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Clinical EVIDENCE

Reducing Clinical Burden via Remote ICM Programming

Real-world Use of Insertable Cardiac Monitor Remote Programming: a Multicenter European Experience (Fareh et al.)[1]

ICD and CRT-D Battery Longevity by Manufacturer

Battery Longevity in Modern Implantable Cardioverter-Defibrillators and Cardiac Resynchronization Therapy-Defibrillators (Nishino et al.)[2]

Is Routine Defibrillation Testing Still Needed in S-ICD?

Defibrillation Testing During Implantation of Subcutaneous Implantable Cardioverter Defibrillators (Kerkouri, et al.)[3]

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Summary

This issue of Clinical Evidence focuses on the LUX-Dx™ Insertable Cardiac Monitor (ICM), ICD battery performance and the subcutaneous implantable cardioverter defibrillator (S-ICD).

A recently published European experience highlights the role of LUX-Dx remote reprogramming and alert-based strategies in improving monitoring efficiency and reducing clinical workload.

Recent multi-manufacturer analyses from a Japanese hospital confirmed the consistently strong performance of Boston Scientific's implantable cardiac devices in terms of battery longevity.

The section dedicated to the S-ICD examines a recently published study involving a large national cohort. This analysis, derived from the French HONEST Registry, provides a comprehensive overview of contemporary clinical practice in France regarding intraoperative defibrillation testing. The study further provides reassuring evidence on patient outcomes when defibrillation testing was omitted.

Reducing Clinical Burden via Remote ICM Programming

Remote programming of ICMs to optimise clinical efficiency

Insertable cardiac monitors (ICMs) are widely used to detect arrhythmias and guide clinical decision-making, but they generate a substantial volume of transmissions, often leading to increased workload for remote monitoring clinics.

The LUX-Dx™ ICM features remote programming capabilities that allow clinicians to adjust device settings without requiring in-person visits.

In this multicentre European study recently published on Heart Rhythm O2, Fareh *et al* [1] evaluates the real-world impact of remote programming, demonstrating how it can reduce transmission burden, optimise clinical workflows, and improve resource efficiency, while maintaining diagnostic accuracy.

697 LUX-Dx ICM implantation procedures in 23 European centres

Median follow-up **9 months**

401 reprogramming events in 230 patients (0.8 reprogramming per patient-year)

156 (39%) reprogramming events were performed **remotely**

Changes in programming setting

- **Lower detection sensitivity** for a more stringent alert criteria.
- Most frequently involved the **parameters for bradycardia detection**.
- **Higher frequency of changes in patients implanted for syncope or reasons classified as "other"**.

A paired analysis showed significant reductions of the rate of transmissions, alerts, and recorded episodes, after reprogramming (all p<0.001).

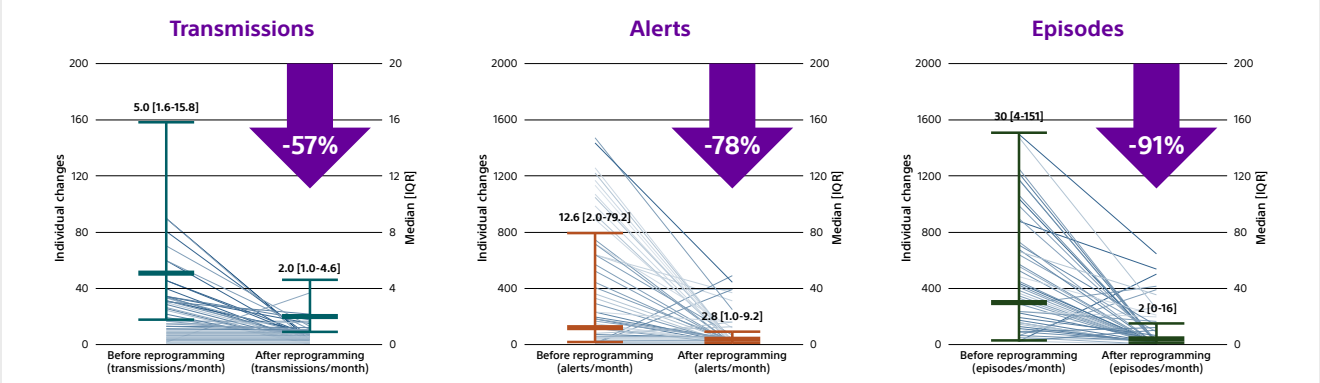


Figure 1. Rates of transmissions, alerts and recorded episodes before and after reprogramming for patients who underwent reprogramming.

Managing a patient with an ICM required **7.1 hours of staff time annually**, equivalent to 0.36 full-time employees per 100 patients.

The combined effect of:

2.1 Hours + **20** Minutes = **2.4** Hours

Alert-based strategy – saving of a median of **2.1 hours per patient-year**

Remote reprogramming – saving of **20 minutes per patient-year**

Total saving of 2.4 hours/year per patient

Key findings:

- ICM reprogramming plays a key role in optimising device performance, leading to a **reduction in transmissions, alerts, and recorded episodes**.
- The LUX-Dx remote reprogramming feature shows **strong potential for broader adoption,** minimising the need for in-office visits and contributing to overall workflow efficiency.
- Shifting to an alert-based strategy could **eliminate scheduled transmissions** and **reduce clinic follow-up workload** by up to one-third.

ICD and CRT-D Battery Longevity by Manufacturer

New evidence on battery longevity of ICD and CRT-D devices

High-voltage devices (ICDs and CRT-Ds) are essential for patients at risk of sudden cardiac death, but generator replacements remain a clinical and economic challenge. Battery depletion is now the leading cause of replacement, despite recent improvements in device longevity[5].

To better understand this issue, Nishino *et al*[2] evaluates battery performance of ICD and CRT-D devices across major manufacturers in a contemporary patient cohort.

The analysis evaluated **353 patients** who underwent ICD or CRT-D implantation or replacement at Hokkaido University Hospital between 2012 and 2021: 63 with devices from Abbott (formerly St. Jude Medical), 150 from Boston Scientific (BSC), and 140 from Medtronic (MDT). The cohort included 244 ICD and 109 CRT-D.

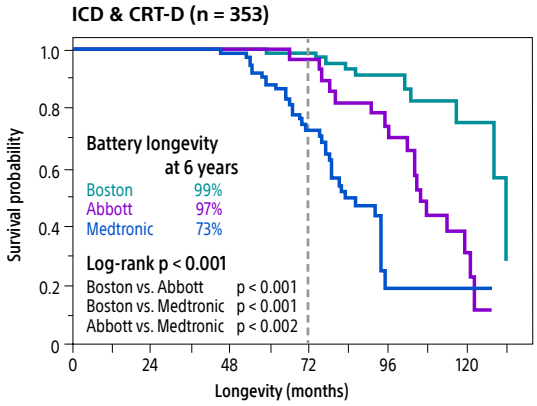


Figure 2: Kaplan–Meier curve showing battery longevity by manufacturer for all devices combined (ICDs and CRT-Ds).

Follow-up

During a median follow-up period of 59 months, 50 patients (14%) died before undergoing device replacement, while 79 patients (22%) had their devices replaced or removed for various reasons. Among these, **63 patients (18%) required replacement specifically due to battery depletion**: Boston Scientific: 7%, Abbott: 29%, Medtronic: 25%.

Device longevity

The 6-year **survival rates for ICDs** were:

- 100% for Boston Scientific
- 100% for Abbott
- 91% for Medtronic

The 6-year **survival rates for CRT-Ds** were:

- 93% for Boston Scientific
- 80% for Abbott
- 21% for Medtronic

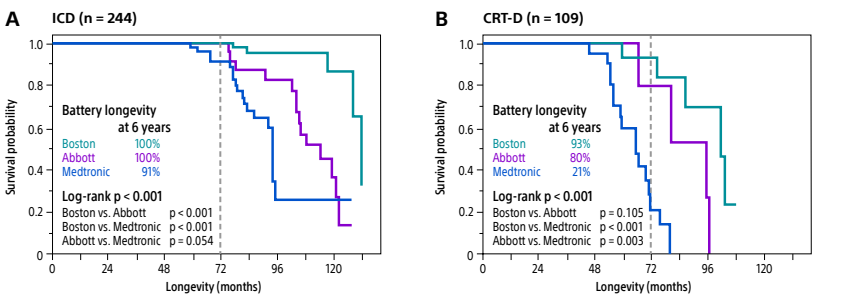


Figure 3: Kaplan–Meier curve showing battery longevity by manufacturer for ICDs only (A) and CRT-Ds only (B).

Predictors of battery depletion

Shock therapies and total shock energy were not associated with battery depletion. Multivariate analysis confirmed the following independent predictors of battery depletion:

Device manufacturer	Device type	Ventricular pacing
Boston Scientific associated with lower risk	**ICDs showing lower risk than CRT-Ds**	**Percentage of Ventricular Pacing**
BSC vs. Abbott: HR 0.13; BSC vs. MDT: HR 0.02	ICD vs. CRT-D: HR 0.23	per 10%: HR 1.16

Key findings:

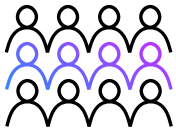
- The study demonstrated **significant differences in battery longevity among manufacturers**, with Boston Scientific showing superior performance and being the only brand whose replacement rate due to battery depletion was lower than the mortality rate during follow-up.
- Prioritising devices with longer battery life and understanding depletion factors can improve patient outcomes and guide more cost-effective resource allocation.

"The superior performance of **Boston Scientific** devices may **reduce the frequency of generator replacements**, thereby minimising risks such as infection and lead damage and reducing healthcare costs, especially in younger patients[2]."

Long-term impact of defibrillation testing during S-ICD implantation

The HONEST (coHOrte fraNcaise des dEfibrillateurs Sous cuTanés) study is a nationwide, ongoing observational registry including all S-ICD recipients in France between 2012 and 2019. Recently, Kerkouri *et al.*[3] analysed data among 4,924 patients from this registry to assess the safety, efficacy, and contemporary relevance of defibrillation testing (DT) performed during subcutaneous ICD (S-ICD) implantation.

150 centres



4,924 patients
implanted with S-ICDs in France between 2012 and 2019

DT (-): n = 859

DT (+): n = 4,065

Mean follow-up
4.2 years

17.4%
No DT

A total of 4.066 patients (82.6%) underwent implantation with DT. A significant temporal trend was observed, with 85.4% of patients undergoing testing in 2012-2014 period compared with 66.9% in 2019 (P for trend <0.001).

99%
Success rate

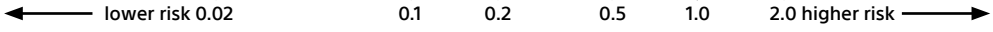
DT was successful in 99.0% of cases, with no significant temporal trend in the failure rates over the years.

Z≥89
Impedance

Independent predictors of DT failure were obesity (BMI ≥ 30kg/m²) and elevated shock impedance (≥89 Ω).

Clinical outcomes associated with DT (-) compared to DT (+)

Outcomes	Forest plot	HR (95% CI)	P Value
Appropriate shocks		1.01 (0.78-1.30)	0.945
Inappropriate shocks		0.98 (0.78-1.23)	0.865
Death		1.17 (0.86-1.61)	0.313
Cardiovascular death		1.04 (0.70-1.56)	0.846
Sudden cardiac death		0.27 (0.04-1.72)	0.167
Composite unknown/sudden cardiac death		0.97 (0.57-1.78)	0.670



Clinical outcomes according to DT status

During a mean follow-up of 4.2 ± 2.2 years:

- DT omission was not associated with increased risks of overall mortality, cardiovascular mortality or sudden cardiac death.
- The proportion of patients experiencing appropriate shocks was comparable between the groups (3.2 vs. 2.8 per 100 person-years) as well as those with inappropriate shocks (incidence rates of 2.8 and 2.7 events per 100 person-years).
- No cases of ineffective shocks were observed in the non-tested group.

Key findings:

- The use of **DT has decreased over time**, despite guidelines recommendations to perform DT to ensure reliable arrhythmia detection and termination.
- **DT can be safely omitted for most S-ICD recipients** – particularly those with low shock impedance – while selectively performing DT in higher-risk subgroups (elevated impedance ≥89 Ω or obesity).

"These results may guide future guidelines toward **individualised rather than universal DT strategies**, thereby minimising unnecessary procedural risks, such as anesthesia-related complications, and hemodynamic compromise – particularly important in patients with reduced LVEF – **without compromising patient safety**[3]."

"Long-term low-voltage impedance measurements in subcutaneous implantable cardioverter-defibrillators"[4]

Mugnai G. et al.

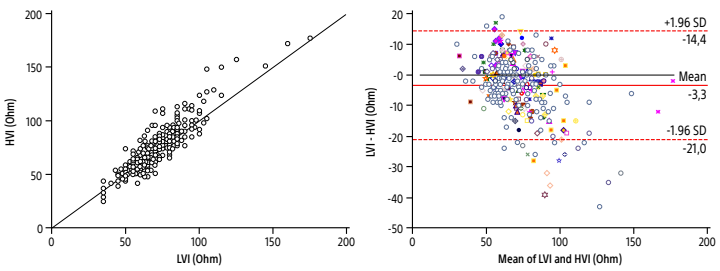
High-voltage impedance (HVI), measured during subcutaneous implantable cardioverter-defibrillator (S-ICD) implantation through defibrillation testing or synchronised shock, is known to correlate with defibrillation efficacy[5, 6].

Recently, S-ICD systems have been enhanced to automatically perform long-term low-voltage impedance (LVI) measurements using a 1-V subthreshold pulse.

This analysis evaluated data extracted from 1,226 patients who underwent de novo S-ICD implantation across 15 Italian centres, aiming to assess LVI as a surrogate for HVI and to characterise its long-term trends in S-ICD recipients.

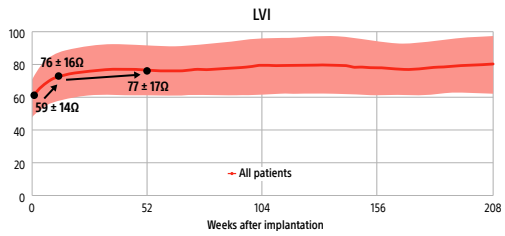
What are the key results?

Strong agreement between LVI and HVI



LVI measurements recorded via the S-ICD strongly correlated with HVI values, supporting the potential use of **LVI as a non-invasive surrogate for HVI.**

Long-term stability after an initial period of progressive increase



LVI *increased progressively during the first weeks post implantation and* **stabilised by the third month**.

Implantation variables influenced LVI values, with **lower impedance** *observed in* **intermuscular** *placements and in patients with* **thinner subcoil fat**.

"An impedance measurement that does not require shock delivery and is automatically performed by the device provides a valuable tool for assessing defibrillation efficacy during follow-up and verifying proper system positioning at the time of implantation[4]."

Key Messages

- **Reducing Clinical Burden via Remote ICM Programming**
  Real-world findings[1] show that strategic LUX-Dx™ ICM reprogramming can reduce transmissions, alerts, and episodes. Remote reprogramming and alert-based monitoring offer a valuable opportunity to ease clinical workload, with strong potential to minimise in-office visits and optimise workflow.
- **ICD and CRT-D Battery Longevity by Manufacturer**
  Nishino *et al.*[2] demonstrated in a contemporary cohort, device longevity varied significantly across manufacturers, underscoring the clinical, economic, and policy relevance of selecting devices with longer battery life to reduce complications and optimise healthcare resources.
- **Is Routine Defibrillation Testing Still Needed in S-ICD?**
  Defibrillation testing (DT) during S-ICD implantation remains highly effective but its necessity is increasingly questioned: in the large nationwide HONEST registry, Kerkouri *et al.*[3] demonstrated that the absence of routine DT did not compromise safety or efficacy outcomes, supporting a more individualised approach to defibrillation testing.

Key Messages & References

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6. Ziacchi M, Ottaviano L, Checchi L, *et al.* The risk of failure of subcutaneous implantable cardioverter defibrillator therapy: from PRAETORIAN score to clinical practice. Europace. 2025 Feb 5;27(2):euaf011. doi: 10.1093/europace/euaf011.
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