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Medicolegal: Issues in the Use of Umbilical Venous Catheters

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The umbilical venous catheter (UVC) is the recommended route for venous access and often the first line placed during resuscitation and stabilization of the newly born infant. Outside the delivery room, a properly positioned umbilical venous catheter permits the central infusion of fluids, medications, and blood products. Measurement of central venous pressure enables assessment of blood volume and cardiac performance. In extremely low birthweight newborns, the umbilical venous catheter may avoid the need for repeated peripheral venous catheters prior to possible peripherally inserted central catheter (PICC) line placement. Malposition of the umbilical venous catheter can be a persistent problem and a source of complications. The catheter may fail to pass through the ductus venosus to terminate in the inferior vena cava appropriately. The catheter tip could also be positioned in the portal venous system, where an infusion of hypertonic solutions can result in thrombosis of the hepatic veins and subsequent liver tissue necrosis (1). As with any central catheter, the formation of thrombi, emboli, and increased risk for infection are well known. Catheter-induced cardiac dysrhythmias can occur with a UVC tip in the right/left atrium. The most feared complication is cardiac tamponade from infusion of fluids in the pericardial space, which can present acutely and has a high mortality rate. A low-lying UVC (e.g., below the level of the liver), while acceptable in an emergency in the delivery room, is frequently used in the NICU setting due to the inability to pass the catheter through the ductus venosus and is not a preferred location.

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When placing a UVC, the provider must weigh the risks and benefits of this procedure. Is the line needed, or could fluid administration be accomplished with a peripheral IV? A UVC is considered a central line, and its management is discussed as part of a CDC guideline to prevent central line-associated bloodstream infections (CLABSIs). Many of the CDC guidelines for UVCs are based on very low evidence levels; for example, considering removing a UVC at seven days of life is a "conditional recommendation" due to the lack of high-level evidence (2).

While most NICUs will obtain a radiograph immediately after UVC placement, very few obtain a follow-up radiograph 24 hours after line insertion or have a standard protocol for imaging localization of the catheter after the first day. UVCs migrate over time from their original correct position; this is more common during the first 48 hours of dwell as the umbilical stump dries. Factors such as taping and securement and abdominal girth changes require further investigation. Since the catheter is usually sutured into the umbilical stump, increases in the abdominal girth with air in the intestines (e.g., from CPAP) will pull the catheter caudad and lower where the distal tip is located. A study demonstrated that 38 of 80 (48%) UVCs remained in satisfactory position 24 to 36 hours after initial placement. In 22 (28%) of 80 patients, the UVC had a position that was too high, and in 20 (25%), that was too low after 24–36 hours (3). Another study obtained a radiograph 1 and 24 hours after the initial placement of 41 UVCs. Migration into the cardiothymic silhouette occurred in 15 (36%) and 9 (22%) at 1 and 24 hours, respectively. (4) Despite multiple formulas to guide initial placement, no one formula has evolved as a standard reference (5).

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Vascular injury is considered a primary initiating event for catheter-related thrombosis/emboli. This can occur early at the time of catheter insertion, or the injury may be progressive, as in the setting of a chronically malpositioned catheter. Denudation of the vascular endothelium can create a potential nidus for thrombus formation (6).

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The most frequent arrhythmia with a high UVC is premature atrial contractions. Supraventricular tachycardia can also occur. These arrhythmias are often benign and resolve with repositioning or catheter removal (6).

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The incidence of pericardial effusion in non-hydropic newborns is 0.01% (7). A pericardial effusion represents increased fluid in the existing pericardial spacer that can result in cardiac tamponade. Initial signs, including tachycardia, respiratory distress, and oxygen desaturation, can be subtle. One early sign may be the diminution of the QRS complex on an ECG monitor, indicating an increase in the telemetric distance from the heart to the external lead caused by the accumulation of pericardial fluid. If a pericardial effusion accumulates gradually, the intrapericardial pressure remains low, and the newborn may be asymptomatic. Muffled heart sounds and rapid deterioration of vital signs can follow this. Pulsus paradoxus, an exaggerated fall in blood pressure with inspiration, is easier to observe in newborns with arterial lines for continuous blood pressure monitoring. A dramatic increase in heart size on CXR will support the diagnosis, but echocardiography is the best way to confirm the diagnosis (8). Often, a relatively asymptomatic baby who has a UVC in place will have an unexpected arrest, and there is no time to wait for a chest radiograph. An emergent pericardiocentesis can be lifesaving in this situation (9). Pericardial tamponades have been reported even when the UVC has been in a "perfect" position (i.e., below the right atrium in the inferior vena cava above the liver). This may be because the pericardial sac extends below the heart over the upper portion of the inferior vena cava (like the wrapper on a "Tootsie Roll Pop"), and hyperosmotic fluid from TPN can still cross into the pericardial space.

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A low-lying UVC is defined as the UVC tip overlying the liver on the thoracoabdominal radiograph, below the level of the liver or in the umbilical vein, while appropriate for emergency use, is traditionally considered malpositioned and not a position recommended for prolonged use. Complications include hepatic hematomas, hepatic or abdominal abscesses, ascites, and central line-associated bloodstream infections (10).

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From a medical and legal perspective, several issues are often the subject of malpractice suits:

Is positioning the UVC in the right atrium (RA) acceptable? Most neonatal textbooks suggest that positioning in the RA is undesirable, but our pediatric surgical colleagues often place deep lines in the RA.

1. All central lines can migrate. How often should X-rays be obtained to monitor UVC placement? This is also very controversial. Some providers check placement by radiography daily. In 2003, Ades suggested that radiography was insufficient to determine the position of the UVC and suggested an echocardiogram to confirm placement (11). Once point-of-care ultrasound is more universally available, this technology for UVC placement will be helpful.

2. How long is it acceptable to keep a low-lying UVC? The potential complications of this positioning should warrant the placement of an alternative intravenous access (IV or PICC) in the first three days. Extended use requires clear documentation of the circumstances.

3. Should an x-ray be taken with any repositioning, whether advancing or withdrawing? Generally, an X-ray should confirm the position of any central line when it is placed or repositioned. Because the liver is domed and the catheter is posterior, an anterior-posterior view of the abdomen may give a false impression of where precisely the tip lies. In these circumstances, a cross-table lateral view may be more definitive. When an x-ray is ordered to evaluate the heart, lungs, or abdomen for other issues, always check for migration of any central line when applicable.

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