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Central venous catheter insertion is a standard and, often, the necessary procedure for critically ill patients. Various access techniques and devices were developed for many indications, including total parenteral nutrition administration, dialysis, plasmapheresis, medication administration, and hemodynamic monitoring, and to facilitate further complex interventions such as transvenous pacemaker placement. Central venous access may be attained with various devices, depending on the indication for catheter insertion. Broadly, central venous catheters allow for the administration of vasoactive medications and agents known as venous irritants. Still, catheters are used to perform dialysis or plasmapheresis or as a conduit to insert additional devices for more complex procedures. This activity reviews central venous catheter insertion and highlights the role of the interprofessional team in managing patients who undergo this procedure.Objectives:Identify the indications and contraindications for central venous catheter insertion.Describe the technique involved in central venous catheter insertion.Review the common complications of central venous catheter insertion.Outline the importance of interprofessional team collaboration, communication, and care coordination to enhance the care of patients requiring central venous catheter insertion to improve outcomes.Access free multiple choice questions on this topic.A central venous catheter (CVC) is an indwelling device inserted into a large, central vein (most commonly the internal jugular, subclavian, or femoral) and advanced until the terminal lumen resides within the inferior vena cava, superior vena cava, or right atrium. These devices and the techniques employed to place them are synonymous with "central line", central venous line (CVL), or "central venous access." The placement of a CVC was first described in 1929.[1] Over the following decades, central venous access rapidly developed into an essential experimental instrument for studying cardiac physiology and an indispensable clinical tool in treating many disease processes.[2]Various access techniques and devices were developed for many indications, including total parenteral nutrition administration, dialysis, plasmapheresis, medication administration, and hemodynamic monitoring, and to facilitate further complex interventions such as transvenous pacemaker placement.[1][3][4][5][6][7]Despite these advancements, the procedure has remained relatively unchanged since the advent of the (now universally employed) Seldinger technique in the 1960s.[8] A notable exception is the adjunct of ultrasound guidance, which has recently become the standard of care for CVCs placed in the internal jugular vein, owing to associated decreases in complications and an increase in first-pass success.[5][9][10][11][12][13] Some controversy persists about the merits of specific site selection (e.g., which vein) and the relative associated complication rates of CVCs placed in different central veins. However, there is broad consensus that today, in the modern era, the competency to establish and manage a central venous catheter is an indisputably essential skill set for clinicians involved in the care of critically ill patients. The purpose of this article is to review the indications, contraindications, techniques, complications, and management of centrally placed venous catheters.There are various access sites for the placement of central venous catheters.The internal jugular, common femoral, and subclavian veins are the preferred sites for temporary prominent venous catheter placement, whereas the basilic and brachial veins are primarily utilized for mid-term and long-term central venous access in the form of peripherally inserted central catheters (PICCs). A discussion of tunneled catheters and other central access obtained via advanced interventional radiology techniques is beyond the scope of this article. We will focus on the three main sites of access routinely used for short-term, or temporary(days to weeks), central access.Understanding the relevant anatomy and adjacent structures is crucial when placing a CVC. The decision of where to place a central line is typically based on clinical parameters and individual clinician experience and preference. Each anatomical site has relative advantages and disadvantages; placement selection is largely driven by an individual patients clinical history.The internal jugular vein (IJ) is often chosen for its reliable anatomy, accessibility, low complication rates, and ability to employ ultrasound guidance during the procedure.[9] The individual clinical scenario may dictate laterality in some cases (such as with trauma, history of head and neck cancer, or the presence/history of other invasive devices or catheters). In the standard patient, the right IJ is the preferred access as it allows a more direct path to the superior vena cava (SVC) and right atrium. It is also wider and more superficial, thus presumably easier to cannulate.[14]The IJ is located anterolateral to the common carotid artery, typically in the superior portion of the triangle created by the two heads of the sternocleidomastoid (SCM) muscle and the clavicle. The internal jugular vein joins the subclavian vein to form the brachiocephalic vein. The right and left brachiocephalic veins join to form the SVC. When anatomic landmarks are used, the IJ site can be accessed anteriorly, centrally, or posteriorly about the bifurcation of the SCM. Generally speaking, the central approach is most commonly used. Still, some have argued that the posterior approach is safest (being furthest from the lung apex and the carotid artery) and that the anterior approach is the easiest (as the carotid artery forms a readily palpable reference landmark). While there may still be no consensus about the correct landmark-based approach, most experts agree that ultrasound guidance provides the best chance of locating the vein and avoiding other structures owing to anatomic variability.[15][16]The subclavian vein site has the advantage of low rates of both infectious and thrombotic complications.[17] Additionally, the SC site is accessible in trauma when a cervical collar negates the choice of the IJ. However, disadvantages include a higher relative risk of pneumothorax, less accessibility to use ultrasound for CVC placement, and the non-compressible location posterior to the clavicle. At the site of puncture for CVC placement, the subclavian vein lies just posterior to the clavicle. Still, the vessel takes a tortuous route as it extends medially from the axillary vein. As the vein courses along the clavicle, from lateral to medial, it progresses from the lateral border of the first rib, slopes cephalad at the middle third of the clavicle, then caudally merges with the internal jugular vein just posterior to the sternoclavicular joint. Of note, the subclavian vein is closely associated with several important structures. The vein is typically anterior and superior to the subclavian artery. The lung is just inferomedially to the subclavian vein, in close approximation to the lateral first rib. The phrenic nerve courses just deep to the brachiocephalic vein at the confluence of the subclavian vein and internal jugular vein. The brachial plexus and right-sided thoracic duct are also nearby and vulnerable to injury.[18] While ultrasound (US) guidance methods have been documented, access at this site is often performed without US guidance in a landmark-guided technique.[19] Data suggests that US guidance may reduce the rates of arterial puncture, pneumothorax, and brachial plexus injury; however, many clinicians are still more comfortable with landmark-guided placement for SC central venous catheters.[16][20][21][22]The SC vein can be accessed above or below the clavicle, though the infraclavicular method is far more commonly employed. The supraclavicular approach offers a well-defined landmark for insertion at the clavisternomastoid angle, a shorter distance from a puncture to the vein, and a straighter path to the SVC, with less proximity to the lung.[22] Authors have used these findings and the observation that ultrasound guidance is easier to perform with the supraclavicular approach to suggest that the infraclavicular approach should no longer be the SC CVC insertion method.[23] However, other studies have found that the supraclavicular approach leads to a higher incidence of hematoma formation, with comparable rates of other complications, offering support for maintaining the status quo.[24]The femoral site is sometimes preferable in critically ill patients because the groin is free of other resuscitation equipment and devices which may be required for monitoring and airway access. Central venous access in the common femoral vein offers the advantage of being an easily compressible site, which may be helpful in trauma and other coagulopathic patients.[25] Additionally, unlike the IJ and SC sites, iatrogenic pneumothorax is not a concern. Patients may be more comfortable with a femoral CVC because it allows relatively free movement of the arms and legs compared to other sites. However, femoral CVCs are typically associated with increased thrombotic complications and likely an increased rate of catheter-associated infections. However, studies have shown conflicting results about the real risk of infection when the proper sterile technique is used.[5][26][27][28]Unlike IJ or SC lines, femoral central lines do not allow for accurate measurement of central venous pressure (CVP), though this is not important in every clinical scenario. The common femoral vein is located within the femoral triangle. This region is outlined by the adductor longus medially, sartorius muscle laterally, and the inguinal ligament superiorly. There are important anatomical considerations to keep in mind when accessing this particular site. Whereas in the neck, the (carotid) artery is medial to the (internal jugular) vein, the artery is lateral to the vein in the leg. The mnemonic NAVEL is useful for recalling the order of lateral to medial structures: femoral nerve, femoral artery, common femoral vein, "space" (femoral canal), and lymphatics.[29] Knowing this anatomy or landmark-guided central line placement band is important because ultrasonography may appear similar.[11]Central lines are placed for the following indications:Hemodynamic instability that requires vasopressor supportNeed for hemodynamic monitoring, including central venous pressureNeed to instill hyperosmolar agents or agents known to cause vein scarring (phlebosclerosis)Inadequate peripheral IV access (either failure to obtain peripheral access in urgent/emergent situations, or requirement of multiple IVs to sustain and resuscitate a patient)Initiation of high fluid volume extracorporeal therapies, such as hemodialysis plasmapheresis, or continuous renal replacement therapyInitiation of multiple infusions that may be incompatible with peripheral intravenous access, including total parenteral nutrition, chemotherapy, and other acidic medications to peripheral veinsMass transfusion protocol in patients with inadequate peripheral accessVenous interventions, including inferior vena cava filter placement, thrombolytic therapy, transvenous cardiac pacing, and intra-venous stentingThere are relative and absolute contraindications to placing central venous catheters,and contraindications may besite-specific. Relative contraindications may be overruled by the urgency with which the catheter needs to be identified and thus require careful consideration of the patients underlying pathology and hemodynamic status.Absolute contraindications:Active skin or soft tissue infection at the potential site of the central line.Anatomical distortion at the site includes implantable/indwelling hardware, such as hemodialysis catheters and pacemakers.Vascular injury proximal or distal to the site of the catheter insertion, such as in traumatic injuries.Relative contraindications:Coagulopathy, though the actual incidence of clinically significant bleeding is around 0.8%.[30]Thrombocytopenia seems to correlate with a greater risk of adverse events.Uncooperative awake patient.Distortion of landmarks by congenital anomalies or trauma.Morbid obesity.Typically, patients with an international normalized ratio (INR) of greater than 3.0 or platelets less than 20 x 10^9/L have severe coagulopathy and an increased risk of bleeding.[31]It may be warranted to consider giving fresh frozen plasma and platelets before the procedure or shortly after that, depending on the urgency of the clinical situation. Site-specific contraindications must be assessed on a case-by-case basis. The SC site is contraindicated in coagulopathic patients, given its anatomical proximity to several other significant vessels and the inability of the proceduralist to hold pressure in the event of an accidental arterial puncture or laceration of the vein itself. The IJ site may be relatively contraindicated if a cervical collar is in place or if the IJ site will be required for another invasive procedure during the same admission. Similarly, the femoral site should be avoided if it is anticipated that femoral access will be needed for a procedure such as cardiac catheterization.Various manufacturers of central venous catheter insertion kits and several different types of catheters exist. Generally speaking, one will require an ultrasound machine with a high-frequency linear transducer, sterile products, mask, and head covering, the introducer kit with a central venous catheter, lidocaine, various sterile syringes, sterile saline flushes in 10 cc syringes, a sterile occlusive dressing, and a bio-patch if available.Nonsterile products:Sterile products:Personal protective equipment: including gloves, gownChlorhexidine swabs or similar antiseptic agentSterile ultrasound probe cover with sterile ultrasound gel"Luer locks" or catheter caps for each lumenCentral venous catheter kit, which generally includes:Central venous catheter (triple-lumen, dual-lumen, or large bore single-lumen)18 gauge introducer needle, with a syringeSuture material (generally 3-0 silk suture with a straight needle or a needle driver)Saline lock (number depends on the type of device)1% lidocaine, small gauge needle (25 or 27 gauge), syringeUltrasound machine with a high-frequency linear transducerCVC insertion should be performed by a proceduralist skilled in the technique. The procedure can either be performed with or without a nurse to assist.It is essential first to obtain consent for the procedure, if possible. Discuss the risks, benefits, and potential complications of the procedure. Once consent is obtained, inform nursing that the patient will be undergoing central venous catheter insertion. Gather the above equipment and necessary personnel, and clear the room of any visitors or non-essential staff to maintain maximum sterility. Use the ultrasound machine to assess the preferable access site (internal jugular, subclavian, or common femoral veins), taking note of anatomical variations, adjacent structures, and the ease with which the procedure can be performed at that site. Place the patient in an anatomically advantageous position for the procedure.With all access options, the proceduralist should adjust the height of the bed, and clear away clothing, jewelry, and any non-essential equipment which may impede the preparation of a clear sterile field. The patient should be placed on a cardiac monitor that can cycle vital signs every 5 minutes and maintain telemetry. For placement of a central line utilizing either the internal jugular vein or and subclavian vein access, the patient should be placed in the Trendelenburg position to increase the size of the vessel and improve the chance of first-pass success. For femoral vein access, the patient should be in a supine position.Once a cursory anatomy scan is performed with ultrasound, the patients access site should be cleaned to remove all ultrasound jelly. After completing appropriatehand hygiene and donning non-sterile personal protective equipment, open all sterile equipment, creating a sterile field. This can be accomplished by grasping the corners of the pure wraps and opening them out and away from the proceduralist. Once a sterile field has been created, clean the site with your chosen antisept; this is typically performed using chlorhexidine, or in the event of a trauma, betadine. Prepare the vascular probe to be easily sheathed with a sterile probe cover. After that, don the sterile personal protective equipment, and prepare the central venous catheter by attaching saline locks with saline flushes and flushing all of the ports to ensure that there are no equipment issues. Next, remove the saline lock from the most distal port. Place the sterile drape over the patient, with the access point over the procedure site. Sheath the ultrasound probe with the sterile probe cover. The needle driver from the central line kit may clamp the proximal portion of the probe cover to the sterile drape to avoid the probe falling off the sterile field during the procedure. Assure that all equipment is within reach before initiating the procedure. Immediately before the procedure, the proceduralist should perform a time out with nursing.The patient should bepositioned in Trendelenburg for IJ or flat for common femoral or subclavian venous access. Depending on the patient's anatomy, a cushion may be placed beneath the vertebral column, facilitating needle insertion and dilation of the SC vein.After preparation is completed, the following steps should be followed:Under ultrasound guidance, identify the vein (check that the vessel is compressible, and if in doubt, check doppler color flow) and use 1% lidocaine to anesthetize the skin and subcutaneous tissue (in awake patients).Under ultrasound guidance, use the finder needle with a ten cc syringe attached; at a 45to 90-degree angle, advance the hand through the skin, holding negative pressure on the syringe until a flash of dark venous blood appears.Be sure to maintain dynamic visualization of the needle tip as it enters the vessel.Following theaspiration of venous blood, stabilize the needle with the dominant hand, disconnect the needle from the syringe, and thread the guidewire through the needle.The wire shouldadvancequickly. If there is any resistance, you may not be in the vessel; there may be an obstruction distal to the entry site, or the j-tip of the wire may be advancing retrograde. Attempt to remove the wire and re-thread. If the wireenters the right atrium, ectopy can be appreciated. Should telemetry demonstrate any ectopy or arrhythmia, the wire should be immediately pulled back until the arrhythmia resolves. Typicallythe wiredoes not need to be pulled out completely.Once the wire is at 15 cm (three hash marks), stabilize the wire between two or more fingertips and withdraw the needle making sure not to sustain a needlestick inadvertently. Never let go of the wire!Once the needle has been removed, re-image the vessel with ultrasound in both a transverse and longitudinal plane. The wire should be visualized within the vessel lumen. If you do not see the wire within the lumen, do not proceed to the next step. If you are uncertain that the wire is in the vessel's lumen, remove the wire, hold pressure on the site, and either re-attempt obtaining access to the boat with the finder needle orswitch toa different anatomic site.In addition to the dynamic visualization of the procedure with ultrasound, some practitioners use manometry to ensure that the catheter is in the venous system and not the arterial system. To do this, an angiocatheter is threaded over the wire, the wire is removed, and the included extension set for the central venous catheter is attached and held upright in the air. The meniscus formed by the column of blood that slowly fills the extension tubing should plateau if the angiocath isin the venous system. However, this method is time-consuming and unreliable in shock states. Regardless, it can be helpful with the subclavian approach, which is often difficult to fully accomplish with dynamic ultrasound visualization.Once the wire is verified to be within the vessel lumen, "preload" the dilator onto the guidewire and thread it toward the junction of the skin and wire. Leave approximately 2or 3 cm between the dilator and the skin edge.Use the scalpelto create a small nick in the skin by sliding the blunt end of the scalpel blade along the wire to make a skin incision approximately 0.5 cm in width and half the depth of the scalpel blade.Remove the scalpel, and thread thedilator into the incision. Pre-loading the dilator minimizes blood loss and improves the ease of insertion.Grasping the dilator in the middle portion, apply gentle, steady pressure, sometimes with a slight twisting motion, to dilate the soft tissue and enable passage of the central venous catheter. Approximately 1/3 to 1/2 of the length of the dilator will need to be inserted into the skin/soft tissue space. This depends upon the anatomic site and the specific type of central venous catheter. Dialysis catheters will require several stages of dilation with increasingly larger dilators and potentially multiple uses of a scalpel to widen the incision.Remove the dilator, and place sterile gauze over the site to maintain sterility and minimize bleeding. Again, at no point should the proceduralist lose control of the guidewire.Thread the central venous catheter over the guidewire. Slide the guidewire slightly out of the skin to help control the guidewire while advancing the catheter. Once the catheter is fully inserted, the guidewire can be gently pulled through the distal port (usually brown)Using a syringe, aspirate blood, remove air from each port, and flush with sterile saline solution. "Luer locks" may be attached to the end of each port either before or after this step.The central venous catheter should be sutured with two sutures, a bio-patch should be placed between the catheter hub and the skin, and a sterile occlusive dressing should be placed over the catheter/skin entry site. Clean drapes and soiled non-sharp products should be disposed of in biohazard bins. All sharps should be placed in sharps bins. The patient should be put back into a position of comfort, and the proceduralist should verify that the line is appropriately set within a central vein.In addition to dynamic ultrasound guidance, three methods ensure that a central venous catheter is placed correctly. A venous blood gas can be obtained from the distal port of the central line, a chest x-ray can be performed, and central venous pressure can be obtained from the distal port.The blood gas and central venous pressure (CVP) are optional. Still, a chest x-ray should be performed in all IJ and SC CVC insertions to confirm placement and verify that no complications (such as iatrogenic pneumothorax) have occurred.The x-ray should demonstrate the distal tip of the central venous line within either the superior vena cava (SC/IJ) or inferior vena cava (femoral).Numerous potential complications can occur during the procedural placement of a central venous catheter but also due to the indwelling equipment.Procedural complications include the following:Arrhythmias typically ventricular or bundle branch blocks due to guidewire irritation of the atria or ventriclesArterial puncturePulmonary puncture with or without resultant pneumothoraxBleeding hematoma formation, which can obstruct the airwayTracheal injuryAir emboli during venous puncture or removal of the catheter[32]Post-procedural complications include the following:Catheter-related bloodstream infections bacterial or fungal[33]Central vein stenosisThrombosisDelayed bleeding with multiple attempts in a coagulopathic patient[32][34]Whenperformed correctly, the insertion of a central venous catheter is safe, productive, and potentially life-saving. However, particular clinical pearls should be at the forefront of the proceduralists mind when performing this procedure.Whenever possible, take the time to prepare for the procedure thoroughly, and ensure that all necessary personnel and equipment are in the room and readily available. Lack of preparation will compound any potential complications that may be encountered.Ensurethat sterile products are not contaminated and that there is no evidence of damage to the packaging. Follow sterile procedures at all times. Central line infections can be severe and life-threatening illnesses.Whenusingthe IJ or SC sitefor access, obtain a stat portable chest x-ray immediately after line placement to ensure no pneumothorax and that the line terminates in the superior vena cava.Suppose one has a failed attempt at theIJ site and needs to seek access at another location. In that case, the ipsilateral subclavian is preferred, given the risk of bilateral pneumothoraces with an attempt at the contralateral internal jugular vein. One may anticipate this possibility by cleaning and prepping the IJ and SC site on the procedure side.If unsure of the placement of a guidewire within the vein and limited views on ultrasound, manometry is a valuable tool to establish that the guidewire is within the venous system. However, this may be falsely reassuring in shock states where arterial pressure is low.Subclavian access does appear to have fewer infections butpotentially higher procedural complications, mainly if performed by a clinician with limited experience.[35]The internal jugular, subclavian, and femoral veins have higher success rates and fewer complications when access is performed with ultrasound.The clinician must maintain hold of the guidewire at all times while it isinside the patient. The wire can be lost inside the patient and may migrate into the right ventricle or inferior vena cava, leading to additional invasive procedures to recover the wire.Always ensure that the catheter is appropriately placed through one or several methods: radiographic evidence,measurement of CVP, or analyzing venous blood gas.[36]Never use excessive force during any part of this procedure. It will lead to damage to local structures.After a CVC placement, nurses are charged with maintaining, monitoring, and utilizing central venous catheters.The bedside nurse must be adept at recognizing complications such as infections, hematoma, thrombosis of the catheter, and signs of pneumothorax and bleeding. Nurses are also responsible for ensuring that the site is maintained in a clean and sterile fashion. Beyond the immediate complications of the procedure itself, nursing must beimmediatelyaware of any ongoing issues and delayed complications. Their role in the interprofessional team is of monumental importance in maintaining the central venous catheter and recognizing potential complications.Clear communication between all team members is essential to appropriate patient care.[37]The clinician should inform the nurse as soon as the proper placement of the CVC is confirmed, and nursing should wait for this confirmation before using the line to administer medications. The nurse and the clinician should be aware of and track when the line was placed. CVCs are temporary, and complication rates increase when lines are left in too long.Daily inspection of the access site and device patency should be performed during nursing rounds. In particular, nursing must disinfect injection ports, catheter hubs, and needleless connectors with institutionally approved antiseptics. Intravenous administration sets should be changed regularly per hospital policy. The site should be checked for bleeding, hematoma formation, and cellulitis signs, including erythema,purulent drainage, and warmth.[38]Dressings should be changed if visibly soiled. This must be performed with proper sterile technique. Importantly, any manipulation of the catheter site should be done using a sterile procedure. A bouffant cap, mask, and sterile gloves must beworn to minimize infection. The area should be cleaned with approved antiseptics, allowed to dry, and a sterile occlusive dressing must be replaced.[38]At interprofessional team rounds, there should be a daily discussion about whether or not the central venous catheter is still indicated. If deemed unnecessary for further management, the central venous catheter should be removed expeditiously.[39]Many potential complications can arise from the placement of central venous catheters. Nursing staff should be aware of the immediate and delayed complications and alert the clinician in charge of the patients care.[39]However, clinicians should also be wary of complications and always consider the catheter (as a source) if the patient showssigns of infection.Review QuestionsChest Radiograph, Malpositioned Central Line Contributed by Scott Dulebohn, MD Central Line, Pericardium Contributed byS Bhimji, MD Central Line, Triple Lumen Contributed byS Bhimji, MD Subclavian vein access Image courtesy O.Chaigasame Central Venous Catheterization Body Access. This image shows different access sites in the body for central venous catheterization. Contributed by A Tariq, MD Femoral Triangle. This figure illustrates the femoral triangle, which is bounded superiorly by the inguinal ligament, laterally by the medial border of the sartorius muscle, and medially by the lateral border of the adductor longus muscle. Clinically, (more...)1.Beheshti MV. 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 MeSH Heading Catheterization, Central Venous Tree Number(s) E02.148.167 E04.100.814.529.875 E04.502.382.875 E05.157.313 Unique IDD002405 RDF Unique Identifier Scope NotePlacement of an intravenous CATHETER in the subclavian, jugular, or other central vein. Entry VersionCATH CENTRAL VENOUS Entry Term(s) Catheterization, Central Central Catheterization Central Venous Catheterization Venous Catheterization, Central Previous Indexing Catheterization (1966-1987) Catheters, Indwelling (1978-1987) See Also Central Venous Catheters Venous Cutdown Public MeSH Note88 History Note88 Date Established 1988/01/01 Date of Entry 1987/05/09 Revision Date 2015/06/22 InfectionIf you notice redness around the line or a discharge from the entry site or if you have a temperature above 37.5 degrees, fever, chills or feel generally unwell, it could mean that you have an infection.Signs of a blood clotPain, swelling or discomfort in your neck or arm on the side of the catheter insertion could be signs of a blood clot.Blocked lineIf the line becomes blocked, then it may be difficult to aspirate blood or to inject through the line. In most cases, the line should not be used until the problem has been dealt with. Special clot-busting drugs can usually help.Rare complicationsRarely, the line can irritate the heart and cause abnormal heart rhythms or cause fluid to build up in the sac around the heart. If you feel any palpitations, light-headedness, dizziness or shortness of breath it is important to seek immediate medical advice.Occasionally, the line can become dislodged. If you notice that the line is further out than normal, then seek immediate medical advice.You should not feel pain when the line is being used if you do, then please report this. ,the free encyclopedia that anyone can edit.117,937 active editors 7,001,389 articles in EnglishThe English-language Wikipedia thanks its contributors for creating more than seven million articles! Learn how you can take part in the encyclopedia's continued improvement.GL Mk.II transmitter vanRadar, Gun Laying, MarkI, or GL Mk.I for short, was an early World WarII radar system developed by the British Army to provide information for anti-aircraft artillery. There were two upgrades, GL/EF (elevation finder) and GL Mk.II (pictured), both improving the ability to determine a target's bearing and elevation. GL refers to the radar's ability to direct the guns onto a target, known as gun laying. The first GL sets were developed in 1936 using separate transmitters and receivers mounted on gun carriages. Several were captured in 1940, leading the Germans to believe falsely that British radar was much less advanced than theirs. The GL/EF attachment provided bearing and elevation measurements accurate to about a degree: this caused the number of rounds needed to destroy an aircraft to fall to 4,100, a tenfold improvement over early-war results. The Mk.II, which was able to directly guide the guns, lowered the rounds-per-kill to 2,750. About 410 Mk.Is and 1,679 Mk.IIs were produced. (Fullarticle...)Recently featured: Andrea NavageroNosy KombaMcDonnell Douglas Phantom in UK serviceArchiveBy emailMore featured articlesAboutLieke Klaver ahead in the women's 400 metres final... that a 400-metre race in 2025 (pictured) was won by Lieke Klaver, who pretended that an absent competitor was running in front of her?... that the land snail Drymaeus poecilus is notable for the striking variety of colors and patterns on its shell?... that a forensic investigation of Signalgate has determined how a journalist was included in a group chat about Operation Rough Rider?... that two of the players involved in the 2005 Vietnamese football match-fixing scandal did not accept payment because they felt

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