THE LAY OF THE LAND
Knowing the correct anatomic locations of individual vessels is crucial for proper placement of the catheter and minimizing trauma.

Abstract
Knowing how certain diseases and conditions affect the blood vessels can help with determining why to choose certain IV catheter placement sites over others. There are many overlooked and underused sites for catheter placement. When catheters are placed in different sites, knowledge of the relevant anatomy, including underlying muscles and nerves, and where the vein is found can help minimize the risk of damaging tissues in the area. Proper care and maintenance of the catheter will increase its longevity and may decrease the number of times a new catheter needs to be placed.
Venous access is critical for patient care in veterinary medicine because it provides a route for administration of fluids, medications, and blood products as well as a source of blood for sampling. The most common “go to” site for intravenous (IV) access in small animal patients is the cephalic vein. However, what happens if this vein is not accessible? Why might we need to choose another IV access site, and what other sites can we choose from? This article discusses sites other than the cephalic vein that can be used for IV catheter placement in small animals (TABLE 1).

**GENERAL INDICATIONS FOR USING ALTERNATIVE IV CATHETER SITES**

Many factors affect the size and accessibility of blood vessels (BOX 1). For example, patients experiencing hypotension, hypothermia, or both will experience vasoconstriction. Neonates and exotic small mammal pets often have extremely small vessels, making it difficult to gain IV access.\(^1\) Physical restrictions to venous access include masses (e.g., lipomas, mast cell tumors, skin tags), skin infections, and edema at the site. Other challenges to IV access include changes to an animal’s conformation, such as angular limb deformities or amputated limbs. Certain catheterization locations may be selected over others to reduce bleeding around insertion sites in patients with thrombocytopenia or other clotting disorders. The number of IV access sites will also be decreased by limb trauma (e.g., fractures, open wounds).

Other considerations include the patient’s mobility and potential for chewing or scratching out the catheter; the potential of catheter soiling by...
frequent diarrhea, urination, or urinary incontinence; and the overall stress during patient restraint for catheter placement in a particular area. Medications themselves can cause phlebitis, which should lead to consideration of other IV catheter options for patients that could potentially receive high concentrations of potassium chloride (KCl) (80 mEq/L or higher), dextrose (7% or higher), mannitol, or chemotherapy agents.

**GENERAL CATHETER PLACEMENT AND MAINTENANCE**

Sterile placement of IV catheters is essential. Hands should be appropriately washed, exam gloves or sterile gloves (location dependent) should be worn, and aseptic technique should be followed. To ensure the site can be as clean and secure as possible and to prevent discomfort during tape removal, the location should be clipped approximately 2 inches above and below where the catheter will be placed and all the way around on peripheral limbs. The site should be cleaned with sterile 0.9% sodium chloride (normal saline) combined with chlorhexidine scrub to form a 0.5% to 2% concentration.\(^2\) After placement, the catheter should be flushed with sterile saline to confirm patency and then secured with sterile bandage material.\(^3\) All catheters, regardless of location, should be rewrapped daily and the insertion site should be evaluated twice daily for signs of dislodgement, swelling, infection (red or yellow discolored skin around insertion site or purulent discharge), or pain and tenderness.\(^2\) For lower limb catheters, the nail and tip of the third and fourth digits should remain visible outside of the bandage to enable monitoring for signs of swelling. Elizabethan collars will prevent licking or chewing at the site. The bandage material should be routinely inspected to ensure that it is dry and free from water, food, urine, or fecal matter. Catheters that are not being used for continuous IV fluids should be kept patent by flushing with normal saline every 2 to 4 hours.\(^2\)\(^4\)

**ALTERNATIVE SITES**

**Jugular Vein**

**Location:** The left and right external jugular veins are located on the ventrolateral aspects of the neck, off the midline on either side of the trachea (Figure 1A).\(^5\) On each side, the jugular vein branches into the subclavian vein which runs into the cranial vena cava.\(^5\) The jugular veins lay superficial to the brachiocephalicus, sternoccephalicus, and sternothyroideus muscles and are innervated by cranial nerve XI (accessory nerve) and the segmental nerves.\(^5\)

**Indications:** When used as a central line, a jugular catheter is a large-bore catheter that is placed in the jugular vein.\(^5\)\(^6\) It can be a regular 1-port catheter or a multiport catheter that enables use of up to 3 ports at the same time. The choice of which type to use is based on access to supplies and whether multiple fluids will be administered or blood samples collected.\(^6\)

**Placement/maintenance:** To reduce the risk for infection, the catheter location should be prepared as aseptically as possible.\(^4\)\(^6\)\(^7\) After catheter placement, bandaging above and below the insertion site will help maintain sterility and protect the catheter from becoming dislodged. Jugular catheters should be sutured in place to prolong their longevity and maintain proper placement. The catheter should be sutured at the base, the top, and both sides of the butterfly tab. If a patient is being monitored for central venous pressure, the catheter should be measured to the third to fifth rib space to ensure that the tip of the

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**BOX 1**

**Indications for Using Alternative IV Catheter Sites**

- Pediatric patient (neonate)
- Coagulopathy (thrombocytopenia and/or low clotting factors)
- Dehydration
- Edema
- Burns
- Masses
- Skin infection
- Fracture
- Open wound (e.g., degloving injury)
- Congenital malformation (e.g., angular limb deformity, amputation)
- Need for frequent blood collection (risk for scar tissue formation)
- Need for medications that have high risk of causing phlebitis or tissue necrosis if extravasated (e.g., KCl, dextrose, mannitol, diazepam, phenobarbital, chemotherapy agents)

*IV=intravenous; KCl=potassium chloride*
<table>
<thead>
<tr>
<th>CATHETER SITE</th>
<th>INDICATIONS</th>
<th>CONTRAINDICATIONS</th>
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</thead>
<tbody>
<tr>
<td>Jugular vein (central line)</td>
<td>Small patient (e.g., neonate, exotic) with tiny peripheral vessels</td>
<td>Thrombocytopenia or clotting factor disorders</td>
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<td></td>
<td>Concurrent administration of fluids or medications that are not compatible with each other (e.g., IV enrofloxacin, n-acetylcysteine, blood products, insulin)</td>
<td>Traumatic brain injury (risk of increasing intracranial pressure)</td>
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<td>Frequent blood sampling</td>
<td>Stress of catheter placement resulting in increased intracranial pressure and patient’s need for oxygen</td>
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<td>All other IV access routes exhausted</td>
<td>Risk for infection, thrombosis, or embolism</td>
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<td>Hyperosmolar fluids (risk for phlebitis in cephalic vein)</td>
<td>Risk of advancing guidewire too far into the heart, causing arrhythmias or loss of guidewire</td>
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<td>Total or peripheral parenteral nutrition</td>
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<tr>
<td>Accessory cephalic vein</td>
<td>Ease of access (prominent vessel)</td>
<td>Damage to the front limb (e.g., fracture, severe edema)</td>
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<td></td>
<td>Mass or edema on proximal aspect of the limb</td>
<td>Aggressive patient (bite risk)</td>
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<td></td>
<td>Inability to keep hind limbs dry and clean due to frequent urination or diarrhea</td>
<td>Skin infection or open sores</td>
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<td></td>
<td>Scar tissue cranial to site caused by previous cephalic vein catheter</td>
<td>Angular limb deformity (catheter would cause patient discomfort)</td>
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<td>Auricular vein</td>
<td>Anesthetized patients (immobile)</td>
<td>Head trauma</td>
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<td></td>
<td>Inaccessible peripheral vessels</td>
<td>Ear infection</td>
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<td></td>
<td>Canine patients with large ears (e.g., basset hounds, mastiffs, Great Danes, Doberman pinschers), and rabbits</td>
<td>Mobile patient</td>
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<td></td>
<td></td>
<td>Risk for ear nerve injury</td>
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<tr>
<td>Lateral saphenous vein (PICC line)</td>
<td>Need for continuous blood sampling</td>
<td>Extremely mobile patient</td>
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<td></td>
<td>Need for multiple separate fluids to be administered concurrently</td>
<td>Edema</td>
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<td>Injured front limb (e.g., fracture, open wound, amputation)</td>
<td>Frequent bouts of urination or defecation</td>
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<td>Severe edema/swelling</td>
<td>Risk for injury to femoral artery</td>
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<td></td>
<td>Aggressive patient</td>
<td>Risk for trauma to underlying muscles and nerves</td>
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<tr>
<td>Medial saphenous vein</td>
<td>Nonambulatory patient</td>
<td>Trauma above the site</td>
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<tr>
<td></td>
<td>Exhaustion of other veins</td>
<td>Mobile site</td>
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<td></td>
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<td>Multiple uses of site for blood sample collection</td>
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<tr>
<td>Common dorsal digital vein (dorsal pedal vein)</td>
<td>Ease of access (patient draped for surgery, less fat or excess tissue over location)</td>
<td>Risk for trauma to underlying muscles and nerves</td>
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<td></td>
<td>Size (small to giant breed patients)</td>
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<td></td>
<td>Exhausted front limb IV access</td>
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<tr>
<td>Sublingual vein</td>
<td>Anesthetized patients only</td>
<td>Severe dental disease</td>
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<td></td>
<td>Main catheter site and other sites inaccessible</td>
<td>Risk for damage to cranial nerve XII (hypoglossal)</td>
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<td>Risk for hemorrhage</td>
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<td>Risk for tissue necrosis from extravasated medication</td>
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<td>Corpus cavernosum</td>
<td>Hypovolemic patient, need for immediate fluid resuscitation</td>
<td>Risk for penile or pelvic trauma, fibrosis, or penile dysfunction</td>
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<td></td>
<td>Exhaustion of other IV access points</td>
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<td></td>
<td>Unavailable intraosseous catheter supplies</td>
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<tr>
<td>Umbilical vein</td>
<td>Postpartum lifesaving efforts for neonate &lt;24 hours of age</td>
<td>Risk for infection of the umbilicus or surrounding abdominal tissue</td>
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<td></td>
<td>Unavailable intraosseous catheter supplies</td>
<td>Abnormal anatomy (e.g., umbilical hernia)</td>
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<td>Open wound</td>
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<td>Risk for sepsis</td>
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<td></td>
<td>Potential for thromboembolism, extravasation, or perforation of the catheter into the peritoneum</td>
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<td>Ischemia</td>
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<tr>
<td>Intraosseous</td>
<td>Neonates</td>
<td>Risk for trauma to underlying muscles and nerves</td>
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<td></td>
<td>Exotics</td>
<td>Risk for fracture</td>
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<td></td>
<td>Extreme hypovolemia</td>
<td>Preexisting fractures (increased risk for fluid and medication extravasation)</td>
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<td>Cardiac arrest</td>
<td>Potential inaccuracy of blood samples</td>
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<td></td>
<td>Burns</td>
<td>Already infected tissue</td>
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<td></td>
<td>Morbid obesity</td>
<td>Risk for osteomyelitis (inflammation of bone usually caused by infection)</td>
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<td>Status epilepticus</td>
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<td></td>
<td>Peripheral vascular thrombosis</td>
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<tr>
<td></td>
<td>Exhausted peripheral vessels</td>
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IV=intravenous; PICC=peripherally inserted central catheter
catheter sits just cranial to the right atrium.\(^7\) A single lateral thoracic radiograph should be taken to confirm that the catheter has not been advanced into the heart (FIGURE 1B).\(^7\) Otherwise, the anatomic location of the central line is not as concerning as long as blood samples can be obtained.\(^7\) If the catheter is a standard peripheral 18-gauge to 22-gauge catheter, then no placement radiograph is needed.

**Accessory Cephalic Vein**

**Location (FIGURE 2):** The accessory cephalic vein branches off the cephalic vein at the proximomedial aspect of the carpus. It is located on the anterior aspect of the metacarpus and makes a “Y” shape as it passes over the carpus.\(^5\) The accessory cephalic vein is superficial to the extensor carpi radialis, superficial digital flexor, and flexor carpi radialis muscles.\(^5\) Innervating these muscles are the distal radial, median, and ulnar nerves.\(^5\) The location of this vein often makes it easier to see than the cephalic vein.

**Indications:** Indications for using this vein include ease of access due to its prominence, restrictions on the proximal aspect of the limb (e.g., masses, edema, scar tissue), or need to avoid use of back limbs because they cannot be kept clean and dry.

**Placement/maintenance:** After catheter placement, be sure to have good padding under the hub of the catheter. For bandages that cover the entire paw to the digits, the nail and tip of the third and fourth digits should remain visible for monitoring. Due to the location of the accessory cephalic vein, the catheter will extend medially. When this vein is used, be sure that other veterinary staff members are aware so that they do not mistake the catheter for a cephalic vein catheter that is twisted sideways and needs to be adjusted.

**Auricular Vein**

**Location:** The auricular veins are located on the rostral (medial auricular vein) and caudal (lateral auricular vein) edges of the ear.\(^5\) These veins are located beside the rostral and caudal auricular nerves, which branch into the auriculopalpebral and facial nerves.\(^5\)

**Indications/contraindications:** This location can be used for anesthetized patients when catheter sites under drapes are inaccessible or no longer functioning or for patients that have large ears (e.g., basset hounds, mastiffs, Great Danes, dachshunds, Doberman pinschers, rabbits).\(^8,9\) Vasoconstriction renders an auricular vein a poor choice for patients with hypothermia or insufficient perfusion. Auricular veins
are extremely superficial, and care should be taken not to puncture through the pinna.

Placement/maintenance (FIGURE 3): Auricular vein catheters can be difficult to secure in place and should not be considered the first choice for a patient that needs significant volumes of fluid. In general, make sure the catheter is secured well to the ear with tape. Suturing the tape to the ear may provide more stability, especially for a patient likely to shake its head. The integrity of the catheter can be maintained by making a splint for the ear with a small cup or tongue depressor. If the patient has to wear an Elizabethan collar, close monitoring is needed to ensure that the collar does not rub against the ear and dislodge the catheter.

Lateral Saphenous Vein

Location (FIGURE 4): The lateral saphenous vein runs over the lateral aspect of the distal tibia, just proximal to the tibiotarsal joint (hock) and superficial to the superficial digital flexor, long digital flexor, and gastrocnemius muscles. Innervating the muscles surrounding this vein are the tibial and peroneal nerves. In dogs, this vein is larger in diameter than the medial saphenous vein.

Indications: The lateral saphenous vein can be used for a regular peripheral catheter or as the introduction site for a peripherally inserted central catheter (PICC line). A PICC line is a long, large-bore catheter, 18-gauge or larger, with single or multiple lumens. It can be inserted into the vein to help deliver larger quantities of fluids, peripheral parenteral nutrition, or multiple medications through multiple ports (the extra lumen ports keep the medications separate). PICC lines can help maintain the longevity and integrity of the vein. In a study performed in 2008, PICC lines successfully remained in patients for an average of 16.2 days. No complications (e.g., venous thrombosis, sepsis, extravasation) were noted during the duration of the catheterization. Bandaging the catheter after placement can be difficult due to the proximity of the tibiotarsal joint. For a regular peripheral catheter, the tape should be tight enough to keep the catheter in place yet should give the skin, muscles, and tendons enough room to
fluctuate in size after fluid resuscitation. Taping too tightly can lead to swelling of the paw and digits. The chance of swelling can be minimized by starting the bandaging at the distal aspect of the paw and proceeding proximally. The third and fourth digits should remain exposed for monitoring. Bandaging should extend proximal to the catheter insertion site (usually proximal tibia).

**Medial Saphenous Vein**

**Location (FIGURE 5):** The medial saphenous vein is located on the mid-to-distal aspect of the proximal femur, superficial to the gracilis and sartorius muscles. The nerves surrounding this vein are the femoral nerve and its distal branch (saphenous nerve).

**Indications:** The medial saphenous vein is a good catheter location for patients that are nonambulatory and have no other patent or accessible veins. In cats, the medial saphenous vein is larger and more easily catheterized than the lateral saphenous vein.

**Placement/maintenance:** For placement of this catheter, the patient should be lying on the same side as the desired vessel (i.e., in right lateral recumbency for access to the right medial saphenous vein), and the person restraining the patient should hold the contralateral pelvic limb in abduction. After catheter placement, tape should be placed around the hub of the catheter and wrapped all the way around the patient’s thigh. Care should be taken to keep the tape loose enough to prevent swelling of the distal limb. Padding (e.g., towels) can be placed between the patient’s legs to prevent compression of the catheterized limb, which can cause swelling or edema around the catheter site. If the patient is too mobile, the catheter could easily become dislodged.

**Common Dorsal Digital Vein (Dorsal Pedal Vein)**

**Location (FIGURE 6):** The dorsal pedal vein is located...
on the dorsal aspect of the paw, superficial to the long digital extensor muscle and the extensor retinaculum. It is innervated by the common fibular nerve.\(^5\) The vein begins to branch into a “Y” shape at the middle of the metatarsal bones; either the left or right branch can be used.\(^5\) Lack of excess fat or skin over the area often makes this vein more visible than most.

**Placement/maintenance:** After the catheter is inserted, tape should be placed around the hub to secure it to the paw. When bandaging the catheter, start from the distal aspect of the limb and extend the bandage proximally to the tibiotarsal joint or above for extra security.

**Sublingual Vein**

**Location (FIGURE 7):** The sublingual vein begins on the rostral portion of the tongue and runs caudally to the mylohyoid muscle.\(^5\)

**Indications:** The sublingual vein can be used for a short time in anesthetized patients. If peripheral IV access has been lost while an animal is anesthetized, catheterization of the sublingual vein can be attempted as the tongue is often still readily accessible. A sublingual catheter is typically used to give IV medications to maintain anesthesia until a new peripheral catheter can be placed.

**Placement/maintenance:** When placing a sublingual catheter, first clean the tongue as aseptically as possible with chlorhexidine solution and saline (0.13% solution). However, before cleaning, ensure that the endotracheal tube cuff is inflated to avoid passage of chlorhexidine cleaning solution or fluids into the trachea. After cleaning the catheter site, rinse the mouth with sterile water or normal saline to avoid the caustic effects of long-term exposure to chlorhexidine on the tongue. Tongue depressors can be used to make a splint to add rigidity to the tongue and make it easier to hold the catheter in place.

**Corpus Cavernosum**

**Location (FIGURE 8):** The corpus cavernosum consists of 2 columns of spongy tissue in the shaft of the penis.\(^5\)
This tissue is filled with blood vessels that become enlarged during erection. The corpus cavernosum is located on the lateral aspect of the penis caudal to the os penis.

**Indications:** Although not used extensively, corpus cavernosum catheterization is a short-term option for administering resuscitation fluids or medications until another route of IV access is achieved.\(^\text{11,12}\)

Experimental models have shown that catheters placed in the corpus cavernosum can support sufficient flow rates to resuscitate hypovolemic animals and can be used to administer cardiac arrest drugs (e.g., epinephrine, atropine).\(^\text{11}\) Although administration of other emergency drugs via this route has not been studied, no complications have been reported after delivery of blood products and IV phenobarbital to some patients via the corpus cavernosum.\(^\text{12}\)

**FIGURE 9.** Intraosseus catheter sites. (A) Catheter in proximal humerus; (B) radiographic appearance of catheter in proximal humerus; (C) catheter in place in trochanteric fossa of femur; (D) catheter in place in tibial tuberosity; (E) radiographic appearance of catheter in proximal tibia; (F) catheter in place in wing of ilium; (G) radiographic appearance of catheter in wing of ilium.
Placement/maintenance: A large-bore catheter (18-gauge or 19-gauge) is inserted on the lateral aspect of the penile skin at a 45° angle caudal to the os penis toward the corpus cavernosum. The catheter can be taped and sutured to the dorsal aspect of the shaft of the penis.

Umbilical Vein
Location: The umbilical vein is located on the umbilicus of neonates.

Indications/contraindications: The umbilical vein can be accessed immediately after birth as long as the vein was not ligated after a cesarean delivery. Because the umbilicus begins to dry and harden and falls off within 24 to 72 hours after birth, this vein may no longer be a viable choice after 24 hours.

Placement/maintenance: Accessing this vein can be difficult and time consuming if not practiced regularly; thus, a better choice for IV access in a neonate may be an intraosseous catheter. For access to the umbilical vein, the base of the umbilicus should be surrounded with umbilical tape that is tightened enough to prevent hemorrhage. To prevent infection and possible sepsis in the neonate, sterility of site preparation should be similar to that for a central line or PICC line. The catheter should not be advanced more than a few centimeters beyond where the flash of blood occurs. Advancing farther could result in the catheter being inserted into the portal venous system. A radiograph should be taken to check appropriate placement.

Intraosseous
Location (Figure 9): The 3 most common locations for intraosseous catheter placement are the medullary cavities of the greater tubercle of the proximal humerus, the intertrochanteric fossa of the proximal femur, and the tibial tuberosity. Other locations include the wing of the ilium and ischium in small mammals and distal ulna and proximal tibia in birds.

Indications/contraindications: Intraosseous catheters can be used when a venous catheter cannot be placed. Most medications that can be administered IV can also be delivered via the intraosseous route. The exceptions are drugs that are toxic to bone marrow (e.g., sodium bicarbonate, chemotherapy agents, large amounts of hypertonic saline). If the catheter was advanced into the spongy portion of the bone that has a network of blood vessels and capillaries, blood can be sampled from an intraosseous catheter. In a study of 12 dogs that compared 0.5 mL of blood collected from the jugular vein versus from the proximal tibia, samples were tested for blood urea nitrogen (BUN), glucose, packed cell volume (PCV), total plasma protein, lactate, potassium, sodium, and chloride. The authors found statistically significant differences between blood collected at the 2 sites for BUN, potassium, sodium, and chloride and a large but not statistically significant difference for PCV. However, it was determined that the differences were not clinically significant and blood from an intraosseous catheter could be used as a method for assessing parameters, excluding potassium and PCV, in healthy dogs. Further studies need to be performed in critically ill patients to determine if this route is reliable for other blood values.

FIGURE 10. Incorrectly placed intraosseous catheter in proximal humerus (A). It is important to take 2-view radiographs because in the lateral view the catheter can look appropriately placed (B) but the dorsoventral view shows the catheter outside of the bone (C).
Placement/maintenance: Because placement of any intraosseous catheter involves going through the superficial and underlying tissues and muscle, there is always a risk for muscle trauma and nerve damage. For example, the intertrochanteric fossa of the proximal femur is adjacent to the sciatic nerve, which innervates the biceps femoris muscle (among others). Other muscles and associated nerves that could be affected during placement of intraosseous catheters include the brachiocephalicus muscle/spinal accessory nerve for the proximal humerus, gluteal muscles/caudal or cranial gluteal nerve for the intertrochanteric fossa of the femur, and quadriceps muscles/femoral nerve for the proximal femur. Two-view radiographs can confirm appropriate placement (FIGURE 10).

As with all catheters, intraosseous catheter placement should be sterile. For traumatized limbs, fractures should be ruled out before placing an intraosseous catheter as any fluid or medication injected through the catheter could extravasate outside the bone into the surrounding muscle and tissue. Patients that are not ideal candidates for intraosseous catheters are those with diseases or conditions that make a bone easily prone to fracture (e.g., osteosarcoma; malnutrition; incomplete bony development due to young age; loss of calcium and phosphorus with resulting decreases in bone density, as in geriatric patients).

SUMMARY
For veterinary nurses, being prepared for the unexpected should be considered part of the normal day. When cephalic veins are not available for any reason, veterinary nurses need to have a backup plan for alternative routes of venous access. Knowing the correct anatomic locations of individual vessels, including bony landmarks as well as underlying muscles and nerves, is crucial for proper placement of the catheter and for minimizing catheter-associated trauma. Of the many options for gaining IV access, the option chosen should be the one that best fits that patient’s condition and needs. TVN

References
Uncommon IV Catheter Sites in Small Animals

TOPIC OVERVIEW
Knowledge of appropriate anatomy including underlying musculature, nerves, and where the vein is found anatomically is important when placing catheters to help minimize the risk of trauma to tissues in the area. Proper care and maintenance of the catheter will increase its longevity and may decrease the number of times a new catheter needs to be placed. There are many uncommon catheter sites that are overlooked and underutilized.

LEARNING OBJECTIVES
Readers will be able to illustrate the location where uncommon IV access points can be placed, recall musculature and nerves associated around the vessel of choice, give examples of indications and contraindications for choosing an IV catheter location, and discuss securing and maintaining uncommon IV access points.

1. In a critically ill hospitalized patient, the need for which medications would steer you toward placing a jugular catheter (central line) to preserve the integrity of the peripheral vessels?
   a. Ondansetron and maropitant
   b. 5% dextrose, colloid fluids
   c. 7% dextrose and potassium chloride (KCl) >80 mEq/L
   d. KCl 50 mEq/L and dexamethasone SP

2. What is the main contraindication for placing an intraosseous catheter?
   a. The patient is extremely hypovolemic
   b. There is a fracture in the bone that is being considered for catheter placement
   c. Dextrose needs to be administered to the patient
   d. Multiple IV medications need to be given to the patient

3. If you advance an umbilical catheter too far, what system does it have the potential to enter?
   a. Portal venous system
   b. Central nervous system
   c. Hepatic system
   d. Cardiac system

4. How can auricular veins be secured to the ear?
   a. Use tissue glue to secure the catheter
   b. Tape the catheter in place like any other peripheral catheter
   c. Use a tongue depressor or paper cup to act as a splint for the ear
   d. Use no bandaging for the catheter so that the ear does not become heavy

5. If a medial saphenous catheter is placed in a laterally recumbent patient, what step can be taken to help preserve the integrity of the catheter?
   a. Roll towels and place between the patient’s legs to help prevent edema and swelling in the down leg
   b. Rotate the patient every 2 hours as it will be unable to get up
   c. Provide significant padding under and around the catheter
   d. Let the patient try to move around on its own with the fluid lines attached
   e. A and C
   f. B and D

6. Which of the following is not a potential complication of corpus cavernosum catheter placement?
   a. Penile trauma
   b. Fibrosis
   c. Pelvic trauma
   d. Renal trauma

7. The distal tibia can be used for an intraosseous catheter in birds.
   a. True
   b. False

8. Which cranial nerve could be damaged during attempts to place a sublingual catheter?
   a. XI
   b. XII
   c. IX
   d. X
9. If a critically ill, hypotensive, hypovolemic patient is anesthetized for a thoracic surgery and the cephalic catheter that was placed before the surgery and is now covered by drapes becomes obstructed, which of the following sites would NOT be considered acceptable for placement of a new catheter to maintain high fluid volumes and administer multiple medications?
   a. Dorsal common digital vein
   b. Lateral saphenous vein
   c. Intraosseous catheter into the trochanteric fossa of the femur, ischium, or wing of the ilium
   d. Auricular vein

10. If a jugular catheter (central line) is placed appropriately for central venous pressure measurement, where should the tip of the catheter be seen on a lateral radiograph?
   a. Third to fifth rib space with the tip of the catheter sitting just cranial to the right atrium
   b. Sixth to eighth rib space with the tip of the catheter inside the right aorta
   c. Third to fifth rib space with the tip of the catheter in the thoracic inlet
   d. Seventh to ninth rib space with the catheter sitting in the right ventricle

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