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2026 HRS consensus statement

Indications for Cardiac Implantable Electronic Device (CIED) Lead Management and Extraction

Article summary of new and modified recommendations

2026 HRS Expert Consensus Statement Update on Cardiovascular Implantable Electronic Device Lead Management and Extraction

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Heart Rhythm Society


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Note: This article only summarizes the new and modified recommendations from the HRS 2026 Consensus Statement, not a full summary of all recommendations.

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Class definitions

Class 1 (strong): Benefit >>> Risk
Conditions for which treatment A should be chosen over treatment B.

Class 2a (moderate): Benefit >> Risk
Conditions for which it is reasonable to choose treatment A over treatment B.

Class 2b (moderate): Benefit ≥ Risk
Conditions for which it might be reasonable to choose treatment A over treatment B.

Recommendations for lead extraction apply only to those patients in whom the benefits of lead removal outweigh the risks when assessed based on individualized patient factors and operator-specific experience and outcomes.

Color key

Class (Strength) of Recommendation	Class 1	Strong (Benefit >>> Risk)
	Class 2a	Moderate (Benefit >> Risk)
	Class 2b	Moderate (Benefit ≥ Risk)
Level (Quality) of Evidence	Level B-R	Randomized
	Level B-NR	Nonrandomized
	Level C-LD	Limited Data
	Level C-EO	Expert Opinion

Abbreviation key

BSI	Bloodstream Infection
CIED	Cardiac Implantable Electronic Device
CoNS	Coagulase-Negative Staphylococci
COR	Class of Recommendation
CT	Computed Tomography
ICD	Implantable Cardioverter-Defibrillator
ICE	Intracardiac Echocardiography
LM	Lead Management
LOE	Level of Evidence
LVAD	Left Ventricular Assist Device
PCR	Polymerase Chain Reaction
SVC	Superior Vena Cava
TEE	Transesophageal Echocardiography
TLE	Transvenous Lead Extraction
TR	Tricuspid Regurgitation
TTVR	Transvenous Tricuspid Valve Replacement
TV	Tricuspid Valve

Lead survival and new technologies

Retrieval and extraction of leadless pacemakers

New recommendations (Class 1 and 2a) for the removal of **leadless** pacing systems.
Snaring expertise recommended for the extracting physician.

COR	LOE	Recommendations
1	B-NR	In patients with a proven leadless device infection, device removal using contemporary extraction techniques is recommended.
1	B-NR	In patients with micro or macro dislodgement of a leadless pacemaker, device removal is recommended.
2a	B-NR	In patients with suboptimal pacing parameters early on after implantation, device removal is reasonable.

Lead recalls and advisories

New Class 1 recommendation stating that patients should be informed about **advisory/recalled leads** with an emphasis of individualized risk assessment and shared decision-making with regards to lead management.

COR	LOE	Recommendations
1	C-EO	Patients with leads under FDA advisory/recalls should be informed about the potential for lead malfunction/abnormalities and advised about the different management strategies in a shared decision-making process. Patients who do not need urgent/immediate intervention should be monitored remotely or in person.

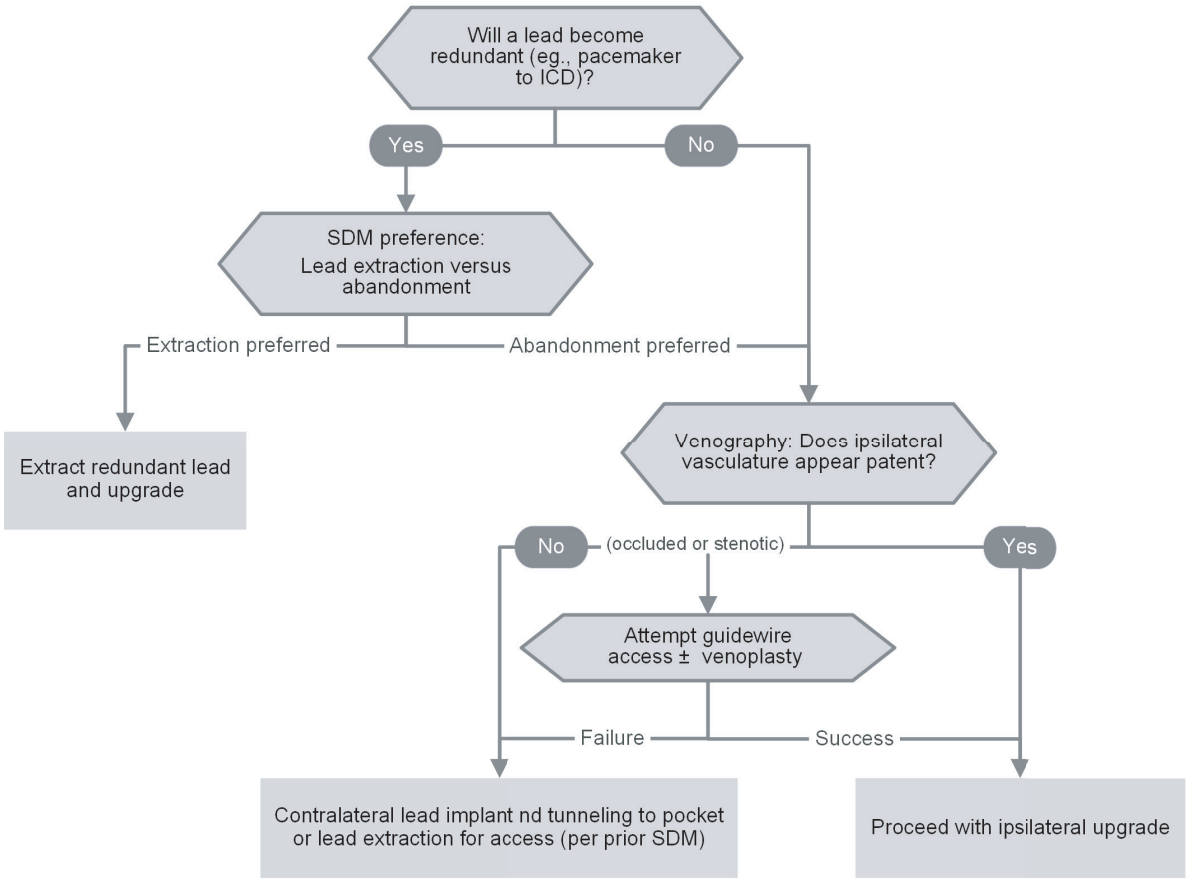
Clinical considerations in CIED lead management - TTVR

New Class 1 recommendation of a multidisciplinary heart team (including an EP with TLE expertise) **evaluate** CIED patients with a lead across the **tricuspid valve** prior to TTVR.

COR	LOE	Recommendations
1	C-EO	It is recommended that patients with CIED leads across the tricuspid valve who are referred for transvenous tricuspid valve replacement be evaluated by a multi-disciplinary heart team, including an electrophysiologist with lead extraction and lead management expertise.

Lead management during cardiovascular implantable electronic device upgrade

New flowchart for decision making on device **upgrade** procedures and the management of **abandoned leads**:



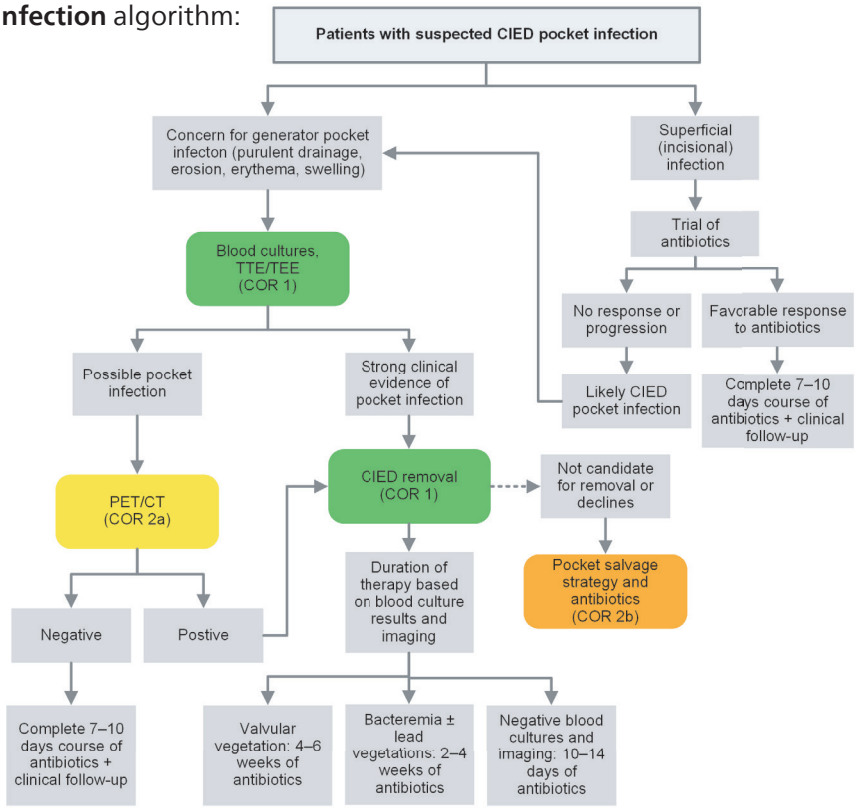
Diagnosis, management, and prevention of CIED infection

Management of CIED pocket infection

Modified guidelines (more specific treatment recommendations) for pocket infections.

COR	LOE	Recommendations
1	B-NR	In patients with CIED pocket infection (clinical signs of pocket purulence, abscess, dehiscence, erosion), complete device system removal with thorough debridement of infected material, fibrotic capsule, and all non-absorbable sutures, followed by pocket irrigation is recommended for effective infection management.
2b	C-LD	In patients with CIED pocket infection who are at a prohibitively high risk for complications from lead extraction or who decline complete system removal, a salvage strategy that includes pocket debridement and chronic suppressive antibiotic therapy may be considered.
1	C-LD	In patients with CIED pocket infection, gram stain and culture of pocket tissue and leads are recommended at device removal to improve identification of causative pathogens and guide antimicrobial therapy.
2b	C-LD	In patients with CIED pocket infection, use of advanced diagnostic technology such as vortexing-sonication or 16S/18s rRNA polymerase chain reaction sequencing of pocket tissue or explanted device components (generator or leads) may be considered to increase identification of causative pathogens.

Improved CIED **pocket infection** algorithm:



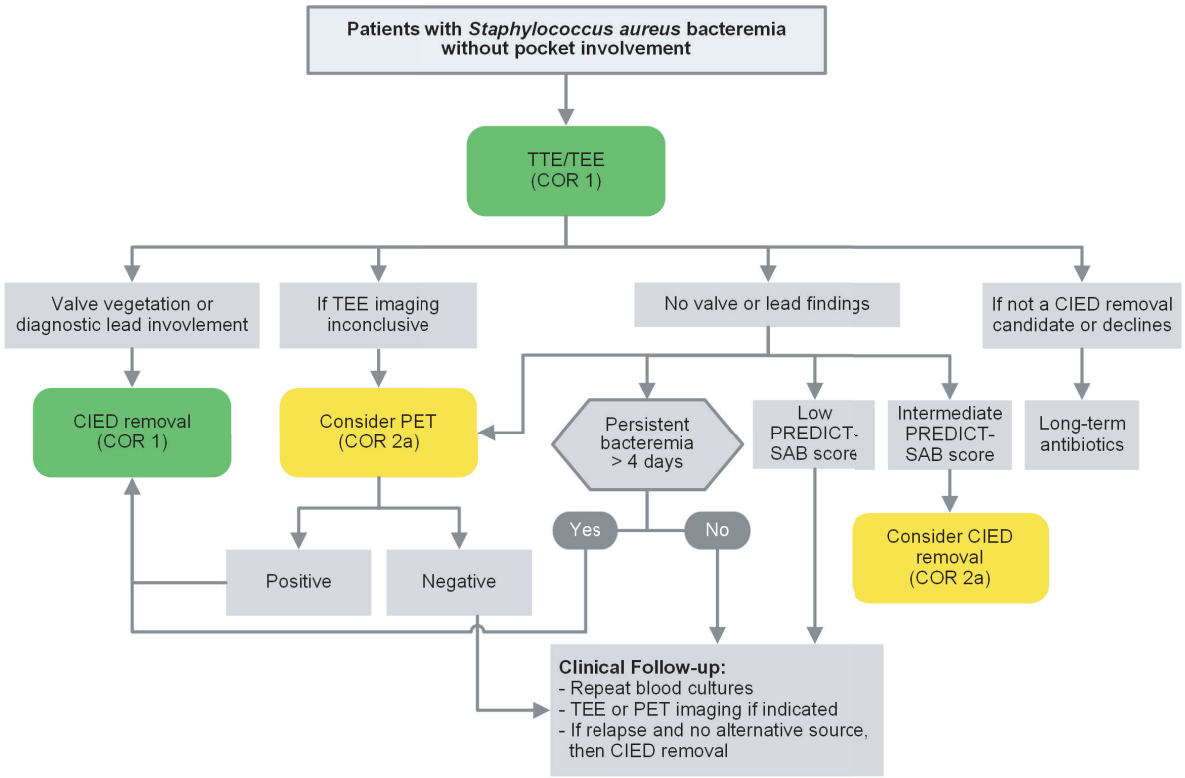
Diagnosis, management, and prevention of CIED infection (cont.)

Management of patients with a CIED and staphylococcus aureus bacteremia or endocarditis

Modified guidelines (more specific treatment recommendations) for **S. aureus/endocarditis**, including indeterminate CIED lead involvement (Class 2a).

COR	LOE	Recommendations
1	C-LD	In patients with CIED and Staphylococcus aureus bacteremia with lead involvement by imaging, CIED system removal is indicated to reduce infectious complications and ensure improved outcomes.
1	B-NR	In patients with persistent Staphylococcus aureus bacteremia for more than 4 days, CIED system removal is indicated to reduce the risk of relapse.
2a	C-LD	In patients with CIED and Staphylococcus aureus bacteremia without conclusive evidence of lead infection, CIED system removal is reasonable to reduce the risk of recurrent infection.
2a	C-LD	In patients with Staphylococcus aureus bacteremia and no signs of pocket infection or vegetation by TEE, validated risk scores, including PREDICT-SAB, can be useful to determine the risk of associated CIED infection and guide CIED management decisions.

Improved **S. aureus bacteremia infection** algorithm:



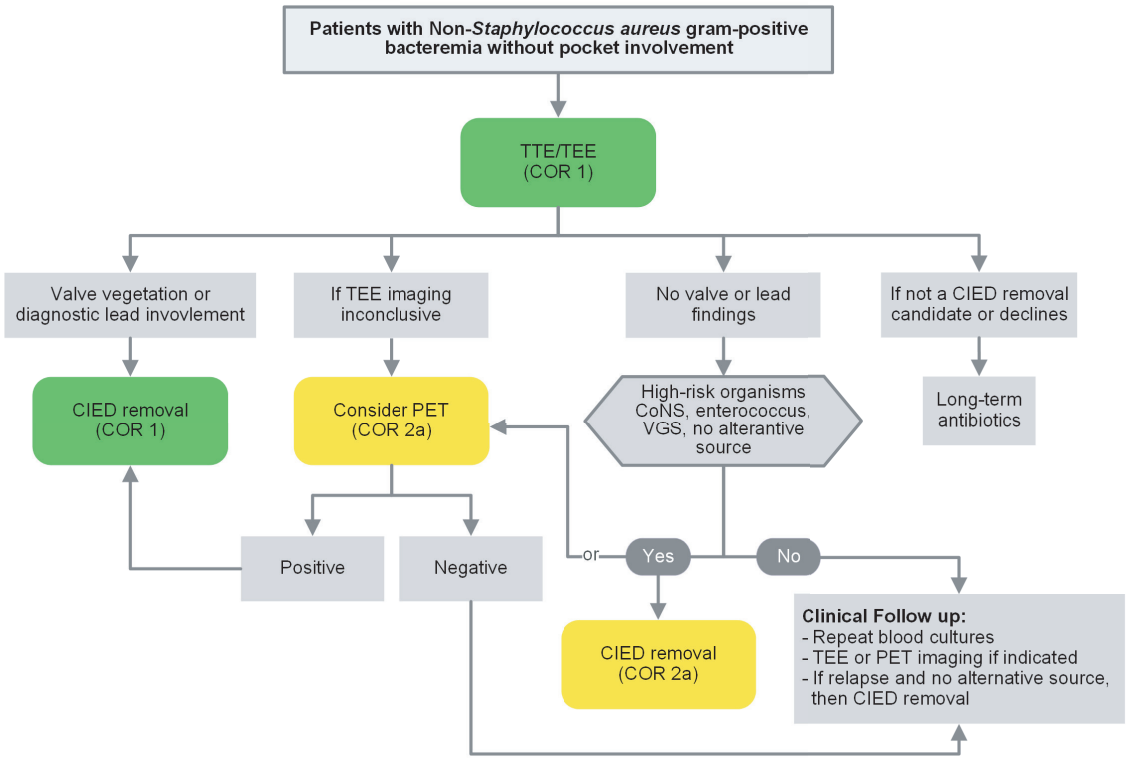
Diagnosis, management, and prevention of CIED infection (cont.)

Management of patients with a CIED and non-staphylococcus aureus bacteremia or endocarditis

Modified guidelines (more specific treatment recommendations) for **non-S. aureus** organisms, including indeterminate CIED lead involvement (Class 2a and 2b).

COR	LOE	Recommendations
1	C-LD	In patients with a CIED and bloodstream infection with non-S.aureus gram-positive organisms (CoNS, Enterococcus, Viridans group of streptococci), and CIED lead vegetation or involvement by advanced imaging, CIED system removal is recommended to reduce the risk of relapse.
2a	C-LD	In patients with CIED and high risk non-Staphylococcal (CoNS, Enterococcus, Viridans group of streptococci, P. aeruginosia, S. marascens) BSI and absence of alternative source of bacteremia, CIED removal can be useful to reduce the risk of recurrent infection.
2b	C-LD	In patients with CIED and bloodstream infection with non-S. aureus gram-positive organisms, but without signs of CIED infection or suggestive imaging, the usefulness of CIED system removal is not well established.
2a	C-LD	In patients with CIED and gram-negative bacteremia without pocket involvement, suggestive imaging, or known alternative source of bacteremia, conservative management with antibiotics is reasonable.

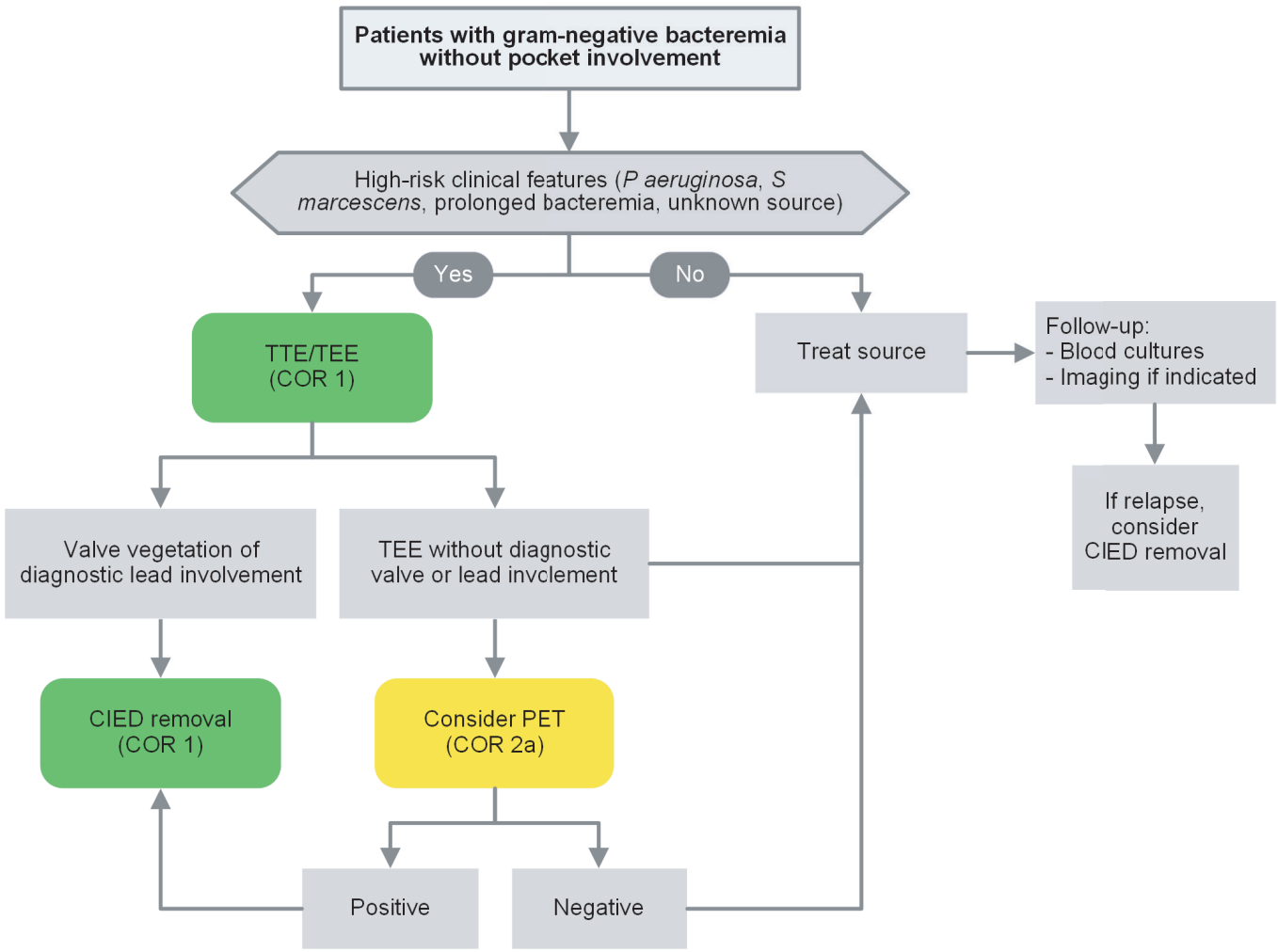
Improved **non-S. aureus gram-positive bacteremia** infection algorithm:



Diagnosis, management, and prevention of CIED infection (cont.)

Management of patients with a CIED and non-staphylococcus aureus bacteremia or endocarditis (cont.)

Improved **gram-negative bacteremia** infection algorithm:



Management of patients with a CIED and fungemia

Modified guidelines (more specific treatment recommendations) for **fungemia**.

COR	LOE	Recommendations
1	C-LD	In patients with CIED and fungal bloodstream infection with suspected CIED involvement, CIED system removal is recommended in addition to antifungal therapy.

Diagnosis, management, and prevention of CIED infection (cont.)

Procedural management for infection indication of CIED removal

New Class 1 recommendation advocating **early lead removal (<7 days)** for CIED infections and new Class 2a and 2b recommendations on managing lead vegetations.

COR	LOE	Recommendations
1	C-LD	In patients with CIED bloodstream infection, gram stain and culture of pocket tissue and lead tips are recommended at device removal to guide antimicrobial therapy.
1	B-NR	In patients with CIED infection undergoing system removal, early removal is beneficial compared with delayed extraction, particularly for virulent organisms such as Staphylococcus aureus.
2a	C-LD	In patients with CIED infection and lead vegetation who are undergoing CIED system removal, transvenous lead removal is reasonable, even in the presence of a larger vegetation.
2b	C-LD	In patients with CIED infection and vegetation > 1-2 cm, percutaneous mechanical aspiration can be effective to debulk lead and valve-associated vegetations.
2b	C-LD	In patients who are at very high risk of complications from transvenous lead extraction (eg, very large vegetations, > 4 leads, long duration of dwell time, high-risk leads, low body mass index, female sex, and no prior cardiac surgery), surgical lead extraction may be considered.
1	B-NR	In patients with a CIED who are undergoing cardiac surgery for valvular endocarditis, particularly with high-risk organisms such as S aureus, complete CIED system removal is indicated to reduce the risk of recurrent infection.
2b	C-LD	In patients with both a CIED and an LVAD who present with systemic or pocket infection, complete removal of the CIED system while leaving the LVAD in situ may be considered.

Diagnosis, management, and prevention of CIED infection (cont.)

Pacing management at CIED removal

New Class 1 recommendation on the use of a **leadless pacemaker** for pacemaker dependent patients during or after CIED system removal.

COR	LOE	Recommendations
1	C-LD	In patients who are pacing dependent and undergoing CIED removal for infection, implantation of a leadless pacemaker during or after CIED removal is useful to reduce the risk of recurrent infection.

Prevention

New Class 2a recommendation on the use of an **antibacterial envelope** to reduce the risk of pocket infection.

COR	LOE	Recommendations
2a	B-R	In high-risk patients with a CIED, such as those undergoing generator replacement or system upgrade, or with prior device infection, immunosuppression, or renal dysfunction, use of an antibacterial envelope can be useful to reduce the risk of pocket infection.

Indications for lead extractions (noninfectious)

Lead malfunction/recalled leads, extract vs abandonment

Modified recommendations (Class 2a and 2b).

COR	LOE	Recommendations
2a	B-NR	It is reasonable to choose lead removal over lead abandonment for patients with malfunctioning lead(s) when the benefits outweigh the risks.
2b	C-LD	In patients with normally functioning advisory leads and/or devices that, due to a design failure, pose a potential future threat to the patient if left in place, lead and leadless device removal may be considered.

CIED upgrade and downgrade

Modified Class 2a recommendations.

COR	LOE	Recommendations
2a	B-NR	It is reasonable to choose removal of superfluous leads over abandonment when upgrading, downgrading or revising a CIED system when the benefit outweighs the risk.
2a	C-LD	Lead removal can be useful if inserting additional lead(s) would result in an excessive number of leads that exceed the capacity of the vasculature.

CIED management in tricuspid valve disease

New recommendations (Class 1 and 2a) for the removal of leads that cross the tricuspid valve for CIED patients with planned **tricuspid valve** replacement procedures, as well as patients with severe TR secondary to the existing leads.

COR	LOE	Recommendations
1	C-LD	In patients with transvenous leads crossing the tricuspid valve and planned TTVR, lead removal is recommended to avoid entrapment of the lead and facilitate the TTVR procedure.
2a	B-NR	Lead removal can be beneficial in selected patients with severe tricuspid regurgitation where the mechanism of tricuspid regurgitation is thought to be secondary to the existing transvenous lead(s).

Management of patients undergoing lead extraction

Pre-procedural evaluation and considerations

New recommendations (Class 1, 2a, and 2b) for pre-procedural management of TLE patients, including involving a **multidisciplinary team** for TLE (Class 1), performing TLE on patients requiring uninterrupted anticoagulation (Class 2b), **reviewing pre-op imaging** (Class 1), obtaining **pre-op cardiac CT** (Class 2b), as well as **pre-op TEE** (Class 2b).

COR	LOE	Recommendations
1	C-LD	In patients with CIEDs undergoing complex TLE procedures, a multidisciplinary team consisting of an electrophysiologist, cardiac surgeon, and cardiac anesthesiologist is recommended for procedural planning.
2a	C-LD	It is reasonable to perform TLE in selected patients requiring uninterrupted therapeutic INR (eg, mechanical valve).
1	C-EO	It is recommended to review pre-operative radiologic imaging to determine the number and location of leads to be extracted for pre-procedural planning.
2b	B-NR	Preoperative contrast chest CT may be helpful to visualize lead findings that may alter extraction planning.
2b	C-LD	It may be reasonable to obtain preoperative TEE for assessing lead(s) in relation to cardiac structures and vegetation(s).

Intraoperative considerations

New Class 1 recommendations for intraoperative management of TLE patients. The new Class 1 recommendations including having a **written TLE protocol** in place for safety as well as complication prevention and management. Additionally, an appropriate procedural room should be chosen with optimal imaging, surgical rescue availability, and a full array of TLE tools including the **SVC occlusion balloon**. Furthermore, a multidisciplinary team (including cardiovascular surgery) should be **available to respond emergently** to complications.

COR	LOE	Recommendations
1	C-LD	It is recommended that a well-established, written institution-specific protocol be in place for the safe conduct of the TLE procedure and management of any complications.
1	B-NR	It is recommended that TLE be performed in appropriate procedural rooms with the necessary equipment & optimal imaging, which allows for immediate surgical rescue if required.
1	C-LD	It is recommended that a multi-disciplinary team be readily available during TLE.

Management of patients undergoing lead extraction (cont.)

Intraoperative considerations (cont.)

New recommendations (Class 1 and 2a) for intraoperative anesthetic management of TLE patients. This includes using **general anesthesia and intubation** (Class 1), arterial pressure monitoring with an **ART line** (Class 1), **femoral** venous access (Class 1), the use of a **rescue SVC balloon kit** to ensure that a support wire is in place in case of vascular injury (Class 2a), and continuous echocardiographic monitoring using modalities such as **TEE or ICE** (Class 2a).

COR	LOE	Recommendations
1	B-NR	General anesthesia with endotracheal intubation is recommended for most patients undergoing lead extraction.
1	C-EO	Invasive arterial pressure monitoring is recommended for most patients undergoing TLE.
1	C-LD	Placement of femoral venous sheaths prior to TLE is recommended for use as volume lines, temporary pacemakers, femoral TLE tools, or emergency use.
2a	B-NR	A rescue balloon kit can be useful with the appropriate support wire placed beyond the SVC prior to extraction when there is significant concern for possible vascular injury.
2a	B-NR	Continuous echocardiographic monitoring is reasonable in patients when there is significant concern for possible cardiac and vascular injury.

New Class 1 recommendations for intraoperative TLE considerations including **operator familiarity of multiple vascular approaches** (superior and femoral) and the tools used in those scenarios. Similarly, all **necessary equipment should be available** to manage complications, and the operator should have the expertise to effectively use the tools for that purpose. This includes preparation and proper deployment of the **SVC occlusion balloon**.

COR	LOE	Recommendations
1	C-LD	Extraction programs should be familiar with multiple vascular approaches (ie, superior, femoral, etc) for TLE and have appropriate tools available.
1	C-LD	Extraction programs should have all the necessary equipment and expertise required to manage all potential complications.
1	C-EO	When powered sheaths are employed from a superior approach, continuous traction must be maintained on the lead to provide a rail.

Management of patients undergoing lead extraction (cont.)

Intraoperative considerations (cont.)

New Class 1 recommendations for using an **SVC occlusion balloon emergently**, as well as performing **pericardiocentesis for cardiac tamponade**, and emergent **sternotomy** for vascular bleeding unable to be managed by alternative methods.

COR	LOE	Recommendations
1	C-LD	If a vascular injury occurs, deploying a rescue balloon catheter is recommended until surgical evaluation and repair.
1	B-NR	Pericardiocentesis is recommended to relieve tamponade, provided it does not delay definitive surgical intervention when needed.
1	B-NR	Emergent sternotomy and initiation of Cardiopulmonary Bypass (CPB) are recommended to repair cardiac and vascular bleeding unable to be managed by alternatives.

New Class 2a recommendation to **assess TVR post TLE.**

COR	LOE	Recommendations
2a	B-NR	It is reasonable to evaluate and manage the development of new or worsening significant tricuspid regurgitation after TLE.

Post-procedural considerations

New Class 2a recommendation for **same-day discharge.**

COR	LOE	Recommendations
2a	B-NR	In selected patients who undergo uncomplicated TLE, same-day discharge is reasonable

Implant lead selection, approach and techniques to mitigate lead malfunction

Perioperative factors that are adjunctive to TLE for the management of CIED patients.

Venous access

New recommendations (Class 1 and 2a) for obtaining vascular access for lead implantation. The authors **recommend against subclavian vein puncture** (Class 1) and recommend using **ultrasound or fluoroscopic venography** for axillary vein access (Class 2a).

COR	LOE	Recommendations
1	B-R	When obtaining access for lead implantation, an extrathoracic axillary vein puncture or a cephalic vein cutdown should be performed (versus subclavian vein puncture) to decrease the risk of pneumothorax and premature lead failure.
2a	B-R	Ultrasound-guidance or contrast-guided fluoroscopy can be useful for axillary vein puncture.

Lead choice

New Class 1 recommendations for selecting leads. The authors **discourage the use of dual-coil ICD leads** due to greater difficulty and worse outcomes with TLE. They also caution the selection of **passive fixation** leads, as well as leads with a **coradial** (vs. coaxial) design.

COR	LOE	Recommendations
1	B-NR	When implanting a transvenous ICD, a single coil (versus dual coil) lead is recommended.
1	B-NR	When implanting transvenous leads, consideration of lead design and fixation mechanisms is recommended in case of the need for future extraction.

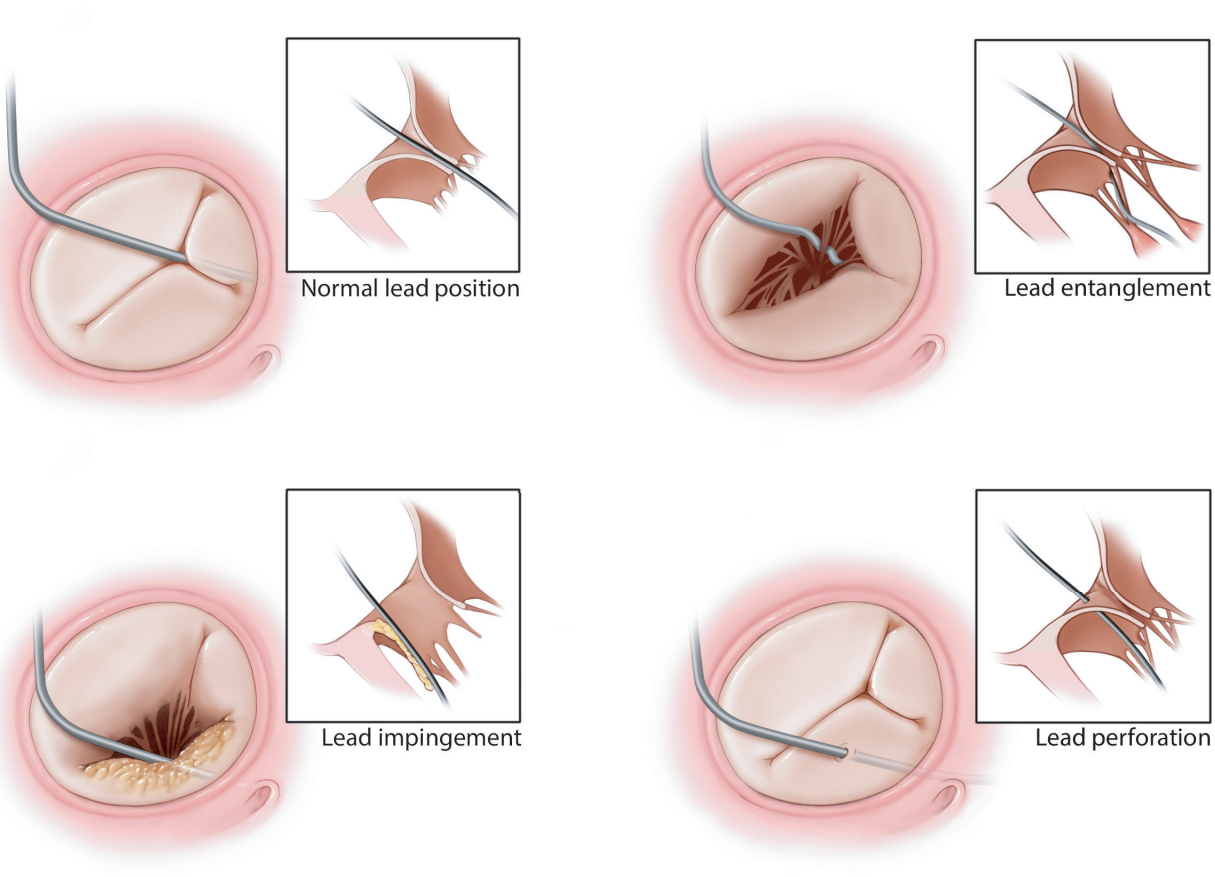
Tricuspid valve regurgitation

New Class 1 recommendation for **avoiding TVR** as a consequence of lead positioning during implant.

COR	LOE	Recommendations
1	C-LD	Ventricular lead implantation should be performed in a manner to decrease tricuspid valve regurgitation.

Implant lead selection, approach and techniques to mitigate lead malfunction (cont.)

Examples of lead interaction with the tricuspid valve:



New Class 1 recommendation for **evaluating tricuspid regurgitation** secondary to lead interaction within 1 year of implantation.

COR	LOE	Recommendations
1	C-LD	Assessment for lead-related significant tricuspid valve regurgitation should be considered within 1 year after ventricular lead implantation.

Number of leads

Modified Class 1 recommendation for **minimizing the number of implanted leads**.

COR	LOE	Recommendations
1	C-LD	For a patient receiving a transvenous device, the number of leads implanted should be minimized. Particular consideration should be given to lead burden in special groups such as pediatric patients.

For the full 2026 HRS Expert Consensus Statement on Transvenous Lead Extraction, please visit https://www.heartrhythmjournal.com/article/S1547-5271(26)02264-2/fulltext

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