A disadvantage of cryopreserved grafts is that they can “sensitize” a patient. Transplantation of any allograft tissue can induce initial cryopreserved graft cost is considerably more expensive. V

Formation is intended to help clinicians become aware of new scientific findings and developments. This resource is not intended to define a standard

FUTURE AV SITES.

Allograft Placement

CARE AFTER CRYOPRESERVED ALLOGRAFT PLACEMENT

Convalution of cryopreserved allografts is possible 10-14 days after placement, and any swelling should subside within 4-6 weeks.

www.lakareol.com

DISCLAIMER

Information contained in the National Kidney Foundation educational resource is based upon current data available at the time of publication. Infor-
nation is intended to assist healthcare providers in their daily decisions. This resource is not intended to replace standard care and should not be construed as such. Neither should the information be interpreted as providing a written course of management. Treatment decisions in every patient will depend on individual patient circumstances, patient preferences, available resources, and limitations unique to each institution and/or practice setting. Healthcare professionals should use the information responsibly for understanding the data and apply it to clinical decision-making in each individual patient.

Made possible through an educational grant from:

References


17. Nassef MM, Fixler DE, Shea D. Could infection of old nonfunc-

18. World Health Organization. Clean Care is Safer Care. Available at: http://www.who.int/gpsc/5may/


25. Multicenter data on file at CryoLife, Inc. (ML0101).


33. Multicenter data on file at CryoLife, Inc. (ML0101).
AVG ACCESS: DEMOGRAPHIC AND INFECTION RISK

Approximately 95% of US hemodialysis patients dialyze with AVGs—the second choice for vascular access after hemodialysis. Primary reasons for using AVGs include insufficient venous access, absence of cephalic vein (AV), radial AV, and graft failure to mature. In general, dialysis patients have high risk of AVG infection due to considerations such as prolonged hospitalization, cardiovascular disease, and diabetes. As the proportion of elderly patients accessing dialysis increases, the AVG infection risk also increases.

The major cause of infection is bloodstream infection, but infection is also common, affecting 9% to 10% of grafts. Primary graft infection rates are usually low because dialysis patients have a lower serum albumin level (albumin <3.5 mg/dL)—a well-known risk factor for infection. Another characteristic is occult infection of soft-tissue grafts, which has been linked to many chronic infections like diabetes. AVG infection results in multiple vascular access procedures and prolonged dependence on central venous catheters (CVCs). Costs incurred overall, including hospital stays, increased drainage, and other in-hospital resources.

Risk of infection associated with AVGs includes insufficient anticoagulation, improper technique, and improper technique. Prevention includes critical vascular access assessments. Strict dialysis precautions and aseptic technique are important for managing AVG infection in select hemodialysis patients. There are 2 methods for treating infected AVGs—cryopreserved allografts or AVG infection management is a balance between resolving the infection and the associated risk of the cryopreserved graft in the thigh position. The infection rates were compared between patients treated with cryopreserved AVGs and those treated with AVGs. The authors conclude that the infection rates in the cryopreserved AVG group were lower than those in the AVG group.

PREVENTION AND MANAGEMENT

Infection prevention is critical for vascular access maintenance. Distinct dialysis practices and patient characteristics are important as we are preventing and managing access infection. The World Health Organization recommends washing hands as follows:

1. Wet hands
2. Apply soap
3. Rub hands together
4. Rub between fingers
5. Rub back of hands
6. Clean under nails
7. Rinse hands
8. Dry hands
9. Hand dryers

AVG infection management is a balance between resolving the infection while preserving the vascular access of the future.

Total removal of infected AVGs and placement of a new device at a new site may be required. This involves placement of a temporary dialysis catheter until the infection is resolved and results in the original graft site. Because permanent access site are well used, AVG infection management is a balance between resolving the infection and the associated risk of the cryopreserved graft in the thigh position. The infection rates were compared between patients treated with cryopreserved AVGs and those treated with AVGs. The authors conclude that the infection rates in the cryopreserved AVG group were lower than those in the AVG group.

CYPHERPRESERVED ALLOGRAFT

Cryopreserved allografts are cryopreserved arterial and venous tissue (Figure 1). Cryopreserved allografts are an option for treating infected hemodialysis AVGs. All grafts have been implated retrogradely or directly into the infected field using the same anatomic region, thus using other fields for cryopreserved allografts in the thigh position. The infection rates were compared between patients treated with cryopreserved AVGs and those treated with AVGs. The authors conclude that the infection rates in the cryopreserved AVG group were lower than those in the AVG group.

ALLOGRAFT METHOD VS. GRAFT EXTENSION METHOD

There are 2 methods for treating infected hemodialysis AVGs—cryopreserved allograft and the graft extension method. The graft extension method is generally used to manage a synthetic graft infection. The graft extension method involves suturing the infected AVG and placing the cryopreserved allograft in the same infected site. The infected AVG is removed and a new AVG is placed in a different site. The authors conclude that the infection rates in the cryopreserved AVG group were lower than those in the AVG group.

EVIDENCE-BASED BENEFITS AND RISKS RELATED TO CRYOPRESERVED ALLOGRAFT

Cryopreserved allografts were used as an alternative dialysis access to treat AVG graft infections. Fifty-four cryopreserved allografts were placed in 38 patients. There was no recurrent infection in those treated for infections and 2 cases of aneurysmal degeneration near the puncture access site within 6 months after the AVG was implanted. The authors reported that there were no infections in any of the cryopreserved AVG vein patients in an acceptable graft conduit in the presence of AVG infection. The infection rates in the cryopreserved AVG group were lower than those in the AVG group.

CONSEQUENCES OF AVG INFECTION

AVG infection management is a balance between resolving the infection and the associated risk of the cryopreserved graft in the thigh position. The infection rates were compared between patients treated with cryopreserved AVGs and those treated with AVGs. The authors conclude that the infection rates in the cryopreserved AVG group were lower than those in the AVG group.

TABLE 1. ALLOGRAFTS FOR TREATING AVG INFECTIONS: RE-INFECTION RATES

<table>
<thead>
<tr>
<th>AVG Type</th>
<th>Patients Treated</th>
<th>Cryopreserved Allografts</th>
<th>AVGs</th>
<th>Re-Infection Rates</th>
<th>Follow-Up Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femoral Vein</td>
<td>Lin et al. 23</td>
<td>35</td>
<td>0%</td>
<td>12 months</td>
<td></td>
</tr>
<tr>
<td>Metzger et al. 41</td>
<td>38</td>
<td>2.5%</td>
<td>2 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metzler et al. 42</td>
<td>32</td>
<td>2%</td>
<td>3 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bolivar et al. 37</td>
<td>4</td>
<td>14%</td>
<td>13 months</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Infection rate: number of patients treated for active AVG infection/total number of patients treated.

---

The cryopreserved allograft has been shown to be effective in the treatment of AVG infections. The infection rates were compared between patients treated with cryopreserved AVGs and those treated with AVGs. The authors conclude that the infection rates in the cryopreserved AVG group were lower than those in the AVG group.

---

The cryopreserved allograft has been shown to be effective in the treatment of AVG infections. The infection rates were compared between patients treated with cryopreserved AVGs and those treated with AVGs. The authors conclude that the infection rates in the cryopreserved AVG group were lower than those in the AVG group.

---

The cryopreserved allograft has been shown to be effective in the treatment of AVG infections. The infection rates were compared between patients treated with cryopreserved AVGs and those treated with AVGs. The authors conclude that the infection rates in the cryopreserved AVG group were lower than those in the AVG group.

---

The cryopreserved allograft has been shown to be effective in the treatment of AVG infections. The infection rates were compared between patients treated with cryopreserved AVGs and those treated with AVGs. The authors conclude that the infection rates in the cryopreserved AVG group were lower than those in the AVG group.

---

The cryopreserved allograft has been shown to be effective in the treatment of AVG infections. The infection rates were compared between patients treated with cryopreserved AVGs and those treated with AVGs. The authors conclude that the infection rates in the cryopreserved AVG group were lower than those in the AVG group.

---

The cryopreserved allograft has been shown to be effective in the treatment of AVG infections. The infection rates were compared between patients treated with cryopreserved AVGs and those treated with AVGs. The authors conclude that the infection rates in the cryopreserved AVG group were lower than those in the AVG group.

---

The cryopreserved allograft has been shown to be effective in the treatment of AVG infections. The infection rates were compared between patients treated with cryopreserved AVGs and those treated with AVGs. The authors conclude that the infection rates in the cryopreserved AVG group were lower than those in the AVG group.

---

The cryopreserved allograft has been shown to be effective in the treatment of AVG infections. The infection rates were compared between patients treated with cryopreserved AVGs and those treated with AVGs. The authors conclude that the infection rates in the cryopreserved AVG group were lower than those in the AVG group.

---

The cryopreserved allograft has been shown to be effective in the treatment of AVG infections. The infection rates were compared between patients treated with cryopreserved AVGs and those treated with AVGs. The authors conclude that the infection rates in the cryopreserved AVG group were lower than those in the AVG group.

---

The cryopreserved allograft has been shown to be effective in the treatment of AVG infections. The infection rates were compared between patients treated with cryopreserved AVGs and those treated with AVGs. The authors conclude that the infection rates in the cryopreserved AVG group were lower than those in the AVG group.

---

The cryopreserved allograft has been shown to be effective in the treatment of AVG infections. The infection rates were compared between patients treated with cryopreserved AVGs and those treated with AVGs. The authors conclude that the infection rates in the cryopreserved AVG group were lower than those in the AVG group.

---

The cryopreserved allograft has been shown to be effective in the treatment of AVG infections. The infection rates were compared between patients treated with cryopreserved AVGs and those treated with AVGs. The authors conclude that the infection rates in the cryopreserved AVG group were lower than those in the AVG group.

---

The cryopreserved allograft has been shown to be effective in the treatment of AVG infections. The infection rates were compared between patients treated with cryopreserved AVGs and those treated with AVGs. The authors conclude that the infection rates in the cryopreserved AVG group were lower than those in the AVG group.

---

The cryopreserved allograft has been shown to be effective in the treatment of AVG infections. The infection rates were compared between patients treated with cryopreserved AVGs and those treated with AVGs. The authors conclude that the infection rates in the cryopreserved AVG group were lower than those in the AVG group.

---

The cryopreserved allograft has been shown to be effective in the treatment of AVG infections. The infection rates were compared between patients treated with cryopreserved AVGs and those treated with AVGs. The authors conclude that the infection rates in the cryopreserved AVG group were lower than those in the AVG group.

---

The cryopreserved allograft has been shown to be effective in the treatment of AVG infections. The infection rates were compared between patients treated with cryopreserved AVGs and those treated with AVGs. The authors conclude that the infection rates in the cryopreserved AVG group were lower than those in the AVG group.
AVG ACCESS: DEMOGRAPHIC AND INFECTIOUS RISK

Approximately 95% of US hemodialysis patients dialyze with an AVG or another type of vascular access device. Many patients require AVGs for hemodialysis. The primary reason for using AVGs includes insufficient venous vasculature for an AV fistula (AVF), failed AVF, and failed fistulae. In general, dialysis patients have a high rate of AVG donation because they are considered as susceptible patients and have cardiovascular diseases. Also the proportion of elderly patients as access donors increases, therefore the AVG usage increases. The major complications are thrombosis, but infection is also common, affecting 5% to 20% of grafts. Primary graft infections are usually due to bacterial, whereas secondary infections are usually due to fungal or viral. The risk of bacterial infection is highest during the first 6 months. Biofilms make the resident microbes resistant to both natural and pharmacologic defenses.9 The incidence of AVG infection in dialysis patients is from 9% (forearm) to 20% (thigh).6 While this is significantly lower than AVF, AVG infection is the most common AVG-related infection. The risk of infection associated with AVGs includes insufficient anti-thrombosis therapy, which increases the risk of AVG-related infection.17 One month prior to AVG infection, many patients may have severe coagulation level (PLT <100,000)—well known medical risk factors. Another conclusion is occult infection of soft-surfacing AVGs, which has been linked to patient infection. The duration of the infection ranges from 6 weeks to 12 months after the AVG was implanted. The researchers reported that cases of AVG infection were treated by removing the infected AVG vein as an acceptable graft conduit in managing prosthetic AVG infection.10,11 (Table 1)

In a prospective study, Matsuura et al. evaluated the use of cryopreserved femoral vein grafts as an alternative AVG access.10 Prosthetic AVG graft infection is associated with morbidity and mortality.10 Sepsis with metastatic infection has been linked to patient mortality.6, 10, 11

AVG infection management is a balance between resolving the infection and salvaging the AV access site. The cryopreserved allograft is useful in managing sites of AVG infection that are not salvageable. The cryopreserved allograft is cryogenically preserved cadaver arteries and veins used for AVG salvage. The cryopreserved allograft is implanted in the infected AVG site. The cryopreserved femoral vein AVG infection may be salvaged using the cryopreserved femoral vein. There are significant differences in infection rates. The cryopreserved femoral vein AVG infection was lower than the AVG infection. The authors concluded that because of the relative resistance to infection, the cryopreserved femoral vein AVG grafts are an alternative. The cryopreserved femoral vein AVG graft site might otherwise be lost to future angioaccess.10 (Table 1)

In another study by Matsuura and colleagues, 30 cryopreserved femoral vein AVG grafts were placed in patients with AVG infection. The cryopreserved femoral vein AVG grafts were placed in 30 patients. The authors concluded that because of the relative resistance to infection, the cryopreserved femoral vein AVG grafts are an alternative. The cryopreserved femoral vein AVG graft site might otherwise be lost to future angioaccess.10 (Table 1)

TABLE 1. ALLOGRAFTS FOR TREATING AVG INFECTIONS: RE-INFECTION RATES

<table>
<thead>
<tr>
<th>Allograft Type</th>
<th>Patients Treated for AVG Infection</th>
<th>Re-Infection Rate</th>
<th>Follow-Up Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cryopreserved Femoral Vein</td>
<td>35</td>
<td>0%</td>
<td>1 year</td>
</tr>
<tr>
<td>Matsuura et al.</td>
<td>38</td>
<td>2%</td>
<td>1 year</td>
</tr>
<tr>
<td>Matsuura et al.</td>
<td>42</td>
<td>2%</td>
<td>3 years</td>
</tr>
<tr>
<td>Bolshov et al.</td>
<td>4</td>
<td>1%</td>
<td>13 months</td>
</tr>
</tbody>
</table>

*Infection risk of patients treated for AVG infection is not available. Data reported is based on location of allograft placement only.

EVIDENCE-BASED BENEFITS AND RISKS RELATED TO CRYOPRESERVED ALLOGRAFT

Liu et al. reviewed the use of cryopreserved allografts as an alternative AVG access to treat AVG graft infections. Fifty-five cryopreserved allografts were placed in 30 patients. Infection was present in 30 patients. There was no recurrent infection in 30 patients treated for effective 2 cases of aneurysmal degeneration over the mean follow-up of 12 months after the AVG grafts were implanted. The researchers reported that cases of AVG infection were treated by removing the infected AVG vein as an acceptable graft conduit in managing prosthetic AVG infection.10,11 (Table 1)

In another study by Matsuura and colleagues, 30 cryopreserved femoral vein AVG grafts were placed in patients with AVG infection. The cryopreserved femoral vein AVG grafts were placed in 30 patients. The authors concluded that because of the relative resistance to infection, the cryopreserved femoral vein AVG grafts are an alternative. The cryopreserved femoral vein AVG graft site might otherwise be lost to future angioaccess.10 (Table 1)

In a prospective study, Matsuura et al. evaluated the use of cryopreserved femoral vein grafts as an alternative AVG access.10 Prosthetic AVG graft infection is associated with morbidity and mortality.10 Sepsis with metastatic infection has been linked to patient mortality.6, 10, 11

AVG infection management is a balance between resolving the infection and salvaging the AV access site. The cryopreserved allograft is useful in managing sites of AVG infection that are not salvageable. The cryopreserved allograft is cryogenically preserved cadaver arteries and veins used for AVG salvage. The cryopreserved allograft is implanted in the infected AVG site. The cryopreserved femoral vein AVG infection may be salvaged using the cryopreserved femoral vein. There are significant differences in infection rates. The cryopreserved femoral vein AVG infection was lower than the AVG infection. The authors concluded that because of the relative resistance to infection, the cryopreserved femoral vein AVG grafts are an alternative. The cryopreserved femoral vein AVG graft site might otherwise be lost to future angioaccess.10 (Table 1)

In another study by Matsuura and colleagues, 30 cryopreserved femoral vein AVG grafts were placed in patients with AVG infection. The cryopreserved femoral vein AVG grafts were placed in 30 patients. The authors concluded that because of the relative resistance to infection, the cryopreserved femoral vein AVG grafts are an alternative. The cryopreserved femoral vein AVG graft site might otherwise be lost to future angioaccess.10 (Table 1)

In a prospective study, Matsuura et al. evaluated the use of cryopreserved femoral vein grafts as an alternative AVG access.10 Prosthetic AVG graft infection is associated with morbidity and mortality.10 Sepsis with metastatic infection has been linked to patient mortality.6, 10, 11

AVG infection management is a balance between resolving the infection and salvaging the AV access site. The cryopreserved allograft is useful in managing sites of AVG infection that are not salvageable. The cryopreserved allograft is cryogenically preserved cadaver arteries and veins used for AVG salvage. The cryopreserved allograft is implanted in the infected AVG site. The cryopreserved femoral vein AVG infection may be salvaged using the cryopreserved femoral vein. There are significant differences in infection rates. The cryopreserved femoral vein AVG infection was lower than the AVG infection. The authors concluded that because of the relative resistance to infection, the cryopreserved femoral vein AVG grafts are an alternative. The cryopreserved femoral vein AVG graft site might otherwise be lost to future angioaccess.10 (Table 1)

In another study by Matsuura and colleagues, 30 cryopreserved femoral vein AVG grafts were placed in patients with AVG infection. The cryopreserved femoral vein AVG grafts were placed in 30 patients. The authors concluded that because of the relative resistance to infection, the cryopreserved femoral vein AVG grafts are an alternative. The cryopreserved femoral vein AVG graft site might otherwise be lost to future angioaccess.10 (Table 1)
AVG ACCESS: DEMOGRAPHICS AND INFECTION RISK

Approximately 95% of US hemodialysis patients dialyze with AVGs—the second choice in the order of preference for hemodialysis. The primary reasons for using AVGs include insufficient venous access available in localized sites (AVF), failed AVF, or failure to mature. In general, dialysis patients have a high rate of AVG infection because they are susceptible to coagulase-negative staphylococci and Staphylococcus aureus with the potential for enteric organism contamination. For this reason, non-AVF access is a prime risk factor for infection—the second most common—after clean/aseptic procedures, until the new AVG is ready for cannulation. Thirty-five percent of patients losing AVGs were history of multiple infections, number of surgical revisions, diabetes are more prone to infection and poor wound healing.

The major AVG complication is thrombosis, but infection is also common. Effecting 9% to 20% of grafts. Primary AVG infection results in multiple vascular-access procedures and prolonged dependence on central venous catheter (CVC). Costs incurred were substantial, including hospital stays, equipment, medications, and travel to hospital personnel. Strive to decrease graft infection would have a positive impact on the morbidity and substantial costs associated with vascular access infections.

RISKS AND CLINICAL CONSEQUENCES OF AVG INFECTION

Non-AVF access is a risk factor for infection—the second leading cause of death in hemodialysis patients. The syphilitic is often referred to as CVC, it is chronic and potentially life-threatening. The incidence of AVG infections is from 0 to 3.0% at 2 weeks. While this is a significantly lower than the central venous catheter (CVC), it is twice the common incidence of active infection (infection rate 1-2.5%); AVG is a common cause of graft failure, accounting for 35% of patients losing AVGs. Risk of infection associated with AVGs is multifactorial and related to surgical technique, surgeon experience, and patient factors. Patient factors include age, diabetes, the presence of active infection, smoking, and other medical conditions. Patient age is a risk factor for AVG infection. In the Multicenter Data 22 study, cryopreserved allografts were used in 38 patients; infection recurrence was low, cryopreserved femoral vein grafts in the thigh position was 1.3% (9/14), this study suggests that the routine use of the cryopreserved femoral vein graft in the thigh position should be avoided. The authors concluded that the use of cryopreserved femoral vein graft in end-implant infection of AVG should be considered if alternative sites for AVG placement are unavailable.
A disadvantage of cryopreserved grafts is that they can “hypo-sensitize” a patient. Transplantation of any allograft tissue can induce an immunological response in the recipient. The possibility that a patient may develop antibodies after allograft tissue transplantation should be considered for any patient who might be a future recipient of allograft tissue, organs, or cells. Therefore, cryopreserved grafts should not be used for hemodialysis access in potential kidney transplant recipients.25

Other advantages and disadvantages of cryopreserved grafts to consider include prevalence, complications, and cost. Studies show that compared to PTFE grafts, cryopreserved grafts have similar patency, are more resistant to infection, are significantly more susceptible to aneurysms. The researchers concluded that cryopreserved allografts should be considered for any patient who might be a future recipient of allograft tissue, organs, or cells. Therefore, cryopreserved grafts should not be used for hemodialysis access in potential kidney transplant recipients.25

A qualitative patient should perform a physical examination and visualize the infected AVG at least monthly. The 3 preferred surveillance techniques for stenosis of AVGs are: 1) intraarterial pressure assessment; 2) direct measurement or derived static venous dialysis; or 3) duplex ultrasound. Other acceptable techniques include physical findings of persistent swelling of the arm, presence of collateral veins, protruding fistula above the elbow, or absence characteristics of a pulse in the AVG. Standardized dynamic pressure values should be used.26

REFERENCES

10. Multicenter data on file at CryoLife, Inc. (ML0101).
22. Multicenter data on file at CryoLife, Inc. (ML0101).
CARE AFTER CRYOPRESERVED ALLOGRAFT PLACEMENT

Contraindication of cryopreserved allografts is possible 10-14 days after placement, and therefore being unable to establish sternal closure can lead to later complications. The postoperative period may be prolonged due to the increased complexity of the surgical technique. The rate of infection varies among centers and is dependent on the patient's underlying health status.

A disadvantage of cryopreserved grafts is the need to "sterilize" a patient. Transplantation of any allograft tissue can induce an immune response in the recipient. The possibility that a patient may develop antibodies after allograft tissue transplantation should be considered for any patient who might be a future recipient of allograft tissue, organs, or cells. Therefore, cryopreserved grafts should be used with caution to mitigate allergy risk in potential kidney transplant recipients.

Other advantages and disadvantages of cryopreserved grafts to consider include price, availability, and cost. Studies show that compared to PTFE grafts, cryopreserved grafts have similar patency and are less prone to infection, but significantly more susceptible to aneurysms. The researchers concluded that cryopreserved allografts should be monitored aggressively for the development of aneurysms. Regarding cost, the initial cost of graft development is considerably more expensive than PTFE grafts. Cost performance, average hospital stay, and overall hospital cost should be considered to determine if cryopreserved grafts using the allograft method may be a cost-effective means of treating infected AVGs.

The ALLOGRAFT METHOD PRESERVES THE VASCULAR ACCESS AND SAVES POTENTIAL FUTURE AV SITES.

The ALLOGRAFT METHOD PRESERVES THE VASCULAR ACCESS AND SAVES POTENTIAL FUTURE AV SITES.

Incepted Arteriovenous Graft (AVG) Access for the Hemodialysis Patient

REFERENCES