# The Implantable Loop Recorder
## An Evolving Diagnostic Tool

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**KEYWORDS**

• Implantable loop recorder • ILR • Clinical • Review • Syncope

**KEY POINTS**

- Implantable loop recorder (ILR) technology has undergone important improvements since first being used clinically in the late 1990s.
- In addition to a longer battery life and greater event storage capacity, improved arrhythmia-detection algorithms and remote monitoring capabilities have increased the number of potential applications of this prolonged rhythm monitoring strategy.
- Future iterations currently under development will result in further reduction in size, ease of implantation, and the addition of other sensors to expand usefulness.
- Although presently recommended by international guidelines primarily in the work-up of syncope, routine ILR implantation may gain greater acceptance in the future for other indications, including the work-up of cryptogenic stroke, atrial fibrillation monitoring following catheter ablation procedures, or to guide anticoagulant therapy and risk stratification for sudden cardiac death.

### INTRODUCTION

Implantable loop recorders (ILRs) were initially developed in the 1990s, as microprocessor technology was being introduced into other cardiac implantable electronic devices. Automated event detection was made possible by heart rate–based algorithms that triggered recordings below or above a prespecified heart rate. Patient-triggered event detection (via a wireless device outside the body) was also featured, which allowed symptom-rhythm correlation. Since their first development, extensive clinical investigation and important improvements have made ILRs an integral part of modern cardiology practice. The ILR has traditionally been used in the work-up of recurrent, unexplained syncope, but recent studies have explored novel uses for the prolonged monitoring afforded by ILRs.

### HOW IT WORKS

ILRs in current use for syncope (Medtronic Reveal DX, Medtronic Reveal XT, and St Jude Medical Confirm) are small, rectangular, titanium-encased devices with an estimated battery life of up to 3 years (Fig. 1). The devices are free from external conductors or leads and are therefore magnetic resonance imaging compatible (after an appropriate healing period following implantation). Subcutaneous placement parallel to the sternum usually allows adequate sensing of cardiac electrical activity, but surface estimation of the optimal sensing vector can also be performed. The sensing bipoles on the ILR are located on opposing ends of the device in order to maximize sensed electrical activity from the heart. As with other cardiac implantable electronic devices, sensed signals are amplified to allow

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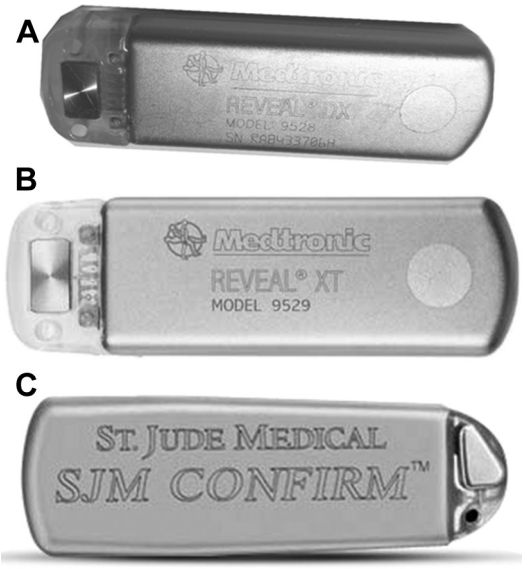


**Fig. 1.** ILRs in current use for syncope. (*A*) Medtronic Reveal DT, used for syncope. (*B*) Medtronic Reveal XT, used for syncope and/or atrial arrhythmia monitoring. (*C*) St Jude Medical Confirm, used for syncope and/or atrial arrhythmia monitoring. (*Courtesy of* [*A, B*] Medtronic, Minneapolis, MN. Copyright © Medtronic Inc. 2014; and [*C*] Confirm and St. Jude Medical are trademarks of St. Jude Medical or its related companies. Reprinted with permission of St. Jude Medical, © 2014. All rights reserved.)

signal processing and filtered to isolate the intrinsic deflection components of the electrogram.[1] The logic circuit is microprocessor driven and allows the identification and storage of rhythm recordings of interest. Early devices were limited in their storage capacity for rhythm events of interest, but this is not a major issue in modern devices.

Communication with the implanted device takes place via radiofrequency communication (telemetry). Options for ILR follow-up now include remote, transtelephonic monitoring in addition to standard, in-person device interrogation via a device programmer (Fig. 2). Patients who are followed remotely are provided with a home monitor, which transmits (automatically, in real time or at scheduled intervals) encrypted data via a standard telephone line. The transmitted data are stored on dedicated servers (Medtronic CareLink or St Jude Medical Latitude network) and can be accessed online by caregivers using a desktop computer or smartphone.[2] The potential benefits of remote ILR monitoring include patient convenience, the ability to provide constant surveillance, and early detection of asymptomatic arrhythmias.[3] However, criteria for automatic event detection and transmission must be carefully chosen in order to avoid the potential burden of analyzing excessive data.[4]

ILRs are also packaged with an external activator device that patients or bystanders can use to trigger a device recording in the event of a symptom (such as presyncope, palpitations, or syncope). Pressing the button on the activator while holding the device over the ILR triggers the ILR to save a SYMPTOM episode, with retrospective and prospective rhythm monitoring. This feature is particularly useful in that it allows patients to capture episodes despite a significant delay in signal transmission, which may occur with episodes of unheralded syncope.

The implantation procedure is generally well tolerated under local anesthesia and conscious sedation, with minimal risks aside from minor bleeding and, rarely, local infection. An injectable ILR (Medtronic Injectable Reveal) has been in development for several years and is expected to be released for clinical use in 2014.

## CLINICAL APPLICATION

### *Syncope*

Syncope remains the most extensively studied clinical indication for ILR implantation. In the largest published study of ILR use to date (the PICTURE registry), ILR data contributed to a definitive diagnosis in 78% of patients after a mean follow-up

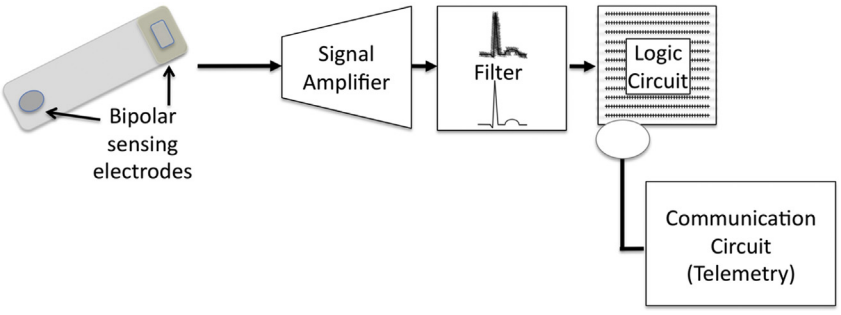


**Fig. 2.** Simplified ILR components.