The subcutaneous implantable cardioverter-defibrillator should be considered for all patients with an implantable cardioverter-defibrillator indication

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The implantable cardioverter-defibrillator (ICD) is an essential lifesaving device implanted worldwide for the prevention of sudden cardiac death (SCD). Several clinical trials have demonstrated the efficacy of ICDs in both primary and secondary prevention cohorts over the last two and a half decades.1–5 Transvenous implantable cardioverter-defibrillators (TV-ICDs) have traditionally been implanted for such purposes. However, the TV-ICD system has considerable limitations and is associated with short- and long-term adverse events related to the endovascular lead.

Concerns related to the TV-ICD system

Evidence has demonstrated that 2%–11% of new TV-ICD implantation procedures result in early complications, such as pocket-related complications, device-related infection, procedure-related complications (pneumothorax, pericardial effusion/cardiac tamponade), device malfunction, and lead-related issues (lead dislodgment, lead fracture requiring revision) within 45–90 days postoperatively.6–9 Several other studies also demonstrated that the long-term risk (up to 10 years) of TV-ICD systems for any complications leading to reoperation or hospitalization remain significantly elevated at 8%–33%.9–10 Interestingly, the National Cardiovascular Data Registry (NCDR) ICD registry reported that women with a TV-ICD system have a higher risk than men for any device-related complications postimplantation (adjusted odds ratio [OR] 1.39; P < .001); 6-month heart failure readmission (adjusted OR 1.32; P < .001); and 6-month all-cause readmission (adjusted OR 1.22; P < .001).11 Acute procedural complications include a higher risk of pneumothorax and cardiac perforation. Another NCDR ICD registry study reported that dialysis patients seemed to be at greatest risk for developing cardiac implantable electronic device (CIED) infection (OR 1.34; P = .0012) within 6 months of TV-ICD implantation.12 A totally subcutaneous defibrillator system was developed to overcome these complications related to the TV-ICD system.

Overview of the S-ICD system

The subcutaneous implantable cardioverter-defibrillator (S-ICD) was first approved by the U.S. Food & Drug Administration (FDA) in 2012 for prevention of SCD. A summary of the differences and similarities between the S-ICD and the TV-ICD system are listed in Table 1. Similar to the single-chamber TV-ICD system, the S-ICD system consists of a defibrillator lead and a pulse generator (PG). The S-ICD is designed to eliminate the need to insert the lead into the vasculature and into the heart, minimizing potential lead-related complications. Before S-ICD implantation, patients are screened with an electrocardiogram (ECG) to evaluate QRS–T-wave morphologies to assure appropriate sensing and reduce the risk of T-wave oversensing, hence minimizing the risk of inappropriate shocks (IAS) or undersensing of ventricular tachyarrhythmias.13–21

Different techniques of PG and lead implantation with the S-ICD system

There are vast differences between the S-ICD and the TV-ICD related to implantation techniques. The PG of the TV-ICD system is traditionally implanted in the left infraclavicular region (less commonly in the right infraclavicular region), and placement of the defibrillator lead requires venous access to the right ventricle through the subclavian, axillary, or cephalic vein. In contrast, the PG of the S-ICD system is implanted subcutaneously in the midaxillary line at the level of the fifth and sixth intercostal spaces, and the defibrillator lead is tunneled subcutaneously from the PG to the left parasternal border. The standard implantation technique of the S-ICD system was originally described using a 3-incision approach.
The subcutaneous implantable cardioverter-defibrillator (S-ICD) has been shown to have comparable efficacy, reliability, and safety outcomes compared to the transvenous implantable cardioverter-defibrillator (TV-ICD) for the prevention of sudden cardiac death (SCD) in patients who do not have pacing indications.

When recommending an implantable cardioverter-defibrillator (ICD) for the primary or secondary prevention of SCD, patients should be given the option of an S-ICD with a high level of recommendation in the absence of pacing indications.

The S-ICD may be preferred over the TV-ICD in patients at high risk for cardiac implantable electronic device infection, those with limited vascular access, and patients on dialysis in the absence of pacing indications.

The S-ICD also may be preferred in younger patients, who may need multiple devices and leads throughout their lifetime, and in women, who are at higher risk for TV-ICD complications, in the absence of pacing indications.

It is important to emphasize that the S-ICD should be included in the shared decision-making process, in addition to discussion about the TV-ICD, when offering ICD therapy for the primary or secondary prevention of SCD in patients who meet implantation criteria without pacing indications.

For patients, these alternative implantation strategies may have cosmetic or comfort advantages. The 2-incision technique for lead placement, and subfascial and submuscular implantation of the PG have also been described.

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**Table 1** Summary of S-ICD* and TV-ICD (single-chamber) systems

|                  | S-ICD†          | TV-ICD                      |
|------------------|-----------------|-----------------------------|
| Preimplantation  | Requires ECG screening | No prescreening            |
| Pulse generator  | Subcutaneous, subfascial, or submuscular | Subcutaneous or submuscular |
| implantation     |                 |                             |
| Lead implantation| Subcutaneous, 2-incision vs 3-incision techniques | Transvenous, requires patent vascular access |
| Battery life     | 7.3–8.7 y[61]†  | 11–12 y,[62]† up to 13 y[63] |
| Pulse generator size | Larger (59.5 cc, 130 g)† | Smaller (30 cc, 68.9 g)[62] |
| Cost             | Higher          | Lower                       |
| Delivered energy | 80 J†           | 41 J                        |
| Energy required to | Higher         | Lower                       |
| defibrillate (J) |                 |                             |
| Capacitor charge time | Longer (14.6 ± 2.9 s) | Shorter (7.1 ± 1.8 s) |
| Shock waveform   | Biphasic        | Biphasic                    |
| Shock tilt       | Fixed, 50%      | Fixed, 50%                  |
| Pacing capability | Not available*  | Available                   |
| (ATP/brady/CF)   |                 |                             |
| Lead removal     | Less complex    | More complex                |
| Infection risk   | Lower (0.9%)    | Higher (1.9%)               |
| (4-y follow-up)  |                 |                             |
| Lead failure/complications | Lower (1.4%) | Higher (6.6%) |
| MRI compatible   | Yes             | Yes                         |
| Atrial arrhythmia monitoring | Yes (AF detection algorithm) | Yes (Various options) |
| Remote patient monitoring | Yes | Yes |

AF = atrial fibrillation; ATP = antitachycardia pacing; brady = bradyarrhythmia; CRT = cardiac resynchronization therapy; ECG = electrocardiogram; ICD = implantable cardioverter-defibrillator; MRI = magnetic resonance imaging; S-ICD = subcutaneous implantable cardioverter-defibrillator; TV-ICD = transvenous implantable cardioverter-defibrillator.

*S-ICD generation 3.

†Data on file with manufacturer. Based on analysis of >2900 Emblem patients followed on LATITUDE June 2017 (https://www.bostonscientific.com/content/dam/bostonscientific/Rhythm%20Management/portfolio-group/EMBLEM_S-ICD/Download_Center/EMBLEM-S-ICD-Spec-Sheet.pdf) and EMBLEM MRI S-ICD Model A209 & A219 User’s Manual 359480-001 EN US 2015-11. (https://www.bostonscientific.com/content/dam/Manuals/us/current-rev-en/359480-004_EMBLEM_S-ICD_Um_en-US_S.pdf).

‡Single-chamber transvenous Boston Scientific Model D140 Extended Longevity, Technical Manual (https://www.bostonscientific.com/content/dam/Manuals/au/current-rev-en/359499-004_ICD_PTM_en-AUS_S.pdf).

§Longevity estimates for Boston Scientific single-chamber TV-ICD device.

¶Programmable on-demand bradycardia pacing at 50 bpm for up to 30 seconds.

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|---|---|
|**Early studies of the S-ICD**| Several major S-ICD studies have shown that the S-ICD consistently demonstrates favorable safety and efficacy outcomes when used for the primary and secondary prevention |

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The submuscular technique is considered a preferred mode of PG implantation, especially in obese patients, because it reduces the distance between the coil and the PG, thus reducing shock impedance and defibrillation energy requirements.

The improvement in implantation techniques, device programming (prespecified with a conditional zone between 200 and 250 bpm), arrhythmia discrimination algorithm, and SMART Pass filter have also resulted in lower IAS rates and better outcomes.

In addition, >95% of S-ICD implants can be safely performed using anatomic landmarks and require zero or minimal fluoroscopic guidance. This offers some additional advantage to the operator, the staff, and the patient in helping to reduce the cumulative lifetime level of radiation exposure.
Table 2  Published major studies on S-ICD

| Study, year (Reference no.) | Design                                   | Study description                          | No. of patients | Age (y) | Primary prevention (%) | LVEF (%) | DFT success (%) | IAS (%) | Complications (%) | Data available      |
|-----------------------------|------------------------------------------|--------------------------------------------|-----------------|---------|------------------------|----------|-----------------|---------|-------------------|---------------------|
| CE study, 2011[35]          | Prospective, nonrandomized               | Initial clinical experience of the S-ICD   | 31              | 53 ± 16 | 67                     | 38.8 ± 15| 100             | 16.1    | 9.7               | 286 d (median)      |
| S-ICD IDE study, 2013[32]   | Prospective, nonrandomized, multicenter, observational registry | Premarket safety and efficacy               | 321             | 51.9 ± 15.5 | 79.4                   | 36.1 ± 15.9| 100       | 13.1 (mean 11–mo follow-up) | 7.9 (180-d complication rate) | 180 d                        |
| Global EFFORTLESS S-ICD Registry, 2017[37] | Nonrandomized, multicenter, registry | Postapproval safety and efficacy*         | 985             | 48 ± 17 | 64.9                   | 43 ± 18  | 99.5            | 2.3 (mean 3.1-y follow-up)  | 11.1 (mean 3.1-y follow-up) | 5 y                          |
| S-ICD system PAS study, 2017[36] | Nonrandomized, multicenter, registry | Postapproval safety and efficacy†         | 1637            | 53.2 ± 15 | 76.7                   | 32 ± 14.6| 98.7            | 0.2 (at 30 d) | 3.8 (at 30 d) | 30 d                           |
| PRAETORIAN trial, 2020[15] | International, randomized, noninferiority | Head-to-head comparison for safety and efficacy‡ | 426[1] vs 423[1] | 63 (54–69) vs 64 (56–70) | 81.2[1] vs 80.1[1] | 30 (25–35)[1] | 99.3[1] | 9.7[1] vs 7.3[1] (4-y cumulative incidence) | 5.9[1] vs 9.8[1] (4-y cumulative incidence) | 49.1 mo (median) |
| UNTOUCHED trial, 2021[11]  | Multinational, prospective, nonrandomized | Primary prevention using standardized programing and improved sensing algorithms[1] | 1116            | 55.8 ± 12.4 | 100                   | 26.4 ± 5.8| 99.2            | 4.1 (at 18 mo) | 7.3 (at 18 mo) | 18 mo                      |
| ATLAS trial, 2022[59]      | Randomized, multicenter, open-label, parallel group | Head-to-head comparison for safety and efficacy with the focus on younger patients | 251** vs 252[1] | 48 ± 12** vs 50 ± 11[1] | 63.7** vs 69.4[1] | NA     | NA             | 6.4** vs 2.8 (at 6-mo follow-up) | 4.4** vs 5.6 (at 6-mo follow-up) | 6 mo                           |

Values are given as number of patients, percentage (%), median (interquartile range), or mean ± SD.

ATLAS = Avoid Transvenous Leads in Appropriate Subjects; DFT = defibrillation threshold; EFFORTLESS S-ICD = Evaluation of Factors Impacting Clinical Outcome and Cost Effectiveness of the S-ICD; IAS = inappropriate shock; IDE = S-ICD System Investigational Device Exemption Clinical Investigation; LVEF = left ventricular ejection fraction; NA = not available; PAS = S-ICD System Post-Approval; PRAETORIAN = Prospective Randomized Comparison of Subcutaneous and Transvenous Implantable Cardioverter Defibrillator Therapy; S-ICD = subcutaneous implantable cardioverter-defibrillator; TV-ICD = transvenous implantable cardioverter-defibrillator; UNTOUCHED = Understanding Outcomes With the S-ICD in Primary Prevention Patients With Low Ejection Fraction.

*S-ICD generation 1.
†S-ICD generation 2.
‡S-ICD (patient received either generation 1 or generation 2).
*TV-ICD group.
§S-ICD generation 2 and generation 3.
**S-ICD generation 3 or subsequent newer generation.
Factors Influencing Selection of S-ICD vs. TV-ICD

- Limited vascular access
  - Venous occlusion
  - Venous anomaly
- Congenital heart disease
  - No venous access to heart
  - Intra-cardiac shunt
- Prior transvenous ICD infection
- Prior bacteremia
- High risk for infection
  - Immunodeficiency
  - Diabetes
  - Renal dysfunction
  - Immunosuppressive therapy
- On hemodialysis
- High risk for infection
- Need for venous access
- Young age
  - Need for multiple leads in lifetime
  - Active with increased risk lead failure
- Hypertrophic cardiomyopathy
  - High defibrillation energy requirement with TV-ICD
- Channelopathies
  - Index arrhythmia VT/PMVT
  - Often young patients
- Women
  - Higher risk complications TV leads compared with men
  - Cosmetic appearance/concealed
- Patient preference
- Need for bradycardia pacing
- Need for CRT
- Known need for ATP for frequent MMVT, without planned VT ablation
- Failed ECG screen (high risk inappropriate shocks)

Figure 1 Factors influencing selection of subcutaneous implantable cardioverter-defibrillator (S-ICD). CRT = cardiac resynchronization therapy; ECG = electrocardiogram; ICD = implantable cardioverter-defibrillator; MMVT = monomorphic ventricular tachycardia; PMVT = polymorphic ventricular tachycardia; TV = transvenous; TV-ICD = transvenous implantable cardioverter-defibrillator; VT = ventricular tachycardia.

of SCD (Table 2). The IDE (S-ICD System Investigational Device Exemption Clinical Investigation) study and the EFFORTLESS S-ICD (Evaluation of Factors Impacting Clinical Outcome and Cost Effectiveness of the S-ICD) registry, 2 earlier studies conducted in the United States and Europe, respectively, demonstrated the safety and feasibility of the S-ICD system for the primary and secondary prevention of SCD. The IDE study and the EFFORTLESS registry demonstrated high first-shock conversion efficacy of 88% and 92.1%, respectively, for any spontaneous ventricular arrhythmias. In a pooled analysis of 882 patients (results from the IDE study and the EFFORTLESS registry with mean follow-up of 22-months), the S-ICD continued to demonstrate favorable safety and efficacy. This study also noted an estimated 3-year all-cause mortality rate of 4.7% and a very low rate of lead issues (<1%) over the course of 3-year follow-up. It is also important to note the S-ICD had a very low rate of infection (<2%). In particular, there were no S-ICD related cases of endocarditis or bacteremia in the cohort with infection over the course of 3-year follow-up.

After publication of these studies that included observational and large registry data, recommendations were published in the 2015 European Society of Cardiology (ESC) guidelines and the 2017 American Heart Association/American College of Cardiology/Heart Rhythm Society (AHA/ACC/HRS) guidelines, giving the S-ICD a class IIa recommendation for patients who meet criteria for ICD implantation and do not require pacing therapy for bradycardia, ventricular tachyarrhythmia, or cardiac resynchronization. In addition, these guidelines gave the S-ICD a class I indication for the prevention of SCD in patients with limited vascular access or at high risk for infection who do not require pacing therapy for bradycardia, ventricular tachyarrhythmia, or cardiac resynchronization therapy.

Heart failure and other comorbidities

After initial approval by the FDA in 2012, the S-ICD was initially utilized in a minority of patients meeting indications for ICD therapy (2.0% in 2016 NCDR publication and 3.4% in 2019 Q1 NCDR registry quarterly report, according to data supplied by the NCDR registry to participating centers), often used as a “niche” device. Recent FDA recalls of the S-ICD system (due to risk of a short circuit, accelerated battery depletion, and electrode body fracture) also might have affected increased adoption of this technology in the United States. In the United States, the majority of patients (3/4) who undergo ICD implantation have a primary prevention indication, particularly for ischemic or nonischemic cardiomyopathy with reduced left ventricular (LV) function, a cohort who often have multiple comorbidities. However, it should be noted that previous S-ICD studies also included patients with heart failure, low ejection fraction (EF), and multiple comorbidities. Low EF patients were well represented in the IDE trial (mean 36% ± 16%, and 70% of patients with EF ≤35%). In the EFFORTLESS registry, patients with a broad range of underlying heart disease were represented, including 29% with ischemic cardiomyopathy and 17% with nonischemic cardiomyopathy. In the combined EFFORTLESS registry + IDE study, 42% had congestive heart failure and 35% had previous myocardial infarction. In the NCDR ICD registry, 74% had heart failure, 40% had previous myocardial infarction and 20% were on dialysis.
The UNTOUCHED (Understanding Outcomes With the S-ICD in Primary Prevention Patients With Low Ejection Fraction) study included only patients with primary prevention ICDs who had LVEF ≤35% (1116 patients implanted with an S-ICD). Compared with patients included in MADIT-RIT (Multicenter Automatic Defibrillator Implantation Trial-Reduce Inappropriate Therapy), which included only TV-ICDs, LVEF in UNTOUCHED was similar (27% ± 7% vs 26% ± 6%, respectively). In the PRAETORIAN (Prospective Randomized Comparison of Subcutaneous and Transvenous Implantable Cardioverter Defibrillator Therapy) trial, 426 patients had undergone S-ICD implantation, including 68% with ischemic cardiomyopathy, 23% with nonischemic cardiomyopathy, 66% with New York Heart Association functional class II–IV heart failure, and median EF 30%. Because there is a large amount of experience with the S-ICD in low EF populations with heart failure and multiple comorbidities, the S-ICD should not be considered a “niche” device.

The evidence and why choose the S-ICD over a TV-ICD?

The S-ICD may be preferred over the TV-ICD because of to the low rates of lead failure and clinically significant infections, specifically bacteremia, due to the absence of a transvenous lead. Specifically, this device may be preferred in patients with limited venous access, those with previous transvenous infection, those with conditions associated with a high risk of infection, such as dialysis or immunodeficiency states, and in patients with hypertrophic cardiomyopathy (who may have a high defibrillation threshold with TV-ICDs). Younger patients with an active lifestyle may be at higher risk for long-term lead failure and women may be at higher risk for procedural complications from transvenous leads, also potentially favoring the S-ICD (Figure 1).

Additional evidence supporting the S-ICD includes real-world data from registries. The NCDR ICD registry examined trends and in-hospital outcomes of S-ICD implantation in the United States (2012–2015), reporting outcomes of 3717 patients who underwent S-ICD implantation. In contrast to the IDE study and the EFFORTLESS registry, patients on chronic dialysis represented 20% of patients who underwent S-ICD implantation in this registry. Patients with the S-ICD had a high success rate of defibrillation testing (99.7%) at ≤80 J and low overall in-hospital complication rates (<1.0%) as well as low in-hospital mortality rates (0.1%), similar to outcomes of patients with single- or dual-chamber TV-ICDs.

PRAETORIAN was the first head-to-head trial comparing the S-ICD (426 patients) with the TV-ICD (423 patients) in general populations with an indication for ICD implantation in the United States (2012–2015), reporting outcomes of 3717 patients who underwent S-ICD implantation. In contrast to the IDE study and the EFFORTLESS registry, patients on chronic dialysis represented 20% of patients who underwent S-ICD implantation in this registry. Patients with the S-ICD had a high success rate of defibrillation testing (99.7%) at ≤80 J and low overall in-hospital complication rates (<1.0%) as well as low in-hospital mortality rates (0.1%), similar to outcomes of patients with single- or dual-chamber TV-ICDs.
patients), the S-ICD was proven to be safe and effective for use, even in older patients with multiple comorbidities and poorer cardiovascular function.\textsuperscript{31} This study also demonstrated a high defibrillation success rate (>92%), high complication-free rate (92.7%), and high IAS-free rate (95.9%) at 18 months without compromising patient safety.\textsuperscript{31} Evidence from these trials supports the use of the S-ICD in older patients and in patients with multiple comorbidities and lower EF.

IAS delivery is one adverse event of ICD therapy that has gained attention with both S-ICDs and TV-ICDs. Studies have shown that IAS greatly reduce quality of life and are associated with increased risk of all-cause mortality.\textsuperscript{45–47} Previous investigation has demonstrated overall similar rates of IAS among TV-ICD and S-ICD recipients, but the reasons for IAS delivery were more often related to supraventricular arrhythmias with the TV-ICD and T-wave oversensing with the S-ICD in a meta-analysis of case-controlled studies.\textsuperscript{48} Use of the SMART Pass filter technology (available in third-generation S-ICDs) and programming the S-ICD with a conditional zone between 200 and 250 bpm have greatly reduced T-wave oversensing and IAS delivery among S-ICD recipients without affecting safety outcomes.\textsuperscript{29,31,32,49,50} In the START (Subcutaneous versus Transvenous Arrhythmia Recognition Testing) study, the S-ICD even surpassed performance of TV-ICD algorithms in head-to-head comparisons of sensitivity and specificity using induced arrhythmias \textit{in vitro}.\textsuperscript{49} Figure 2 demonstrates a comparison of annual IAS rates across different major S-ICD and TV-ICD studies.

In addition, recent data from the ATLAS (Avoid Transvenous Leads in Appropriate Subjects) trial have once again proven that the S-ICD has lower major lead-related complications compared with the TV-ICD (0.4% vs 4.8%; \(P < .0003\)) at 6-month follow-up.\textsuperscript{51} In this study, there was no significant difference in ICD performance between the 2 devices with respect to the rate of IAS and failed first shock/arrhythmic death during 6-month follow-up.\textsuperscript{51} It is important to note that younger patients aged 18 to 60 years were enrolled in the ATLAS trial. Previous studies have shown that younger patients are at higher risk for TV lead failure/fracture, and there is an increased need for early reoperation in this age group.\textsuperscript{10,52,53} Therefore, we would highly recommend the S-ICD for primary prevention of SCD in younger patients with no indication for pacing.

Last, but not least, a recent systematic review and meta-analysis, which was a pooled analysis of 5 high-quality studies (1195 patients received S-ICD; 1192 patients received TV-ICD), reported that patients implanted with the S-ICD had a lower risk of lead-related complications (risk ratio [RR] 0.14; \(P < .0001\)) at 30 to 60 months of follow-up.\textsuperscript{55} Both the S-ICD and TV-ICD seemed to have similar rates of device-related complications (RR 0.59; \(P = .07\)), similar rates of infection (RR 0.94; \(P = .897\)), similar rates of appropriate shock therapy (RR 0.87; \(P = .732\)), and no significant differences in IAS therapy (RR 1.06; \(P = .695\)) and all-cause mortality (RR 1.02; \(P = .943\)).\textsuperscript{54}

In summary, there certainly are many important points and tradeoffs to consider when selecting either the S-ICD or the TV-ICD. The implanting physician should be open-minded and consider the evidence because both types of devices are indicated for many patients undergoing ICD implantation. This can be a tough decision for patients. Hence, it is utterly important for us, their trusted health care providers, to adopt a shared decision-making model and provide the most up-to-date clinical evidence when selecting between the S-ICD and the TV-ICD for sudden death prevention. Figure 1 outlines considerations for device selection and situations for which the S-ICD may be preferred, or not preferred, over TV-ICDs.

### Current limitations of the S-ICD

There are some current known limitations of the S-ICD system as mentioned previously (Table 1), including shorter battery lifespan, larger PG size, lack of pacing support, and lack of direct atrial arrhythmia recording. However, major improvements and advancements have been made in S-ICD technology over the past few years. These include enhanced battery longevity, smaller PG size, and algorithms to help with detection of atrial arrhythmias despite absence of an atrial lead. In appropriately selected patients, there is a very low risk of needing a TV-ICD system for pacing indications.\textsuperscript{15}

Investigation is underway evaluating the combination of a leadless pacemaker or a cardiac contractility modulation device with the S-ICD system, which seems to be feasible and effective in small animal and human case studies.\textsuperscript{55–59} The concept of combined leadless pacing with the S-ICD currently is being evaluated in a larger study—MODULAR ATP (Effectiveness of the EMPOWER\textsuperscript{™} Modular Pacing System and EMBLEM\textsuperscript{™} Subcutaneous ICD to Communicate Antitachycardia Pacing).\textsuperscript{60} Until then, the S-ICD is indicated in a wide variety of patients without cardiac pacing indications for all the reasons noted here and should be strongly considered as upfront therapy at the time of initial ICD implantation in the shared decision-making process.

### Conclusion

Available evidence strongly supports use of the S-ICD in patients without cardiac pacing indications for the primary and secondary prevention of SCD. Although previous guidelines gave the ICD a class IIa indication, they were written before the availability of data from more recent trials, and it is anticipated that this level of recommendation will be elevated with the next guideline update. In addition, the S-ICD may be preferable to TV-ICD systems in certain special populations, including younger patients, women, those with vascular access issues, patients at high-risk for CIED infection (previous CIED infection, recent endocarditis, prosthetic heart valve replacement, dialysis, or immunodeficiency states), and those with complex congenital heart disease. It may also be a good device for patients with...
hypertrophic cardiomyopathy (who may have high defibrillation thresholds with TV-ICDs) and inherited arrhythmogenic syndromes (often young patients with a low risk for development of monomorphous ventricular tachycardia). In any case, a patient-centered approach and a shared decision-making model that provides the most up-to-date clinical evidence should be utilized when selecting between the S-ICD and the TV-ICD for sudden death prevention.

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