Implantable cardiac defibrillators (ICD) are recommended for those deemed at risk of ventricular arrhythmia (VA) and sudden cardiac death (SCD) on either a primary or secondary prevention basis.¹ In one meta-analysis, secondary prevention ICD’s were associated with a 28% reduction in mortality.² The number of ICDs being implanted is increasing and in 2014, >6,000 ICDs were implanted in the United Kingdom.³

The Transvenous Route
The transvenous (TV) approach is conventional; using either a cephalic, axillary or subclavian vein for lead insertion, and local anaesthesia for a pre-pectoral generator pocket. This route, by merit of endocardial contact, allows for bradycardia pacing, Anti-Tachycardia Pacing (ATP) and Cardiac Resynchronisation Therapy (CRT). However, there are risks associated with TV access including pneumothorax, lead displacement or myocardial perforation.⁴ The most common complications arising from device implantation are lead-related, with a 2.3-6.4% occurrence quoted.⁵, ⁶ Leads may fail, become damaged or infected,⁷ often necessitating lead revision or extraction. Some patients have challenging venous access and those with lines or fistulae are at higher risk of device infection.⁸ TV lead placement is associated with progressive venous stenosis and obstruction with 65% incidence found at 6 months,⁹ increasing the complexity of any subsequent lead revisions or extractions. Thus, for younger patients, or those at risk of infection, the chance of a lead complication from TV access increases as the leads age and with each re-intervention.

The Subcutaneous ICD
The larger, electrically active subcutaneous (S-ICD) generator is implanted in a mid-axillary pocket with a tunneled shock coil running horizontally toward the xiphisternum and then tunneled superiorly, parallel to the sternal border (Figure 1). This positioning creates the necessary electrical vectors from the coil to the can. The S-ICD will deliver shock therapy across the myocardium in the event of sensed VA, and up to 30 seconds of post-shock bradycardia pacing. Given the larger pocket, lead positioning and currently recommended Defibrillation Threshold (DFT) testing, the S-ICD is often inserted under general anaesthesia (GA), although deep sedation techniques are also described.¹⁰

Take Home Messages
- Defibrillators may be implanted via transvenous or subcutaneous routes
- Choosing the right approach for the patient may reduce morbidity
- The subcutaneous ICD particularly benefits younger patients or those with previous device infections
- The transvenous route remains useful for those needing pacing therapy

Promoting excellence in cardiovascular care
Table 1 summarises some features that can be considered when deciding between TV or S-ICD as part of a shared decision making process. These are discussed in more detail below:

Advantages of the Subcutaneous ICD
The S-ICD will deliver shock therapy for VA, whilst leaving TV routes patent and avoiding the inherent risks of TV access outlined above. It offers a comparable implant time of ~70 minutes, with a 5-10 implant learning curve suggested for new operators. The 2% risk of major complications (infection, haematoma) is much lower than for TV routes. Younger patients, those with prior device infections or TV complications are particularly recommended for the S-ICD which can be revised or removed with significantly less risk of morbidity. The S-ICD is effective in both primary and secondary prevention cohorts and there was no lead deterioration seen at three years in one study of >800 patients. On efficacy analysis, 90% of VA are terminated with a single 80J shock, with 98% efficacy overall, comparable to TV systems.

Some have expressed concern that patients receiving S-ICD will later progress to require endocardial pacing, particularly those needing beta-blockers. The numbers of patients requiring their S-ICD be replaced with a TV system for endocardial pacing appears low, with 0.8% incidence described at three years. In this study, a number of patients receiving the S-ICD were already on beta-blockade as part of standard heart failure therapy, however, those who were commenced on beta blockers post S-ICD implant did not see an increased need for conversion to a TV system. With the S-ICD still being relatively new, a long term analysis of outcomes and cost-comparisons of the two systems is still awaited.

Figure 1. PA and lateral chest radiograph following S-ICD implantation
Caveats of the Subcutaneous ICD
Due to the activation of surrounding musculature, the S-ICD is more painful when it fires and those with traditional indications for CRT or bradycardia pacing should be offered a TV system. Although 90% of VA are terminated with a single shock, the benefit of minimising shocks with ATP is important to consider when planning device therapy. Patients with recurrent monomorphic VT for example are most likely to derive benefit from ATP whilst patients with a primary prevention indication for ICD may prefer the benefits of an S-ICD.

Correct generator and lead placement is essential for effective device function and can be more challenging in obese patients. Optimum device placement can be improved by marking desired generator and lead positioning on the patient’s skin prior to commencing the procedure and by radiographically checking adequate depth and positioning of the lead along the parasternal line. As with any cardiac device, the S-ICD relies on adequate sensing of the cardiac electrogram and inappropriate shock therapy is a risk (usually due to T wave oversensing or supraventricular tachycardia >170bpm). This was reported as 13% incidence at 3 years, although is now reducing with increased operator experience, dual zone programming and pre-implant testing. Battery longevity is slightly less than TV ICDs with 46% of patients requiring generator change by 5 years.

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<thead>
<tr>
<th>Features Favouring TV-ICD</th>
<th>Features Favouring S-ICD</th>
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<tr>
<td>Endocardial Pacing required or anticipated-CRT, bradycardia</td>
<td>Previous device infection</td>
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<tr>
<td>Limited ability to deliver deep sedation or general anaesthesia</td>
<td>Long-term venous access in situ</td>
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<tr>
<td>Concerns over T-wave over-sensing</td>
<td>Challenging venous anatomy</td>
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<tr>
<td>Monomorphic VT responsive to ATP</td>
<td>Younger age</td>
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<td>Patients at risk of infection- diabetes, recurrent infections</td>
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Table 1. Summary of some features which favour either the transvenous or subcutaneous ICD

Regional Anaesthesia
Implanting the S-ICD is more painful for patients and many require opiate analgesia for several days post-discharge. Some centres are utilising truncal plane blocks (TPB) to reduce patient discomfort during implant and recovery, and the methods described may assist those implanters who wish to move away from GA whilst maintaining patient comfort. One study compared TPB + deep sedation vs TPB + GA, observing reduced opiate use from the patients in the deep sedation arm, however no difference in procedure or recovery time suggesting the TPB may improve comfort for patients, but not necessarily lab efficiency. This remains an under-investigated area.
Conclusion

The ICD is now a well-established therapy and its benefits are evident in primary and secondary prevention cohorts. Many will have encountered the pitfalls associated with TV access including lead displacement, damage, infection and the morbidity and mortality associated with TV lead removal. The S-ICD shows equivalent efficacy to TV systems although appropriate patient selection is paramount. Patients facing decades of device therapy are more likely to encounter complications related to TV access and lead failure and may derive increased benefit from an S-ICD. TV access remains vital for those requiring endocardial pacing, however, rates of conversion from an S-ICD to TV system for endocardial pacing appear low. The risk of T wave over-sensing with the S-ICD can be reduced by pre-implant screening, two-zone programming and optimal lead positioning at implant. It is anticipated we will see increasing use of the S-ICD for appropriate patients and with increasing familiarity and rates of implantation, more long-term analysis of the S-ICD will emerge.
References


