization. Organisms may be introduced if the catheter hub goes unscrubbed, if the catheter is manipulated, or if poor flushing technique is used. Organisms migrate from the hub toward the catheter tip and then to the patient. Biofilm develops, with organisms remaining nested in the biofilm or detaching to float freely in and outside the lumen.

Signs and symptoms of infection can be specific or vague. Redness or swelling may occur at the insertion site. Nonspecific indications include fever, chills, and hypotension.

CLABSIs may warrant central-line withdrawal. Treatment depends on the specific organism present, extent of illness, signs and symptoms, catheter type used, duration of anticipated need for venous access, and presence of alternative venous access.

Bacterial phlebitis

Bacterial phlebitis is an inflammation of the vein intima associated with bacterial infection. The least common type of phlebitis, it is more serious because it predisposes the patient to systemic complications. Contributing factors include:

- poor hand hygiene by healthcare providers
- failure to check equipment for compromised integrity
- poor aseptic technique during catheter site or system preparation
- poor cap or hub disinfection before obtaining catheter access
- poor insertion technique
- inadequate or breached dressing
- infrequent site observation and failure to assess adequately for complications
- preexisting patient condition or infection.

Keep in mind that wearing gloves doesn't eliminate the need to wash your hands before and after patient contact. Use a hand sanitizer or wash your hands for 10 to 15 seconds with soap and running water.

Catheter occlusions

A catheter occlusion occurs when a blockage prevents caregivers from flushing the central line or aspirating blood. An occlusion can be thrombotic or nonthrombotic (not caused by a thrombus). About 40% to 50% of occlusions are nonthrombotic and result from mechanical or postural factors, medication precipitate, catheter malpositioning, or undesirable catheter-tip location.

If you suspect your patient's catheter is occluded, assess the entire infusion-delivery system for obstructions and kinks. Determine if blood return is hampered by the position of the patient's arm or other body part (when either lying or standing). Evaluate the patient's medication profile for drug incompatibilities. Next, assess catheterpatency: Does the catheter flush easily, or only with difficulty? Do you see a blood return? Finally, have a qualified clinician assess catheter-tip location from a recent X-ray, if available.

Mechanical occlusions

A mechanical occlusion can be external or internal. External occlusions stem from a kink or clamp in the portion of the catheter that's outside the patient. Check whether any clamps are activated, and look for sutures or a securement device that could be pinching the catheter too tightly. Then check for kinks in the catheter. Finally, examine the I.V. tubing and pump for obstructions and malfunctions.

Internal occlusions occur inside the patient and are harder to assess. Causes include lodging of the catheter tip against a vessel. If you suspect an internal occlusion, consult the ordering physician or licensed independent practitioner, who will weigh the risks and benefits of keeping the catheter in place vs. replacing it.

Another cause of internal cathe¬ter occlusion is pinch-off syndrome, in which the catheter passes through the areolar tissue of the space outside the vessel lumen and becomes compressed between the clavicle and rib. As the patient raises and lowers the shoulder, repeated compression and shearing forces put pressure on the catheter. A more lateral catheter insertion allows the catheter to travel within the sub¬clavian vessel. Pinch-off syndrome is a serious complication requiring immediate attention. It may occur with acute, tunneled, and implanted lines placed via the subclavian vein. It doesn't occur with peripherally inserted central catheters (PICCs) because they're inserted in the arm and approach the superior vena cava from inside the vessel.

Postural occlusions

A postural occlusion affects catheter patency or blood flow, depending on patient or catheter position. To find out if patient positioning is affecting blood return, instruct the patient to change positions by raising and lowering the arm, or to take a deep breath or cough. If a position change helps obtain a blood return, consult with the physician on the risks and benefits of leaving the catheter in place vs. removing it.

Medication-precipitate occlusions

If the I.V. bag contains multiple medications, such as potassium, incompatibility may occur in the tubing, causing precipitation. Infusion of parenteral nutrition, lipids, phenytoin, aminophylline, or potassium gluconate with other medications promotes precipitate occlusions. The precipitate forms quickly, causing the line to become sluggish and hard to flush.

If you suspect a catheter occlusion caused by precipitate, review the patient's medical record for possible drug incompatibilities. Consult the pharmacist, who may recommend a fibrinolytic or nonfibrinolytic agent. With a nonfibrinolytic agent, the goal is to increase precipitate solubility by changing the pH in the catheter lumen. For this procedure, first determine the catheter's fill volume. Fill volume varies from PICCs to ports, ranging from 0.3 to 0.5 mL. Larger catheters, such as dialysis catheters, have larger fill volumes; the volume may be marked on the outside of the catheter. In still the proper amount so the medication contacts the precipitate, not the outside of the catheter.

Thrombotic occlusions

Most catheter occlusions are thrombotic, caused by changes in blood flow, venous stasis, hypercoagulability, or trauma to the vessel wall. (See *Types of thrombotic occlusions* by clicking the PDF icon above.) Thrombosis has been linked to central-line–associated bloodstream infections (CLABSIs), so managing a thrombotic occlusion is crucial to prevent infection. Management entails timely patency assessment and treatment.

If a catheter becomes partially occluded or loses its blood return, a fibrinolytic typically is ordered, to be given according to manufacturer's guidelines. Currently, alteplase is the only fibrinolytic approved by the Food and Drug Administration (FDA) to treat thrombotic occlusions.

Bleeding and hematomas

Expect minimal bleeding after catheter insertion. However, know that certain catheter types, insertion techniques, and laboratory values can make patients more prone to bleeding. When assisting with catheter insertion, control bleeding at the site before the final dressing is applied. If the insertion site continues to bleed or ooze blood, apply a sterile 2″ x 2″ gauze dressing under the transparent dressing; change the dressing every 24 to 48 hours. Follow your facility's policy on caring for and maintaining a gauze dressing.

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Catheter-tip migration

If the catheter loses its blood return, suspect catheter-tip migration. The tip may migrate out of the superior vena cava at any time due to catheter- or patient-related factors. Some catheters are made of stiffer materials (such as the nontunneled dialysis catheter), whereas PICCs are more flexible and more likely to migrate. Power injection, power

flushing, push-pause flushing methods, vomiting episodes, and suctioning also can cause the catheter tip to migrate in and out of the superior vena cava.

Signs and symptoms of catheter-tip migration include changes in catheter patency or loss of blood return; discomfort in the upper arm, shoulder, jaw, chest, or ear during infusions; and an external catheter length that differs from the length at the time of insertion. For example, if the external length of a PICC was 1 cm at insertion but is now 20 cm, assume the PICC is no longer in the superior vena cava. This also can happen with a central line in the chest: If the line was inserted in the subclavian vessel with 1 cm exposed externally but 3 cm are exposed on day 5, suspect it's no longer lodged in the vessel. (See *Assessing for catheter malposition* by clicking the PDF icon above.)

Catheter rupture

Pressure generated during catheter flushing can't be measured accurately. A small syringe size (less than 3 mL) may cause higher pressures within the catheter. With partial or complete occlusions, higher pressures occur within the catheter. Excessive pressure on the syringe plunger also can cause unmanageable pressure within the catheter, leading to rupture.

If you encounter resistance when flushing the catheter, stop flushing and try to determine the cause. Don't keep flushing against resistance, as this may lead to catheter embolus or leakage.

If the catheter breaks during flushing, the healthcare team must consider whether to repair or replace it. Points to consider include the following:

- How much longer will central-line therapy continue? Catheter repair may be more appropriate if therapy will continue for a few days, whereas replacement is more appropriate for longer-term therapy.
- Are vessels available for a new insertion? Did the inserting clinician note that the catheter was inserted with much difficulty? Does the patient have a history of multiple catheter insertions?
- Is the catheter appropriate for exchange? Is there a chance of contamination or infection with this catheter or insertion site?
- Is repair feasible based on variables of catheter damage and exposure? What are the possible risks of contamination and infection?
- What are the manufacturer's recommendations? Many catheters don't come with repair kits. Depending on leakage or breakage location, repair may be impossible—for instance, with a double-lumen catheter that's leaking below the bifurcation.
- If the catheter is visibly ruptured on the outside, is there a possibility it has ruptured on the inside? This can be determined only by X-ray or dye study.

If catheter repair is appropriate and a healthcare provider writes an order for it, an infusion or vascular expert should repair it following the manufacturer's guidelines and using aseptic technique, with modification equipment supplied by the manufacturer.

Phlebitis and related pain

Another complication of a central line is phlebitis (vein inflammation) with related pain. Although most common with a PICC, it can occur with any central line. Phlebitis causes erythema, pain, or swelling along the path of the vein in which the catheter is lodged. The condition is classified as chemical, mechanical, or bacterial.

Mechanical phlebitis

Mechanical phlebitis is associated with catheter movement that irritates the vein intima. Early-stage mechanical phlebitis stems from mechanical irritation of the venous endothelium. It usually occurs several inches proximal to the insertion site. Signs and symptoms include tenderness, erythema, and edema. The most common causes of mechanical phlebitis are large-bore catheters and inadequate catheter securement.

Treatment entails application of low-degree heat from a continuous, controlled source. Continue applying heat until all signs and symptoms resolve, which usually occurs within 72 hours after treatment begins. If they don't resolve, discontinue catheter use. The healthcare team should consider an ultrasound study to rule out DVT. (Patients with prior DVT and surgery lasting longer than 1 hour are at increased risk for catheter-related DVT.) If ultrasound reveals DVT, consult the ordering clinician about treatment options, which includee anticoagulants given either with the catheter in place or after its removal.

Embolism

An embolism may involve the catheter itself, fibrin, or air entry.

Catheter embolisms

A catheter embolism occurs with catheter rupture and may result from using too much pressure when flushing the line. If the catheter doesn't flush easily, never try to force it. Assess it for mechanical or fibrin occlusions. Other causes include power-injecting a non power-injectable central line. (The FDA has posted guidelines on power injection and

events of catheter breakage. Visit www.fda.gov/MedicalDevices/Safety/AlertsandNotices/TipsandArticlesonDeviceSafety/ucm070193.htm.) Other causes of catheter embolism include migration and catheter breakage from internal and external causes. To prevent these problems, always secure the catheter adequately, avoid pulling or tuggingon it, and follow recommendations for its removal when it's no longer needed.

Fibrin embolisms

A fibrin embolism occurs when fibrin breaks off from the catheter during flushing. Signs and symptoms depend on where the clot travels. This type of embolism must be treated immediately, but can be hard to detect due to the resources needed (such as computed tomography and angiography). The best way to prevent a fibrin embolism is to assess the catheter every shift and provide proper care and maintenance.

Air embolisms

An air embolism can arise during catheter insertion, maintenance, or removal. Be sure to minimize air entry during insertion by positioning the patient and equipment properly. Air embolism also can occur during central line removal. To decrease this risk, use techniques that prevent air from entering the insertion site after catheter removal. For removal, position the patient flat or in a slight Trendelenburg position to increase intrathoracic pressure. Have the patient hold the breath or breathe out. For a patient on a ventilator, check the manufacturer's guidelines on whether to remove the catheter on inspiration or expiration. Many of the new ventilator settings provide pressure on expiration for catheter removal.

Result

Total number of cases observed - 164

Age group [in yrs]	Total central line insertion
12 - 30	15
30 - 50	70
50 and above	79

Various complication observed and their number

Complications	Nu. Of cases
Pneumothorax	02
Hemorrhage	02
Infection	07

Toward better outcomes

With the basic information in this article, you can help prevent, recognize, and troubleshoot central-line complications. Also be sure to consult your facility's policy and procedures; all healthcare facilities should use current guidelines recommended by national organizations, research, and evidence-based practice. Your expanded knowledge base and use of evidence-based policy and procedures can help you optimize patient outcomes.

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Conflict of Interest statement Nil
Word count : 4853

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