Fatal Vascular Access Hemorrhage: Reducing the Odds

CNE Continuing Nursing Education

Lynda K. Ball

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Vascular access hemorrhage is not a frequently occurring complication associated with hemodialysis fistulas and grafts, but when it occurs, it can be fatal to patients and devastating to patients' families and dialysis unit staff members. The End Stage Renal Disease Notification of Death CMS-2746 forms indicated that between the years 2000 and 2006 (the most recent national data available), there were 1654 fatal vascular access hemorrhages. Specific issues that place patients at high risk for access rupture have been identified, and some are directly related to access physical assessment and cannulation. Recognizing at-risk accesses during physical assessment and improving site selection for needle placement can modify some risk factors for fatal vascular access hemorrhage and improve patient outcomes.

Key Words: **Fatal vascular access hemorrhage, dialysis access hemorrhage, and vascular access rupture.**

Goal

To recognize accesses at-risk for fatal vascular access hemorrhage (FVAH) and implement strategies to decrease FVAHs.

Objectives

1. Discuss current data relevant to fatal vascular access hemorrhage (FVAH) episodes.
2. Describe access assessment techniques to reduce the risk of developing an FVAH.
3. List three interventions that can reduce the risk of FVAH in accesses.

Vascular access hemorrhage can be a fatal complication of hemodialysis. In 2007, the Maryland medical examiner recognized a pattern of deaths in 24 patients on hemodialysis whose vascular accesses had ruptured since 2000, with 22 ruptures occurring while the patients were away from their dialysis facilities (Bor, 2007). In an effort to understand and identify risk factors, the medical examiner's office conducted a retrospective study from 2000 to 2007 and compared deaths of non-access hemorrhage cases to deaths from access hemorrhage (Ellingson et al., 2012).

In 2008, the Centers for Disease Control and Prevention (CDC) initiated a regional investigation (District of Columbia [D.C.], Maryland, and Virginia) into fatal vascular access hemorrhages (FVAHs). Initial data were based on a review of End Stage Renal Disease (ESRD) Notification of Death (CMS-2746) forms from 2000 to 2007. Among the causes of death listed on the CMS-2746 form are three vascular causes that could identify death from hemorrhage: #39-Hemorrhage from vascular access, #40-Hemorrhage from dialysis circuit, and #41-Hemorrhage from ruptured vascular aneurysm (U.S. Department of Health and Human Services, 2004). In the U.S. from 2000-2006, 1654 patients on hemodialysis died from FVAHs, which represented 0.4% of deaths of patients on hemodialysis. For the D.C./Maryland/Virginia region, 88 confirmed cases of FVAH were identified (67 from the CMS data and 21 from reviews by the Maryland Medical Examiner). Based on a comparison of the number of FVAH deaths identified by the Maryland Medical Examiner beyond those reported on the CMS forms, CDC investigators expressed a belief that the incidence of FVAH derived from the CMS forms underestimate the actual number of deaths due to FVAH (Ellingson et al., 2012).

Based on their regional investigation of FVAHs, the CDC team identified the following risk factors:

Lynda K. Ball, MSN, RN, CNN, *is the Vascular Access Specialist for Fresenius Medical Care, ANNA National Secretary, a member of the Nephrology Nursing Journal Editorial Board, and a member of ANNA's Greater Puget Sound Chapter. She may be contacted via email at lynda31699@msn.com*

Disclaimer: *The materials presented in this article were collected from surgeons and physicians from around the world. The author has no knowledge of where the patients, whose accesses are presented in this article, receive(d) their dialysis treatments.*

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Note: *Additional statements of disclosure and instructions for CNE evaluation can be found on page 304.*

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- Over half of the access ruptures occurred in AV grafts.
- Approximately three-quarters of the deaths occurred at home, in assisted living, or nursing homes.
- Access-related complications had occurred within six months prior to bleeding deaths.
- Hypertension.

This article reviews the major risk factors associated with FVAH, provides an in-depth assessment for hemodialysis unit staff members to recognize high-risk vascular accesses for earlier referral for intervention, and reviews the National Kidney Foundation (NKF) (2006) Kidney Disease Outcomes Quality Initiative (KDOQI) recommendations addressing when to refer vascular access for intervention. Education for patients at risk for access rupture is also discussed.

Figure 1
Complete Erosion of a Buttonhole Tunnel Due to a 3-Day-Old Infection Exposing Arteriovenous Fistula (AVF)

Source: Used with permission of Antoine Samaha, MD.

Literature Review

A review of the current literature identified risk factors other than those already mentioned. Surgeons Jaffers and Fasola (2012) described their experience with a group of 24 patients who presented with ulcerated, bleeding fistulas. They identified poor site rotation in all but two of these patients. Other risk factors included age greater than 50 years, limited length of the fistula, and two patients who died had experienced spontaneous bleeding episodes. Their recommendation is for urgent referrals for ulcers and aneurysm/pseudoaneurysm formation.

Pathologists Byard and James (2007) have described selected cases of FVAH in their report on a prospective study of 1380 adults from 47 centers in 16 European countries. There were 489 complications identified in a one-year period. Byard and James (2007) found that the predisposing factors for hemorrhage included coagulation abnormalities, stenosis, local sepsis, repeated trauma, and hypertension, and that grafts had four times the rate of thrombosis and six times the rate of hemorrhage compared to fistulas.

The New York Medical Examiner's office reviewed 100 cases of FVAH and identified the risk factors to be infection, age of the access, anticoagulation therapy, the type of access, and platelet dysfunction (Gill, Storck, & Kelly, 2012). A striking 81% of patients experienced their hemorrhage at home, and of those, 44% died in their homes. The remaining 19% of patients experienced access hemorrhage in nursing homes hospitals, and jails. Of these, 91% of the upper arm extremity accesses experienced FVAH.

Holden, Harman, Wang, Holland, and Day (2008) investigated major bleeding episodes in patients on hemodialysis, focusing on anticoagulants, warfarin and aspirin. They studied 255 patients to determine the incidence of major bleeding episodes. One half of the patients who experienced bleeding episodes were taking warfarin for access preservation. They suggested those bleeding episodes could have been eliminated by stopping this practice because they could find no evidence to support it.

Assessment of Vascular Access

Assessment of vascular accesses should include observation for infection, stenosis, and aneurysms and pseudoaneurysms.

Infection

Infection is a major risk when utilizing grafts as a vascular access. It is imperative that staff members recognize signs and symptoms of infection as early as possible so that antibiotics can be started to avoid full-blown sepsis. Infection can occur due to erosion of the skin caused by repeated cannulation in the same small area over grafts (Ryan, Calligaro, Scharff, & Dougherty, 2004).

While arteriovenous (AV) fistulas have the lowest infection rates of all hemodialysis accesses, the introduction of the buttonhole technique has seen a rise in infections over the last decade. An infected buttonhole site in which the entire upper buttonhole site has been completely eroded away over only three days is shown in Figure 1. This is a critical event because it has exposed the fistula, and the opening to the blood vessel wall is the weak spot where a rupture can occur.

Stenosis

Stenosis is a narrowing of a blood vessel that interferes with the flow of

blood. The stenosis restricts the outflow of blood, causing the blood to back up within the vascular access, thus increasing the pressure within the access. This higher pressure can cause extended bleeding times, and can be the final insult that causes the weakened area to rupture and cause a FVAH. When a patient is experiencing extended bleeding, stenosis must be ruled out by checking other parameters or clues that could indicate a venous system problem. For AV fistulas, the Arm Raise Technique is a quick, non-invasive tool that can immediately check for any venous drainage issues. To perform the Arm Raise Technique, have the patient elevate his or her arm. If the vessel flattens out, it is unlikely that a stenosis is present. However, if the proximal portion of the vessel flattens while the distal portion remains distended, this may be suggestive of a stenotic lesion at the point of the distention, restricting venous drainage.

One-Site-Itis (Aneurysm And Pseudoaneurysm)

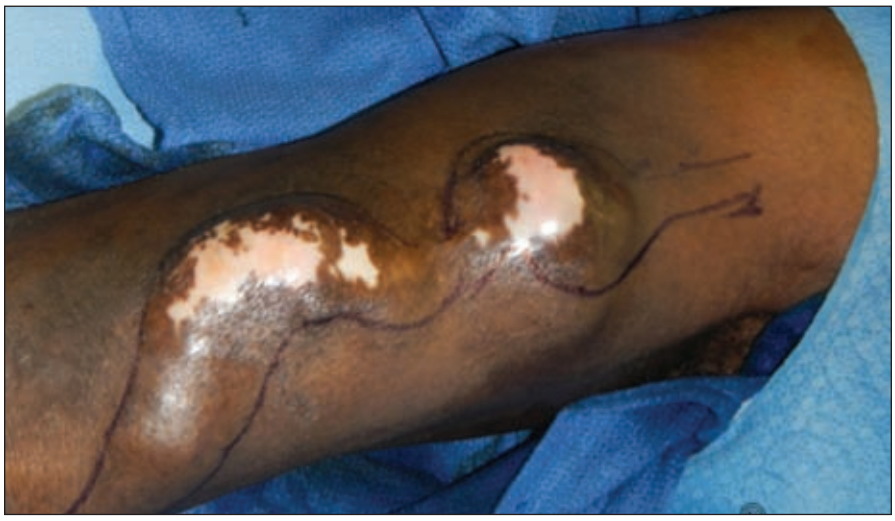
Some specific factors indicate that a patient's access may need referral for intervention to prevent either excessive bleeding or access rupture. Krönung (1984) compared site rotation, area puncture, and constant site (buttonhole) cannulation techniques and found that more aneurysms formed when staff cannulated using the area puncture technique. Vascular access assessment is a critical part of determining the possible need for referral for intervention because aneurysm formation has been identified as a risk factor for FVAH (Byard & James, 2007; Gill et al., 2012; Jaffers & Fasola, 2011; Saeed et al., 2011).

In the AV fistula shown in Figure 2, there is a color difference between the aneurysmic area in relation to the surrounding skin. As the aneurysm continues to expand, the wall of the fistula becomes thinner along with the skin over top of the aneurysmic area, producing the color change. In people of color, attention must be paid to the separation of pigment as the aneurysm enlarges and the skin becomes thinner (see Figure 3). In Figure 5, a bleeding ulceration has formed on top of the venous cannulation area where the pigment has separated. Any time there is leaking or bleeding from a puncture area (see Figure 5), it is a potential warning sign of impending rupture (Byard & James, 2007).

Figure 2
Assessment for Risk Factors

Source: Used with permission of Tushar Vachharajani and Fistula First Breakthrough Initiative (www.fistulafirst.org).

Figure 3
Depigmentation of the Skin Due to Tightly Stretched Aneurysms



Source: Used with permission of S. Shenoy, MD.

The aneurysm should also be observed to determine if it has become shinier than the surrounding tissue and appears to be stretched tight. It is important to determine if the aneurysm is soft or firm. This can be accomplished by holding the fingers of one hand together like a mit-

Figure 4
Brachiocephalic Arteriovenous (AV) Fistula with Skin Erosion at the Cannulation Sites

Source: Used with permission of Eric Peden, MD.

Figure 5
Ruptured Arteriovenous (AV) Fistula Ulcerated Site

Source: Used with permission of S. Glazer, MD.

ten and gently palpating the side of the aneurysm wall to determine if it is firm or soft – firm is an ominous finding. Aneurysms are often referred to with terms such as "ballooning out," and they are very similar to balloons. A balloon without any air is opaque and dull looking, but as air causes the balloon to expand, the surface or wall of the balloon begins to change from a dull to a shiny exterior as more air stretches the balloon. The increasing air starts to give the balloon shape. Initially, it is very soft and squeezable, but as more and more air fills the balloon, the wall becomes firmer and thinner. Too much air will eventually cause the balloon to burst, and that is exactly what will happen to an aneurysmic area that is shiny, tight, and firm to touch.

Another tool that can be utilized is to compare the original vessel diameter to the base of the aneurysmic area. If the diameter is more than three times the original diameter, then the access should be evaluated (Pasklinsky et al., 2011). Graft evaluation is the same; the skin should be observed for signs of erosion, infection, or any sloughing in the cannulation zone. For pseudoaneurysms, the skin serves as the pressure dressing for the enlarging hematoma, so it is common to see skin breakdown begin to occur. In the access shown in Figure 6, staff members have been cannulating in just two areas on a thigh graft. A stenosis, which caused increased pressure within the graft, caused the access to hemorrhage.

Staff members must not be allowed to become complacent about aneurysm and pseudoaneurysm formation because these formations should not be construed as "normal." Correct site rotation within the cannulation zone should cause the entire fistula to dilate evenly (Krönung, 1984). If aneurysms or pseudoaneurysms form, staff members may not be leaving a proper distance between cannulation sites, or the cannulation segment of the access is too short for site rotation. Too short a segment for cannulation should be discussed with the surgeon, and if there is no surgical alternative, the constant site cannulation technique might be an appropriate approach to consider.

The KDOQI Clinical Practice Guidelines (NKF, 2006) have identified criteria for when aneurysms and pseudoaneurysms should be referred for evaluation and intervention (see Table 1). One criteria for referral is the absence of another site for access cannulation. The KDOQI Guidelines are also very clear that an aneurysm or pseudoaneurysm should ***never*** be cannulated because of the high risk

Figure 6
Femoral Arteriovenous (AV) Graft Bleed from Repeated Cannulation in the Same Area and Increased Pressure in the Graft from a Stenosis

Source: Used with permission of Eric Peden, MD.

Table 1
National Kidney Foundation – Kidney Disease Outcomes Quality Initiative (KDOQI): When to Refer Aneurysms and Pseudoaneurysms for Intervention

When to Refer Aneurysms and Pseudoaneurysms
Aneurysms
Skin over the arteriovenous fistula (AVF) is compromised
Risk of fistula rupture
Available puncture sites are limited
Pseudoaneurysms
Greater than twice the diameter of the graft
Difficulty achieving hemostasis post treatment
Spontaneous bleeding from sites

involved: hemorrhage (a significant amount of blood loss), exsanguination (a fatal amount of blood loss), and death (NKF, 2006).

Documentation and Education

When an aneurysm is identified, it should be documented in the medical record. At this point, education for access care needs to begin with the patient and family members. Education should include prevention of further damage, signs and symptoms of infection, the importance of talking with the nephrologist and surgeon, and emergency response procedures.

Patient education is critical for patient survival post-rupture. There is no better way to educate patients than to have them practice, practice, practice. Patients need to understand the importance of learning to hold their own cannulation sites in their dialysis facilities so that it will be an automatic response to hold those sites at home, should bleeding occur. Reinforcement of practice needs to occur on a regular basis, such as monthly. The teach-back technique, in which the patient performs a return demonstration of what he or she would do should the access rupture, can be an effective strategy. This needs to begin immediately and be documented in the medical record. If the patient cannot do a return demonstration, the nurse should re-educate the patient and document the repetition.

Emergency Response

When an access ruptures, there will be a significant amount of blood loss. The patient needs to immediately apply direct pressure and elevate the ruptured area of the bleeding above the level of the heart, which makes it more difficult for the blood flow to reach the ruptured area due to gravity. Patients should be instructed to hold pressure on the access site for at least 10 minutes without peeking (Byard & James, 2007). This is an emergency situation. Patients must understand they should not take the time to look for gauze to place over the site – they need to get their fingers over the ruptured area and apply pressure immediately. Providers can prescribe antibiotic therapy for an infection that a patient may acquire while performing the potentially life-saving action of compressing a ruptured vascular access. It should also be emphasized to the patient to not wrap a towel around the bleeding site because this can serve as a wick, and the patient will lose more blood unnecessarily (see Figure 7). Too much blood volume loss will cause the patient to become unresponsive and possibly die.

After the bleeding has stopped, emergency physicians Larsen, Weathers, Schwartzwald, and Barton (2010) suggest observing the patient for an additional 1 to 2 hours for any recurrence of bleeding. They identified that a pattern of post-dialysis bleeding for more than 15 to 30 minutes can provide a clue to identify those patients on hemodialysis who are at increased risk for bleeding.

If bleeding does not stop, or if it is obvious that the bleeding cannot be controlled, the patient or anyone else present should call 911 immediately. There is no agreement among surgeons as to whether or not patients should be taught to apply a tourniquet for a ruptured access. Some believe that fingers placed directly in the rupture would be sufficient to stop bleeding. One potential drawback would be giving a tourniquet to a patient and it is put it away "somewhere." The patient may try to find the tourniquet in an emergency instead of applying direct pressure and elevating the extremity. Several trauma surgeons with whom the author spoke are concerned that tourniquet application could result in complete loss of limb, which might not have otherwise occurred. One suggestion would be to evaluate patients carefully to see if they would be able to apply a tourniquet correctly. It might be prudent to teach patients who have a high pressure/high flow access, as well as those who live alone, to apply a tourniquet (see Figure 8).

Implications for Nephrology Nurses

Nephrology nurses should evaluate vascular access assessment procedures in their dialysis facilities to ensure that patients whose accesses might be at risk for rupture are referred in a timely manner for evaluation and intervention. It is critical that cannulation, which has been delegated to patient care technicians, is done according to established policies and procedures to prevent damage to vascular access walls or the tissue within the cannulation zone.

The burden of educating staff and patients falls squarely on nephrology nurses. Now that there is more information about risk factors, there should be specific evaluation for FVAH with regular education for patients and their families (Blake, Quinn, & Oliver, 2012; Vincenti, Aronica-Pollack, Sharfstein, & Fowler, 2007).

Finally, CDC Epidemiologist Matt Arduino (n.d.) has stressed the need to follow established standards

Figure 7
Wicking Effect of Wrapping a Towel Around a Ruptured Vascular Access

Source: Used with permission of Marek Rawa, MD.

Figure 8
Vascular Access Hemorrhage with Tourniquet Application

Source: Used with permission of Marek Rawa, MD.

and practices that can be obtained from the American Nephrology Nurses' Association (ANNA) (Gomez, 2011). Incorporating vascular access issues into a facility's Quality Assurance Performance Improvement (QAPI) program can keep the entire healthcare team on top of any potential risk factors.

Culture of Safety

Glickman (2012) discussed the need for a culture of safety with respect to FVAH and has described three goals that the renal community should embrace. The first goal is to prevent FVAH from occurring – this is something about which we need to be proactive, not reactive. The second goal is to ensure that safety extends beyond the dialysis facility because the majority of incidents occur outside of the dialysis facility. The third goal is to develop an organized safety program in which there is appropriate staffing to monitor the vascular access program and to ensure that staff members are following the organization's policies and procedures.

Conclusion

This article has addressed many reasons behind vascular access rupture. A good number of these issues can be managed with better assessment and cannulation techniques. The renal community alert issued by the Maryland Department of Health and Mental Hygiene (n.d.) indicated that some deaths may have been preventable, and encouraged the renal community to provide ongoing education to both patients and staff. Because patients can lose a significant amount of blood in a very short time, the education provided by patient care staff can literally be a lifesaver. We must do a better job of identifying patients at high risk for FVAH to reduce the risk and ensure that patients have the knowledge of what to do in the event their access ruptures.

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