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Original article

Surgical Management of Isolated Tricuspid Valve Endocarditis: Single Center Experience

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ABSTRACT

Introduction: Tricuspid valve endocarditis (TVIE) is a serious disease that carries high morbidity and mortality. It is commonly seen in patients who administer drugs intravenously. The aim of this study is to review the outcomes of surgical treatments for TVIE. This is a retrospective chart review of 48 patients who received surgical treatment for TVIE at an urban tertiary care center between January 1, 2010 and December 31, 2021.

Material and methods: The 48 patients in our study ranged from age 18-54 and were composed of 34 women and 14 men, including 47 White and 1 African American. All but one patient were IV drug users (IVDU). The most common presenting symptoms were fever, chills, dyspnea, chest pain, and myalgias. All patients received preoperative antibiotic regimens for around 6 weeks. Surgical interventions included 38 tricuspid valve replacements, 5 tricuspid repairs, and 5 AngioVac debulking procedures.

Results: Outcomes include 30-Day mortality in 1 patient, 90-Day Mortality in 2 patients and Over 90-Day Mortality in 3 patients. Postoperative complications include complete heart block (8), bleeding (1), fluid volume overload (1), and 1 patient experienced cardiogenic shock and multiple organ failure postoperatively. Thirty-two patients had readmissions during the study, twenty-two of which were due to recurrence of TVIE. Thirteen patients required reoperations following their initial operation.

Conclusions: Although patients benefit from antibiotic treatment, surgical intervention is required when infection leads to structural damage of the tricuspid valve. However, risk for recurrence of TVIE in IVDUs places a burden on the long-term success rates of surgical management.

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Tratamiento quirúrgico de la endocarditis aislada de la válvula tricúspide: experiencia en un solo centro

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RESUMEN

Introducción: La endocarditis tricúspide (EVT) es una enfermedad grave con alta morbilidad y mortalidad. Se observa con frecuencia en pacientes que se administran fármacos por vía intravenosa. El objetivo de este estudio es revisar los resultados de los tratamientos quirúrgicos para la EVT. Se trata de una revisión retrospectiva de historias clínicas de 48 pacientes que recibieron tratamiento quirúrgico para la EVT en un centro de atención terciaria urbano entre el 1 de enero de 2010 y el 31 de diciembre de 2021.

Material y métodos: Los 48 pacientes de nuestro estudio tenían entre 18 y 54 años y estaban compuestos por 34 mujeres y 14 hombres, incluyendo 47 blancos y 1 afroamericano. Todos los pacientes, excepto uno, eran usuarios de drogas por vía intravenosa (UDIV). Los síntomas de presentación más comunes fueron fiebre, escalofríos, disnea, dolor torácico y mialgias. Todos los pacientes recibieron regímenes antibióticos preoperatorios durante aproximadamente 6 semanas. Las intervenciones quirúrgicas incluyeron 38 reemplazos de válvula tricúspide, 5 reparaciones tricúspides y 5 procedimientos de citorreducción con AngioVac.

Resultados: Los resultados incluyen mortalidad a los 30 días en 1 paciente, mortalidad a los 90 días en 2 pacientes y mortalidad a más de 90 días en 3 pacientes. Las complicaciones postoperatorias incluyen bloqueo cardíaco completo (8), hemorragia (1), sobrecarga de volumen de líquidos (1) y un paciente presentó shock cardiogénico y fallo multiorgánico postoperatorio. Treinta y dos pacientes reingresaron durante el estudio, veintidós de los cuales se debieron a recurrencia de EVT. Trece pacientes requirieron reintervenciones tras su primera intervención.

Conclusiones: Si bien los pacientes se benefician del tratamiento antibiótico, se requiere intervención quirúrgica cuando la infección provoca daño estructural de la válvula tricúspide. Sin embargo, el riesgo de recurrencia de EVT en pacientes con UDIV afecta negativamente las tasas de éxito a largo plazo del tratamiento quirúrgico.

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1. INTRODUCTION

Here introduce the paper, and put a nomenclature if necessary, in a box with the same font size as the rest of the paper. The paragraphs continue from here and are only separated by headings, subheadings, images and formulae. The section headings are arranged by numbers, bold and 9.5 pt. Here follows further instructions for authors.

Tricuspid valve infective endocarditis (TVIE) is a valvular disease strongly associated with intravenous drug use (IVDU). With the increasing frequency of IVDU in recent decades, as well as other risk factors for TVIE including long term IV catheters and implantable cardiac devices, an increasing number of patients are at risk of developing this disease [1]. About 30% to 40% of cases of TVIE are tied to IVDU, and the most common demographics for both IVDU and TVIE are young, white males [2].

Diagnosing TVIE initially involves a clinical evaluation, including systemic symptoms, chest pain, dyspnea on exertion, cough, anorexia, and weight loss. Common physical examination signs include tachypnea, hypotension, cardiac murmur, splinter hemorrhages, Roth spots, Osler nodes, petechiae, and splenomegaly. A CBC is likely to depict leukocytosis and neutrophilia. Two sets of blood cultures are used to identify the infective pathogen. Echocardiogram (ECHO) is the gold standard imaging study to identify characteristics of the lesions, with an initial transthoracic ECHO used for non-invasive imaging, followed by transesophageal ECHO for more detailed visualization [3].

For acutely ill patients, empiric antibiotics may be started prior to receiving blood culture results. Less symptomatic patients should wait until culture results are available in order to receive a targeted antibiotic regimen. However, cases refractory to antibiotics (>1 week), large vegetations (>2cm), or severe tricuspid regurgitation (TR) with right-sided heart failure secondary to TVIE require surgical intervention [2]. Depending on the extent of the disease, a

cardiothoracic surgeon will decide whether the patient may undergo tricuspid valve repair (TVr), tricuspid valve replacement (TVR), or transcatheter vacuum-assisted mass extraction (TVME) of vegetations.

Historically, surgical management of TVIE also included complete excision of the tricuspid valve, or valvulectomy. A 20-year study following 55 patients that received valvulectomy for intractable TVIE demonstrated that most patients were successfully treated without requiring valve replacement. However, 11% of patients required prosthetic valve replacement for medically refractory right-sided heart failure and 29% of patients suffered mortality [4].

The first surgical management of right-sided infective endocarditis using TVr was reported in 1961 [1]. Further advancements in TVr were seen in the 1970s by Danielson, et. al., and Carpentier, et. al., with more modern techniques introduced by da Silva and colleagues in 2007 and later modified by Dearani [5]. In general, TVr is the preferred surgical intervention for cases of TVIE. TVR, using either bioprosthetic or mechanical valves, is considered in elderly patients with clinically significant comorbidities, patients with extended infection, patients with cardiac devices, patients with recent pulmonary events, and patients requiring reoperation with a high recurrence rate [6]. TVME, or AngioVac debulking, is a newer minimally invasive procedure approved for right-sided valvular vegetations in 2014 and serves as a bridge towards surgical debridement in patients at high-risk for open-heart surgery. Emerging evidence has demonstrated faster recovery rates for patients receiving AngioVac debulking compared to TVr and TVR, as well [7].

TVIE is a serious disease that carries high morbidity and mortality if left untreated [2], and progression of TVIE and valvular dysfunction require patients to receive surgical management. The aim of this study is to review, compare, and evaluate the outcomes of surgical treatments for TVIE regarding post-operative complications, mortality, readmissions, and reoperations.

2. MATERIAL AND METHODS

This study is a retrospective chart review of 48 patients who received surgical treatment for TVIE at an urban tertiary care hospital between January 1, 2010 and December, 31 2021. This facility primarily uses EPIC software for electronic health records, and patient charts were reviewed with IRB approval and HIPAA Waiver of Authorization approval. The hospital's clinical research center completed a data extraction to provide a list of patients with the inclusion criteria of TVIE diagnoses and surgical treatment with TVr, TVR, or AngioVac debulking, resulting in 117 patients. The list was filtered to match the criteria for isolated TVIE to remove patients with comorbid valvular diseases that may act as confounding variables, resulting in 48 patients.

Data were analyzed using descriptive statistics. Categorical variables were expressed as absolute frequencies and percentages n (%), while continuous variables were reported as mean ± standard deviation (SD) or median and interquartile range (IQR), depending on their distribution.

The study protocol was reviewed and approved by the Institutional Review Board (IRB) at the University of Kentucky on August 11, 2023 (IRB Number: 89549). The research was conducted in accordance with the ethical standards of the Helsinki Declaration and its later amendments.

The data supporting the findings of this study are available through the University of Kentucky Center for Clinical and Translational Science. Requests for access to these datasets should be directed to the corresponding department, subject to institutional data sharing agreements and ethical restrictions.

3. RESULTS

The finalized chart review led to a study population ranging in age from 18-54, with 34 women and 14 men, and 47 White and 1 African American patients. In this study, we saw disproportionately high female patients in contrast to epidemiological patterns of TVIE seen in literature. All but one patient were IVDUs. The most common presenting symptoms included fever, chills, dyspnea, chest pain, and myalgias. Some patients presented with respiratory failure and/or signs of sepsis. The most common causative organisms were Methicillin-Resistant *Staphylococcus aureus* (MRSA) found in 28 cases and *Methicillin-Susceptible Staphylococcus aureus* (MSSA) in 13 cases, and all other causative organisms are seen in Figure 1. All patients received preoperative antibiotic regimens for around 6 weeks, with the most common being Vancomycin for 21 patients, Daptomycin for 9 patients, and Nafcillin in 6 patients**.** Surgical interventions included 5 TVr, 38 TVR, and 5 AngioVac debulking procedures. The appropriate intervention for each case was decided by the surgeon based on the extent of the disease and patient comorbidities that may impact operative outcomes. AngioVac debulking was offered to patients at high-risk for open heart surgery, requiring urgent debulking to restore valvular function, or to prevent severe complications such as septic emboli. Of the patients that received TVR, 32 were bioprosthetic TVR, 5

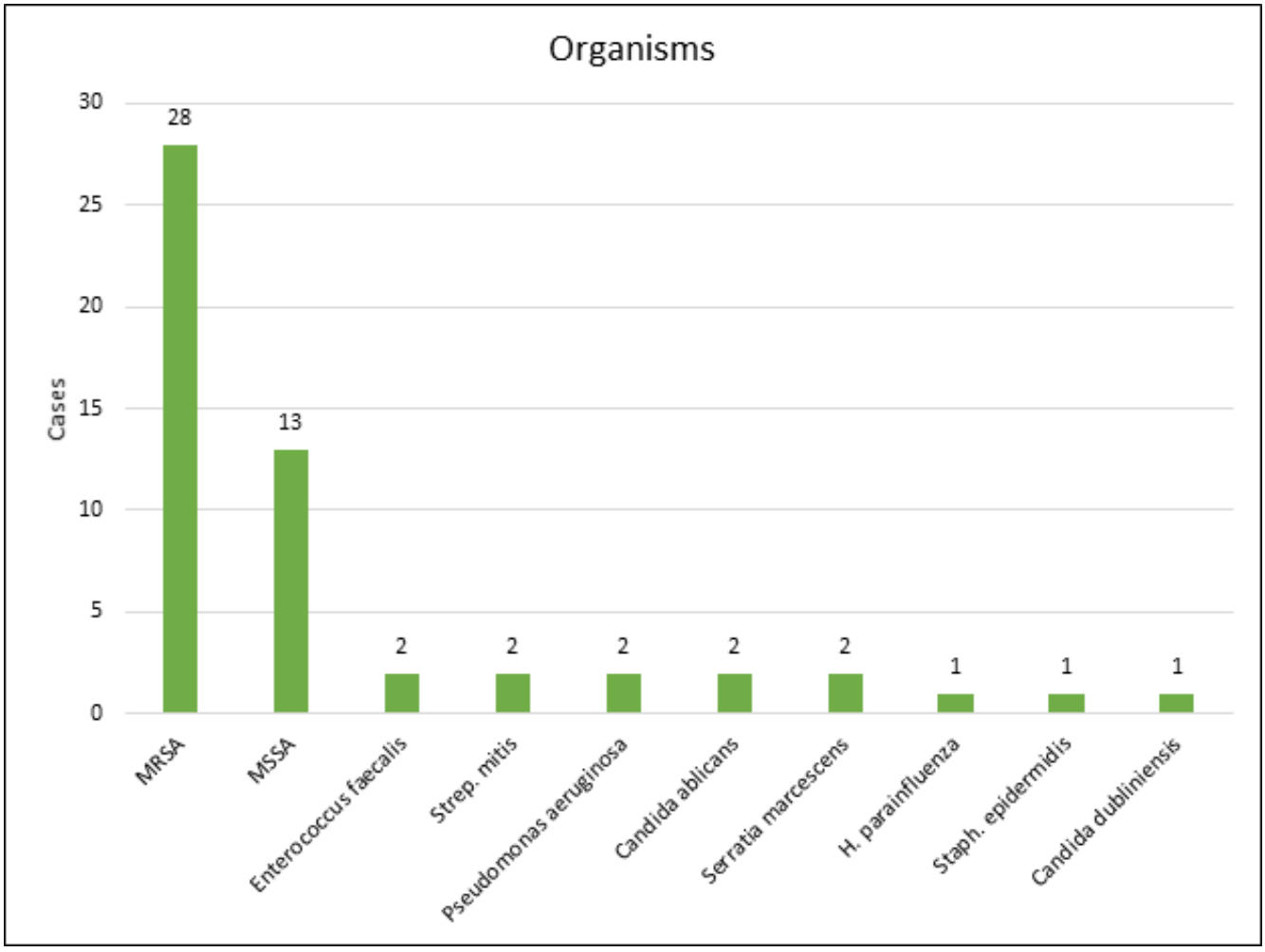

Figure 1: *Bar graph displaying all causative organisms for TVIE in the study and the number of reported cases for each organism. Some patients tested positive for polymicrobial infections, resulting in greater than 48 cases noted in the graph. MRSA: Methicillin-Resistant Staphylococcus aureus: MSSA: Methicillin-Susceptible Staphylococcus aureus.*

mechanical TVR, and 1 unidentified TVR. Each patient was assessed for post-operative complications, all-cause mortality, all-cause readmissions, readmissions involving TVIE recurrence, length from the surgical intervention to readmission, and surgical reoperations of the tricuspid valve following the initial surgical intervention.

Table 1: Reported and total post-operative complications per surgical procedure

Procedure	Post-Operative complications	
	No (%)	Yes (%)
Replacement	30 (79)	8 (21)
Repair	5 (100)	0 (0)
AngioVac Debulking	4 (80)	1 (20)
Total	39 (81)	9 (19)

The most common postoperative complication for these patients receiving surgical treatment for TVIE was complete heart block, seen following 7 TVR (18.4%) and 1 AngioVac debulking procedure (20.0%) (Table 1). One patient receiving TVR suffered from postoperative bleeding and fluid-volume overload (2.6%), and one patient suffered from cardiogenic shock with hypoxic respiratory failure, and acute renal failure following an extensive lysis of adhesions and resection of an infected bioprosthetic valve.

All-cause mortality was reported in 6 patients (12.5%). The only 30-day mortality was seen in a patient who suffered from cardiogenic shock with hypoxic respiratory failure and acute renal failure (2.1%). Two patients suffered 90-day mortality (4.2%), and over 90-day mortality was seen in three patients (6.3%). The distribution of all-cause mortality depending on the procedure received is depicted in Table 2. Sixteen patients did not have a readmission following their surgical treatment (33.3%). Two patients were readmitted

only for obstetrics-related hospitalizations. Twenty-two of the remaining thirty patients were readmitted with recurrent TVIE, including endocarditis of a prosthetic valve (45.8%). One-year TVIE recurrence avoidance was 62.3% (SE 7.8%) and 3-year recurrence avoidance was 45.0% (SE 8.5%) (Figure 2). One patient was readmitted within 30-days of their procedure (2.1%), twenty-two patients had intermediate-length readmissions (30 days to 2 years) (45.8%), and nine patients had long-term readmissions (2 years to 5 years) (18.8%) (Table 3).

Thirteen patients required reoperation on the tricuspid valve (27.1%), due to recurrent endocarditis or tricuspid regurgitation following prior surgical management. Ten reoperations were required within 2 years (20.8%), and the remaining three were between 2 to 5 years (6.3%). Five out of the six patients suffering all-cause mortality required reoperation.

4. DISCUSSION

When considering the safety of surgical management for TVIE, this study discovered only 1 patient suffering from 30-day mortality; furthermore, this mortality was primarily due to comorbid cardiac and renal failure. Out of the other 10 patients with postoperative complications, only 1 patient suffered a 90-day mortality. A large-scale study analyzing the Society of Thoracic Surgeons (STS) Adult Cardiac Surgery Database for outcomes of isolated tricuspid valve surgery demonstrated a low operative mortality of 5.6% [8]. This single-center study demonstrates an operative mortality for patients receiving surgical management of TVIE reflective of the operative mortality seen in the broader STS patient population. As TVME and AngioVac debulking are currently reserved for patients with higher surgical risks, further implementation of these procedures may show promise for reducing mortality rates in future studies.

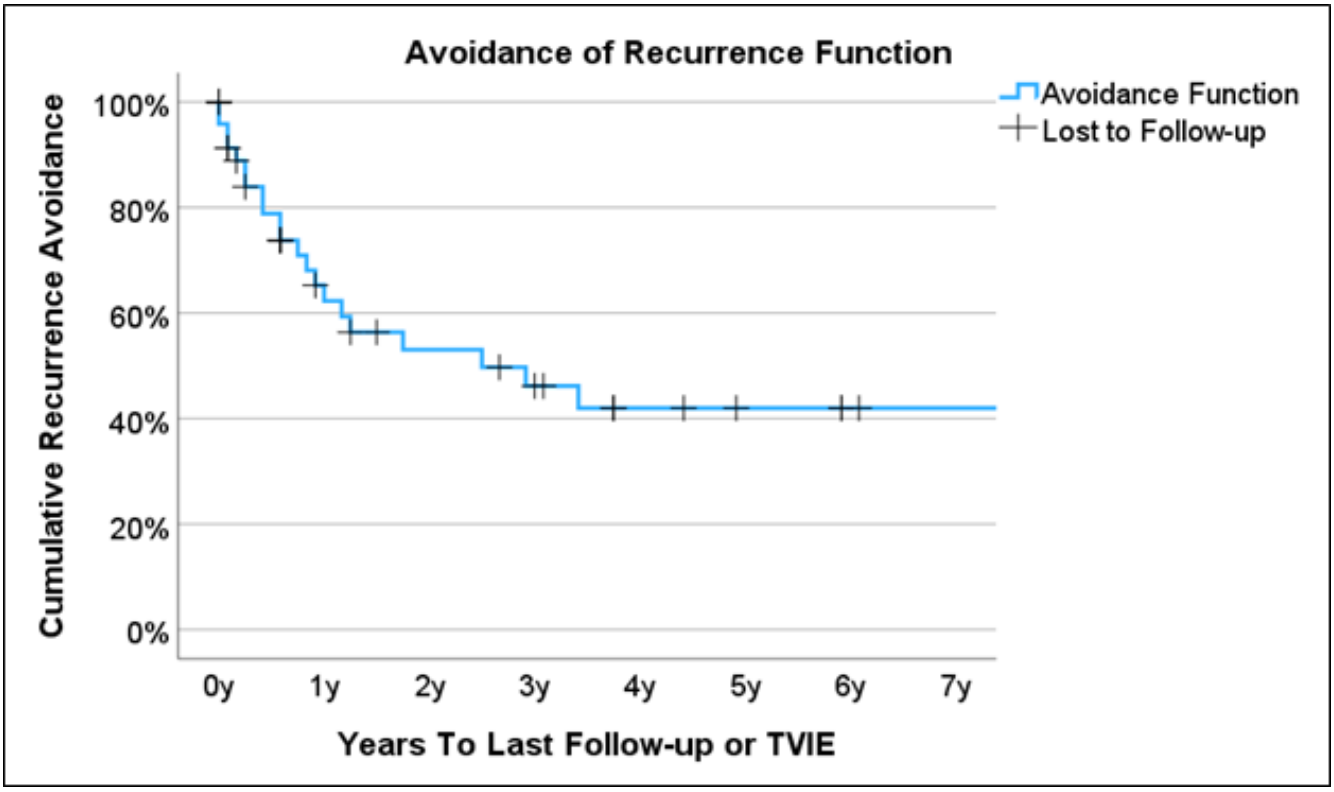

Figure 2: *Kaplan-Meier analysis of TVIE recurrence across the course of the study, also depicting the points at which patients were lost to follow-up.*

Table 2: Number of patients suffering all-cause mortality per surgical procedure stratified by the length of time from the initial procedure

Procedure	Length of all-cause mortality			
	None (%)	30-day (%)	90-day (%)	>90-day (%)
Replacement	35 (92)	1 (3)	1 (3)	1 (3)
Repair	5 (100)	0 (0)	0 (0)	0 (0)
AngioVac Debulking	2 (40)	0 (0)	1 (20)	2 (40)
Total	42 (88)	1 (2)	2 (4)	3 (6)

Most patients in this study received TVR, while only 10 patients received either TVr or AngioVac debulking. A nationwide cohort study comparing the outcomes of TVR versus TVr found that TVr had lower rates of perioperative complications, lower risks of all-cause readmission, and lower all-cause mortality [9]. AngioVac debulking is a relatively new surgical procedure, and a meta-analysis comparing TVME versus surgical debridement for TVIE found no significant difference in overall mortality between the two approaches, recommending further prospective randomized control trials to better understand and compare outcomes of the procedures [7]. The discrepancy with patients who underwent TVR was likely due to patients presenting to this tertiary care center with more advanced disease stages, or patients having received repair in the past followed by recurrent TVIE and worsening valvular health.

Table 3: Number of all-cause readmissions following the date of initial surgical procedure

Length	Readmissions (%)
30-Day	1 (2)
Intermediate (30 day - 2 years)	22 (46)
Long-Term (2-5 years)	9 (19)
Total	32 (67)

Many patients required readmissions and reoperations due to recurrent endocarditis secondary to substance abuse relapse. Furthermore, most readmissions fall into the intermediate or long-length categories. The majority of patients requiring reoperation initially received TVR, while no patients that received TVr required reoperation. This issue raises concern for whether patients are receiving adequate post-operative follow-up, particularly regarding management of their substance use and postoperative management. Recurrence of TVIE coincides with IVDU in the study's patient population due to the combination of major socioeconomic challenges, opioid crisis, and limited access to healthcare found in this region, especially in rural areas [10]. Both continuous IVDU and TVR (vs. TVr) are significant risk factors for recurrent endocarditis and poorer postoperative outcomes [11]. Furthermore, whether surgical or conservative management is optimal for patients with active IVDU remains unclear due to the current lack of robust evidence, producing both medical and ethical challenges for surgeons [12]. For patients to maintain the integrity and function of valve replacements and repairs, it is imperative that patients adhere to lifestyle changes and recommendations by their surgical team. Patients with active IVDU should be provided a multidisciplinary approach, including consultation and outpatient referrals to addiction medicine services providing rehabilitation and routine evaluations.

5. CONCLUSIONS

TVIE is a dreadful disease that is commonly seen in patients with IVDU. Although patients often benefit from antibiotic treatment alone, surgical intervention is required when infection leads to structural damage of the tricuspid valve. Based on our patient outcomes analysis, TVIE surgical interventions show low operative mortality, only 1 of 48 patients (2.1%). Complete heart block is the most common postoperative complication. Almost all patients in this study had a history of IVDU, and with the relatively high frequency of readmissions and reoperations due to recurrent TVIE and worsening valvular function, it is evident that improved long-term outcomes for patients receiving surgical management for TVIE depends on effective postoperative management, adherence to follow-up, and management of substance abuse.

6. LIMITATIONS

Limitations to this study include the small patient population that fit the exclusion criteria used in this single-center analysis, insufficient statistical power resulting in a hypothesis-generating study, and conducting a retrospective chart review as compared to a prospective study. A significant number of patients were lost to follow-up due to the broad region over which the healthcare facility receives patients and poor patient adherence with follow-up.

7. CONFLICT OF INTERESTS

The authors have no conflict of interest to declare. The authors declared that this study has received no financial support.

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