Chapter

Contemporary and Evolving Treatment of Tricuspid Endocarditis

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Abstract

The current treatment paradigm for right sided infective endocarditis is rapidly evolving. The existing recommendations for right sided infective endocarditis include medical therapy with surgical therapy used in certain situations. Surgical therapy is based on the size of the vegetation, presence of infective complications and certain causative organisms as well the retention of intracardiac devices. Unfortunately, medical therapy alone is usually not enough to clear the infection, especially when intravenous drug use is associated as the etiology. Intravenous drug use is associated with a high rate of recidivism in tricuspid valve endocarditis. Even with indications for surgery, these patients present an ethical dilemma as most of these patients will re-infect their valves post-surgery. This often provides little option than for the surgeon to re-operate in a setting with a higher risk of mortality and morbidity. We present an evolving technique of percutaneous extirpation of vegetation, allowing for rapid clearance of endocarditis, less chance of failure of medical therapy with a lower risk profile for complication.

Keywords: tricuspid endocarditis, percutaneous treatment, cardiac implantable device endocarditis, CIDE, extirpation

1. Introduction

Endocarditis is defined as inflammation of the inner layer of the endocardium, usually involving the heart valves and or chambers of the heart, the valves being more commonly affected than the heart chambers [1]. Endocarditis is further categorized into non-bacterial thrombotic endocarditis (NBTE) or noninfectious endocarditis, and infectious endocarditis (IE) [2]. NBTE is rare and associated with malignancy and chronic inflammatory states such as systemic lupus erythematosus, rheumatoid arthritis, ANCA-vasculitis, burns, and sepsis [2, 3]. Conversely, IE is more common, with annual incidence of 3–10 cases per 100,000 people [4, 5]. It occurs due to bacterial and less commonly due to fungal infections [1, 4, 5]. *Staphylococcus aureus* is now the leading cause of IE, accounting for about 26.6% of all cases [4]. Staphylococci, streptococci (including the viridans group) and enterococci comprise about 80–90% of all cases of IE [4, 5]. The other 10–20% of cases are due culture negative endocarditis and fastidious organisms such bartonella species, brucella species, *Coxiella burnetii*, haemophilus species, *Aggregatibacter actinomycetenomitans*, *Cardiobacterium hominis*, *Eikenella corrodens*, *Kingella kingae*

and *Tropheryma whipplei* [5]. Endocarditis is characterized by lesions, known as vegetations. These vegetations follow endocardial injury where platelets and fibrin form a nidus which becomes secondarily infected by microorganisms circulating in the blood. (1) Endocarditis can involve both the right and left side of the heart and often can have differing causative organisms and etiologies. Left sided endocarditis can involve the aortic valve, mitral valve and in severe cases can involve the aorto-mitral curtain causing damage to the electrical structures of the heart. Right sided endocarditis typically involves the valvular structures on the right side of the heart most commonly the tricuspid valve and less often the pulmonary valve. In addition, the right sided endocarditis may also involve foreign bodies that are typically found transversing the right atrium such as pacemaker leads, central lines.

2. Right sided infective endocarditis

Right sided Infective Endocarditis (RSIE) accounts for about 10% of all IE cases [6]. Typically, these patients are younger with fewer medical comorbidities and less underlying valve disease as compared to patients with left-sided IE [6]. RSIE involves both tricuspid valve endocarditis (TVE) and cardiac implantable device endocarditis (CIDE). RSIE is most frequently seen with intravenous drug use (IVDU). Other predisposing risk factors include use of central venous catheters, cardiovascular implanted electronic devices, congenital heart disease, prosthetic heart valves, and end-stage renal disease on hemodialysis [5, 6]. Mortality rate of RSIE is typically 5–15% [6]. The risk factors and independent predictors of death are age, *Staphylococcus aureus* infection, heart failure, embolic events and health care-associated IE [5].

2.1 Tricuspid valve endocarditis

2.1.1 Epidemiology

Ninety percent of RSIE involves the tricuspid valve, of which infection resulting from intravenous drug use (IVDU) constitutes approximately 30–40% of all tricuspid valve endocarditis cases. The incidence of tricuspid lesions in IVDU is approximately 50–65%, with a prevalence of about 2–5% per year [6]. With ongoing IVDU, IE reoccurs in about 28% of cases due to prior damage or replacement of the valve [6]. *Staphylococcus aureus* is the predominant causative organism in TVIE, just as in all types on of IE [4, 6]. The opioid epidemic over the last several years has seen an increase in patients with IVDU as subsequently an increase in TVE. Heroin abuse has more than doubled over the past decade along with TVE during the same period. A study by Wallen et al. showed a fivefold increase in surgical volume for tricuspid endocarditis from 2011 to 2017. In addition, the average age of patients seemed to decrease from 52.85 +/−19.6 years to 39.2 +/−12.9 over the same five-year period [7]. In addition, multiple other studies have reported an increase in tricuspid-related IE corresponding to an increase in IVDU during the same period [8–10].

2.1.2 Treatment and prognosis

As a whole, RSIE carries a good prognosis. TVIE clears in 70–85% of cases with antibiotic treatment alone. Non-operatively treated TVIE carries an in-hospital mortality of 7–11% [6]. Non operative treatment typically consists of 4–6 weeks of intravenous antibiotics. However, approximately 5–16% cases of RSIE will require surgical intervention [6]. Indications and timing for surgery are less clear

for RSIE than for left-sided infectious endocarditis (LSIE). According to the most recent AHA/ACC guidelines, surgery for native RSIE is indicated for patients with antibiotic failure, multi-drug-resistant organisms, tricuspid vegetations greater than 2 cm, embolic complications, or right-sided heart failure with poor response to diuretics [11, 12]. Most patients with infected prosthetic TV will require surgery, except in patients with unacceptable intra-operative mortality risk [6]. Surgery is less often performed for TV regurgitation due to IE, as it is more amendable to medical management and unlike aortic or mitral valve regurgitation, most patients can tolerate TV regurgitation up to a certain period [6]. Patients with isolated TVIE have an operative mortality between 0 and 15% and excellent survival. The post-surgical in-hospital mortality for TVIE is less than 10% and long term post-surgical mortality for TVIE is less than 15%, but increased in the presence of additional risk factors such as continued intravenous drug abuse, hemodialysis, valve replacement, *S. aureus*, and vegetation greater than 20 mm [6].

2.1.3 Current surgical options

Over the years, various surgical options have been used in TVIE. Surgical options range from valve repair or replacement to the removal of the tricuspid valve leaflets and chordae tendinae without replacement (valvectomy). Valvectomy, essentially commits the patient to require surgical repair, but has been used with success to temporize a patient while fighting ongoing systemic infection [6]. According to a systematic review by Luc et al., the post-operative 30-day mortality, right heart failure, and recurrent endocarditis was the same with valvectomy compared to surgical valve replacement for endocarditis but with a slightly higher non-significant trend towards higher postoperative right heart failure and 30-day mortality [13]. Tricuspid reoperation rate, however, was higher in valvectomy (56%) versus valve replacement (14%) in addition to an increased likelihood of prolonged ventilation (40% vs. 26%) in the valvectomy group [13].

Tricuspid valvectomy can be a feasible option in patients with active ongoing IVDU, normal pulmonary pressure, normal biventricular heart function, high degree of valvular destruction and high risk of reoperation, recidivism and recurrence for infection [13, 14]. Valvectomy with valve replacement as a staged procedure can allow patients to self-select in terms of their ability to maintain adequate follow-up, undergo detoxification and drug rehabilitation, optimize their social and financial situation, and demonstrate abstinence from IVDU prior to tricuspid valve replacement. However, valvectomy is largely falling out of favor due to the potential of severe right heart failure and the ventricularization of right atrial pressures [13, 15]. In patients with normal heart function pre valvectomy, severe right heart failure with symptoms of peripheral edema and ascites can occur within 6–9 months post valvectomy [6]. Therefore, patient with elevated pulmonary artery pressure are therefore not candidates for complete valvectomy [6].

The preferred surgical procedure is that of repair, particularly because it adheres to the basic principles cited for the successful surgical treatment of infective endocarditis. These include aggressive and extensive debridement of vegetations; correction of defects that have developed; use of autologous tissue to avoid implantation of artificial material [13, 16]. Most centers will prioritize valve repair prior to valve replacement or valvectomy [13].

2.1.4 Valve choice with replacement

Both bioprosthetic valves and mechanical valves have been used for valve replacement in TVIE. The gold standard anticoagulation after mechanical valve

replacement is warfarin. Warfarin is can be difficult to manage as levels are dependent on patients' variable vitamin K intake and requires frequent monitoring. Furthermore, problems with compliance with monitoring and anticoagulation therapy is more frequently seen in patients with IVDU and this population is also the most common to present with recurrent right-sided endocarditis and require surgery for valve replacement. With bioprosthetic valve replacement, only first three months of anticoagulation after replacement are required to prevent thrombosis, although this practice itself can be variable [17, 18]. This time frame allows for reendothelialization to the suture zone [17]. Due to decreased duration of anticoagulation, bioprosthetic valves are associated with lower rates of bleeding complications [19].

Another advantage of bioprosthetic valve replacement compared to mechanical valve, is the thrombosis risk. Obstruction of the tricuspid mechanical prosthesis due to thrombosis is 20 times more frequent than left-sided prosthetic valve thrombosis [17]. This is likely due to low flow state of the right heart compared to the left. Lastly, Patients with bioprosthetic valve replacement are still candidates for pacemaker and ICD placement as compared to mechanical valves [6]. Similarly, embolic events are more common with mechanical valves [19]. Ergo, prosthetic valve replacement may be a better option from this perspective. Mechanical tricuspid valve replacement may be beneficial from the durability perspective as they last longer than bioprosthetic valves [6, 19]. Previously average failure time for tricuspid bioprosthetic valve was 7 years [19]. However, the durability of new bioprosthetic valves have improved over the years as recent data suggest no difference in long term data between bioprosthetic and mechanical valves at 15 years [20]. Additionally, mitral homografts have been used in the tricuspid space but with limited experience and long-term data [21].

2.1.5 Percutaneous options for valve replacement

Percutaneous tricuspid valve replacement (PTVR) creates unique challenges as compared to the left side. One, the tricuspid annulus is large is size compared to the mitral annulus and can be further increased with right ventricular dilation. For large valve replacement, large caliber sheaths and large bore venous access must be obtained [22]. Only jugular and femoral veins can accommodate such large bores of up to 45 French [22]. Trans-atrial approach has been used in the past; however, this requires surgical expertise. Two, tricuspid valves are more difficult to anchor percutaneously as there is limited calcification and the structure itself is dynamic (changes in diameter in systole and diastole). Three, PTVR carries an increased risk post-procedural conduction defects just as with surgical repair [6, 21]. Frequently with percutaneous replacement the tricuspid annulus becomes stretched. This can cause a complete atrio-ventricular (AV) block, requiring pacemaker placement, due to proximity of the AV node and the bundle of His to the tricuspid valve. Similarly, proximity of the tricuspid valve to the right coronary artery, coronary sinus, vena cava create additional challenges with percutaneous placement and valve design [22]. Furthermore, patients with pacemaker or ICD devices are not great candidates for percutaneous tricuspid valve replacement as placement of a valve may dislodge leads. Lastly, there is very limited data on the percutaneously placed tricuspid valve replacement durability and more studies are necessary. Unlike, for surgical tricuspid valve replacement there are no guidelines regarding timing of percutaneous valve aortic valve replacement after infective endocarditis. Without surgical debridement or percutaneous debulking and with antibiotics use alone, there is a high theoretical reinfection risk of the new tricuspid valve placed using a percutaneous approach after endocarditis.

2.2 Cardiac implantable device endocarditis

Cardiac implantable device endocarditis (CIDE) involves cardiovascular implantable electronic devices (CIED) which include permanent pacemakers (PPM), implantable cardiac defibrillators (ICD), and cardiac resynchronization systems (CRT). CIDE is diagnosed based on the presence of the following four criteria:

- Presence of a cardiac device;
- No other source of infection;
- A positive culture for typical causative agents from the pocket of the device or its leads; and
- Echocardiographic findings of vegetation on the tricuspid valve or at the end of the electrical lead [23].

Specifically, for CIDE diagnosis, the Duke criteria should be used. Patient presentation can be variable and can involve all or just a few symptom including fevers, rigors, anorexia, fatigue, local tissue inflammation. In addition, there may be possible purulent discharge, device exposure, focal pain that may help localize the primary site of infection. Other symptoms could be neurologic or cardiac consistent with embolic stroke, or symptoms of volume overload [23].

2.2.1 Epidemiology

Intracardiac device infections constitute approximately 10% of all endocarditis cases [24]. CIEDs have been implanted in patient as early as 1960s, but over the last two decades had significant increase in incidence. According to American Heart Association update, between 1997 and 2004, PPM placement increased by 19% and ICD placement increased by 60% [25]. Other studies quote an even higher increase of 30% for PPM and over 500% for ICDs [26]. In the United States greater than 500,000 PPMs and ICDs are implanted per year with over 4 million implanted between 1993 and 2008 [27]. Notably, more patients who are elderly and those with many comorbidities have been receiving these devices [25]. In developed countries 20–35% of CIEDs were placed in patients older than 80 years of age [25].

Over the years, changing the implantation site of ICD from abdomen (associated with 3.2% infection rate) to pectoral site (associated with 0.5% infection rate) initially decreased the incidence of device related infections [25]. Despite the innovation in PPM and ICD technology together with better surgical technique, the rate of infections associated with cardiac devices has increased by 124–210% [25, 26]. About 1.8–31.1 cases of CIED infection per 1000 device years has been reported for PPM and ICD devices and overall higher rates of infection with ICDs and CRTs [27]. This change is likely due to increased rate of CIED implantation in people over the age of 65 and presences of major comorbidities such as renal failure, respiratory failure, heart failure and diabetes [26]. CIED infections are associated with up to 18% of morbidity and mortality and increase by 47% per decade hospital charges [26].

Early infection typically arises from device implantation [27]. With first time implantation the rate of CIED related infection is 0.5–1% and 1–5% with device replacement or upgrade [27]. CIED related infection can involve the bloodstream, the generator pocket, the leads, or endocardial structures [26, 27]. Late infection typically arises from patient poor health or other clinically significant processes.

Almqvist et al., further divides the spectrum of CIED infections into six different categories: early post-implantation inflammation, uncomplicated pocket infection, complicated pocket infection, definite CIED lead infection, possible CIED lead infection, CIED-associated endocarditis, and probable CIED infection [26].

2.2.2 CIED infection risk factors

Patients with chronic kidney disease, long-term corticosteroid use, presence of more than 2 pacing leads, diabetes mellitus, heart failure and oral anticoagulation are at higher risk for CIED infection [25, 26]. Use of preprocedural temporary pacing, fever within 24 hours prior to implantation, blood stream infections, and early reintervention were also associated with higher risk of CIED infection [25]. Lower rates of CIED infection was associated with antibiotic perioperative prophylaxis new device placement, use of pectoral approach rather than abdominal or transthoracic approach, and device placement by a high-volume physician [25].

2.2.3 Pathogenesis and microbiology

Source of microorganisms often originate from the skin during the implantation of the electrical agent in the subcutaneous tissue, from the pocket in which the electrical agent is placed, the tunnel that forms around the lead before its point of entry into the blood vessel or from bacteria unrelated to the CIED, which may be present in the form of a foreign body placed on or in contact with the endocardial tissue, or that applies pressure to the endocardial tissue and tricuspid valve [23, 27]. Alternatively, contamination of the CIED can occur at different stages or from various causes. This includes but is not limited to manufacturing or packaging, infection prior to or during implantation, secondary to surgical site infection or via hematogenous seeding from a distant site or after erosion through the skin [24, 25, 27].

Physical and chemical properties such as electrostatic charge, surface tension and hydrophobicity of each device plays an important role in the interaction with bacteria and development of bacterial attachment and biofilm formation [23]. More hydrophobic surfaces such as polyvinyl chloride, polyethylene, silicone, latex and stainless steel are associated with higher microbial adherence [24]. Pathogens are more likely to adhere to irregular surfaces and may also adhere to the patient's matrix proteins (fibrinogen, fibronectin and collagen) that coat the surface of an implanted device [25]. CIED infections are more likely to occur due to gram positive bacteremia than gram negative bacteremia [25]. Staphylococci species, especially coagulase negative staph, have a knack for adhesion to CIEDs via host matrix proteins and to each other thus forming biofilms [24, 25]. Coagulase negative staphylococci comprise 42% of all PPM and ICD infections, followed by oxacillin sensitive *S. aureus* (25%), oxacillin resistant *S. aureus* (4%), with the remaining causative organisms being other gram positive cocci (4%), gram negative bacilli (9%), fungal (2%), polymicrobial (7%), and unidentified/culture negative (7%) [28].

2.2.4 The role of biofilm

Biofilm is a group of one or more microbial species firmly attached to a device surface and each other and covered by extracellular polymeric matrix [24, 25]. This matrix provides a protective barrier and results in antibiotic resistance and extreme difficult of bacterial irradiation that frequently requires device explanation [24, 25]. Some bacteria are more adept to adhering to non-biological materials such as staphylococci.

2.2.5 Treatment and prognosis

Antibiotics are generally empirically initiated after obtaining at least three sets of blood cultures. These usually consists of broad-spectrum intravenous antibiotics covering both gram-positive and gram-negative bacteria, including methicillin/oxacillin-resistant *Staphylococcus aureus* [29]. Antibiotic therapy alone without device removal, however, is associated with a 7 times increase in 30-day mortality [28]. Treatment of CIDE as recommended per the 2017 HRS Consensus Document include complete device and lead removal in addition to antibiotics [29]. Immediate system removal is associated with a 3 times decrease in 1-year mortality as compared to preliminary antibiotic treatment and delayed system removal [30]. Mortality rates in patients with endocarditis who had systems removed and antimicrobial therapy are 18% or less compared with up to 66% on antibiotic therapy alone [27]. Multiple clinical studies have now demonstrated a 97.7% clinical success rate with hardware removal in addition to antibiotic therapy [30].

2.2.6 Duration of treatment

The start of antibiotic therapy duration is counted from the first day of negative blood cultures, therefore it is reasonable to obtain blood cultures every 24 to 48 hours until they are negative [31]. If the patient requires surgery and the surgical cultures are negative, then the duration of therapy is still counted from the first day of negative blood cultures [31]. If surgical cultures are positive, then the start of antibiotic therapy duration occurs the next day, after the achievement of source control [31]. This applies to post device removal as well as some authors recommend obtaining new blood cultures 48–72 hours post device removal [26]. If the need for CIED remains in patients treated for bacteremia, negative blood cultures should be documented at least 72 hours prior to new device implantation [29]. Duration of treatment usually consists of 4–6 weeks of IV antibiotics, in addition to removal of CIED [29].

3. Evolving percutaneous options for treatment

Given that 10–15% of patients fail medical therapy, percutaneous treatment options as an adjunct to medical therapy have now started to become mainstream. Specifically, the use of AngioVac device (AngioDynamics, Latham, New York) has begun to get traction because of its ease of use, low risk profile and ability to debulk the vegetation and prevent septic pulmonary emboli. The AngioVac system is a veno-venous extracorporeal system. The most common configuration is as a bilateral femoral venous platform or via the right internal jugular and femoral platform. The system mainly consists of a cannula and a circuit along with a trap, which captures the undesirable material. AngioVac is currently used in the setting of thromboembolic disease, particularly in the vena cava or the right atrium. Both the cannula and circuit are indicated for use in procedures requiring extracorporeal circulatory support for periods up to six hours for removal of fresh, soft thrombi or emboli. The cannula and circuit are designed to be used with off shelf pump, filter and reinfusion cannula. The device itself leverages the use of blood flow through a centrifugal pump to create negative pressure in order to extirpate undesirable intravascular material, such as thrombus, emboli or vegetation.

3.1 Cannula

The current iteration of the cannula is in its third generation. It is available in either a 180- or 20-degree angled tip (**Figure 1**). The cannula itself is radiopaque with a self-expanding nitinol tip which allows for visualization under fluoroscopic imaging. The tip is funnel shaped which allows for greater contact surface area of the unwanted material and the cannula shaft supported by a flat stainless-steel coiled wire within the catheter body to support greater pushability, kink resistance, and column strength. The cannula is further supported by a slide over sheath (**Figure 2**), which allows the user to maintain the desired angle needed to engage the unwanted material.

3.2 Circuit

The circuit consists of ½ inch tubing typically used for extracorporeal circulation with the use of quick connectors which allow for greater efficiency and ease of use. The quick connector are rotating adapters that allows for rotation of the cannula independently without twisting or kinking the circuit tubing. In addition, the circuit has a built in Y-Adapter with touhy insert allowing for over-the-wire capability through a working side port (**Figure 3**). This allows the user to use up to a 17 French adjunctive device alongside the cannula if needed.

Figure 1.
AngioVac cannula.

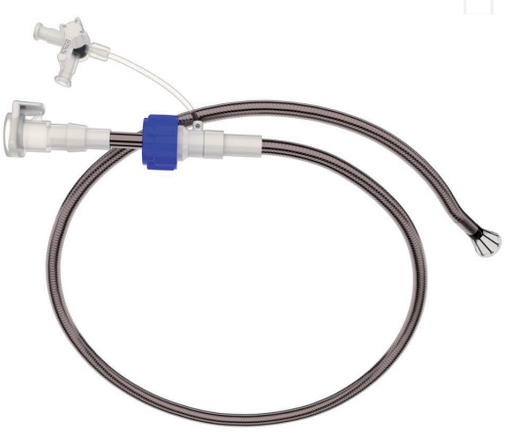

Figure 2.
AngioVac cannula with slide over sheath.

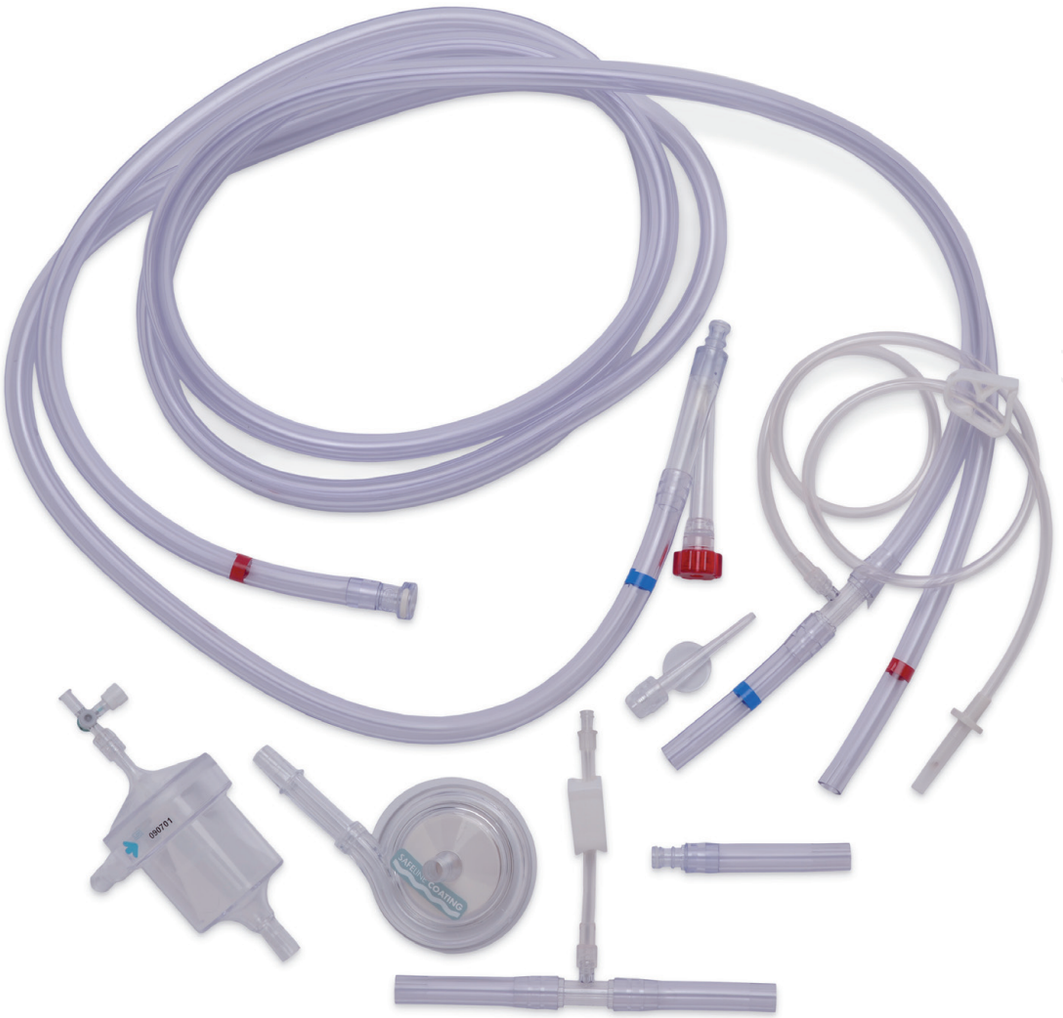

Figure 3.
AngioVac circuit.

3.3 Pump

The pump used with this system can be any off the shelf centrifugal pump. The centrifugal pump leverages negative pressure with increase in flow rates to extirpate undesirable material into the trap. Typical flow rates are around 3-4 Liters/minute. Once the material is engaged, flows will almost always come down to zero, but the negative pressure of the pump circulating allows the material to be suctioned up into the cannula and subsequently into the circuit and trap. Cavitation can occasionally occur but is well tolerated on the right side especially if the patient does not have a patent foramen ovale. When cavitation occurs, clamping the inflow and outflow and deairing the circuit is made simple due to the quick connectors.

3.4 Placement

As mentioned earlier, the AngioVac cannula can be used in the vena cava as well as the right atrium. It is not indicated for use in the pulmonary artery, but centers have used it in the right ventricle on occasion to extirpate vegetation or clot underneath the tricuspid valve. As centers have gained more experience with thromboembolism mainly in the right atrium, more centers are now using AngioVac for vegetations particularly on the tricuspid valve [32–34]. Access is obtained usually percutaneously in both femoral veins or through the right internal jugular vein and a femoral vein for a veno-venous configuration (**Figure 4**).

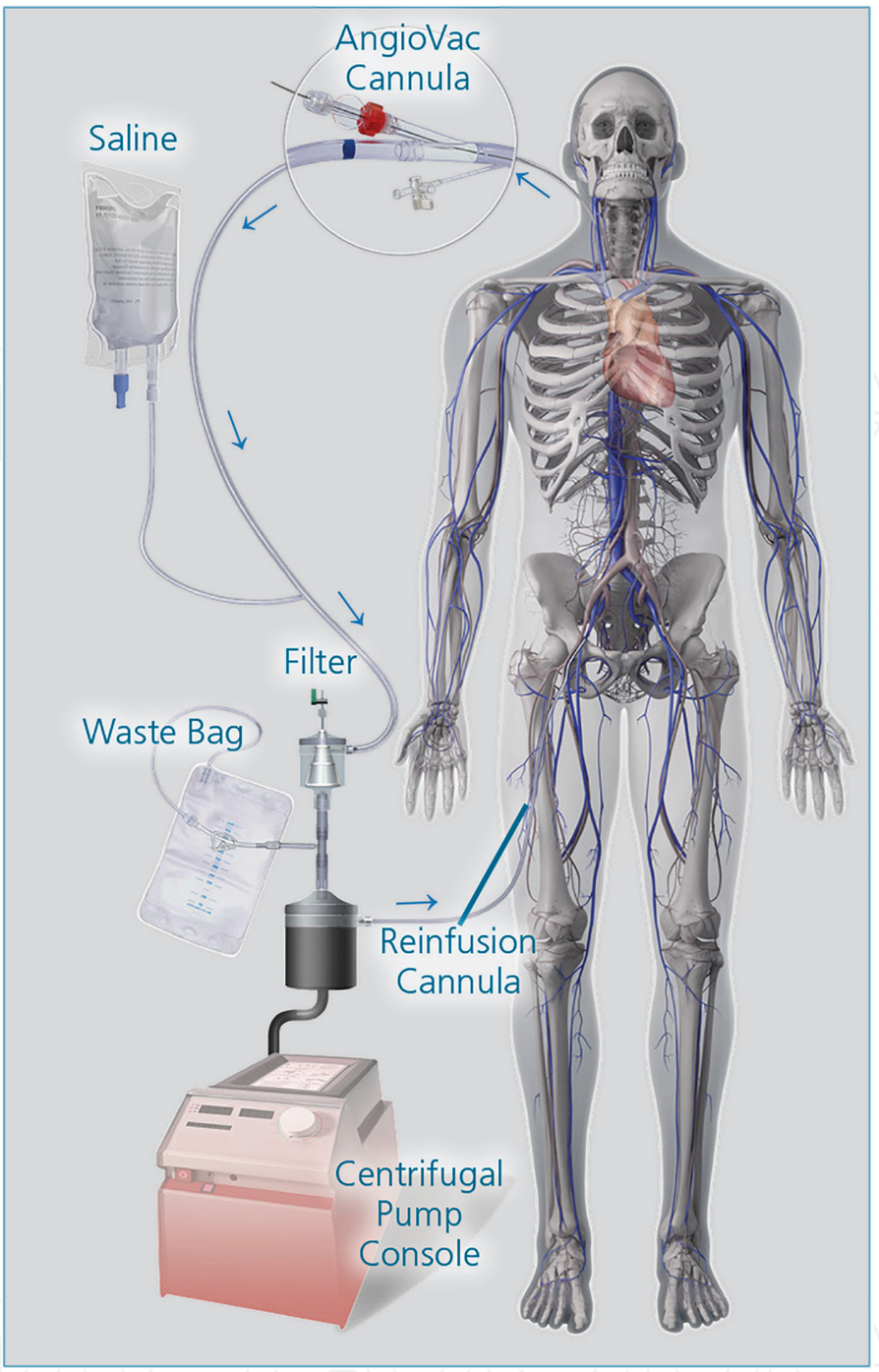

Figure 4.
AngioVac placement and configuration.

3.5 Indications

The surgical indications for TVE are less clear than that of endocarditis involving the left side of the heart. Current indications for surgery include vegetations >2 cm, evidence of septic pulmonary emboli, methicillin resistant organism, fungal infections and structural deterioration causing severe tricuspid valve regurgitation and heart failure [21]. However, given the repeat IVDU in these patients a surgical treatment is less likely to last for long due to repeat episodes of TVE. More concerning is the potential of prosthetic valve endocarditis which almost always necessitates a reoperation. Surgeons often find themselves in an ethical dilemma when patients represent needing a reoperation, especially when they have failed a second or third time. The risk of reoperation steadily increases and at some point, the risks outweigh the benefits.

However, a percutaneous option is more appealing due to its less invasive nature and the fact that it can be done multiple times without increasing the risk for the patient.

4. Current data

4.1 Percutaneous valve debulking in tricuspid valve endocarditis

Although vast data for the use of percutaneous valve debulking (PTVD) is rare, there are some retrospective data available. George et al., look at a review of 33 consecutive patients over 40 months who were declined traditional surgical management for TVE. Procedural success was defined as the removal of >1 cm of particulate and/or the ability to removal additional particulate. Patients were young with a vast majority being positive for IVDU (73%) with staphylococcal species being the most common causative agent. (75%). The average size of the tricuspid vegetation was 2.1 + 0.7 cm. More than 75% of patients had clearance of bacteremia within 48 hours of the procedure. Roughly 43.5% of patients however had worsening of their tricuspid regurgitation [32]. The same group also compared PTVD to valve replacement in a retrospective study which showed that the 1-year mortality was unchanged between the two cohorts, with the PTVD cohort having a shorter hospital length of stay [33].

A recent multicenter retrospective review showed at in 89 patients, 70% of patients had complete clearance of bacteremia within 48 hours of the procedure with only one patient requiring surgery for severe TR and heart failure. Surprisingly, the TR was unchanged in most patients (60%) and improved in 20% and worsened in 20%. The group of patient who had worsening of their TR were those who was on the borderline of mild–moderate and moderate–severe TR [34].

4.2 AngioVac in CIDE

Recent data from Starck et al. in 101 patients undergoing lead extraction with vegetation showed low risk and possible survival benefit when PTVD was combined with lead extraction [35]. Extraction was performed with either mechanical, laser or traction alone in the setting of a femoral to femoral venous configuration of AngioVac. This resulted in a theoretical reduction of septic pulmonary emboli with low intraprocedural complication rate. Overall, thirty-day mortality was 3% which was due to severe sepsis.

5. Conclusion

RSIE is increasing particularly due to the incidence of patients with CIEDs and IVDU particularly due to the opioid epidemic (7–10). Medical management alone is these groups of patients leads to medical failure and can lead to further complications such as septic pulmonary emboli. Surgical intervention in TVE is associated with higher risk of recurrent infection, thromboembolic and bleeding complications and reoperation with valve replacement [6]. In addition, contemporary series have shown that valve repair is preferred over replacement especially in IVDUs [6, 36, 37]. In addition to current recommendations, the use of percutaneous aspirational techniques provide a unique and effective way to treat these patients. These techniques are evolving and may become standard of care involving a multidisciplinary approach and avoid the need for surgical intervention at the time of presentation and potentially allow for a greater chance of needing of having a repair rather than a replacement in patients with structural deterioration of their valve.

Conflict of interest

Dr. Mark Joseph is a consultant for AngioDynamcis.

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