# Real-world battery longevity of Implantable Loop Recorders implanted for Unexplained Syncope: results from a large single center registry

L. Duvillier[1], A. Demolder[1], S. Van Renterghem[1], C. De Mey[1], F. West[1], and Jan De Pooter[1]

[1]Universitair Ziekenhuis Gent Hartcentrum

July 16, 2024

**Abstract**

**Background/Purpose** Implantable loop recorders (ILR) are increasingly used in cardiac rhythm monitoring and diagnostic work-up of unexplained syncope. ILR battery longevity according to manufacturers' product performance specifications typically ranges between two to four years, but real-world data in this population are lacking. **Methods** This monocentric, prospective, observational study included consecutive patients with unexplained syncope undergoing ILR implantation between 10/2007 and 10/2019 The main purpose was to determine real-world battery longevity of ILR. Diagnostic yield and relationship between arrhythmogenic diagnosis and duration of ILR-monitoring was explored. **Results** The study included 309 patients (59 years [38-73], 49% female) with ILR implantation for unexplained syncope. Median battery longevity was 42 [40-45] months. 99.5% of ILR reached prespecified battery longevity. The time to end-of-life varied by up to 33 months among the same ILR models. Overall arrhythmogenic diagnostic yield counted 27% (73% sick sinus syndrome, 20% atrioventricular block and 7% ventricular tachycardia). Median time to diagnosis was 10 [2-25] months, with the latest event at 43 months. The cumulative diagnostic yield for arrhythmogenic event was 15.7%, 22.9%, 34.9% , 54.2%, 72.3% and 100% at 1, 2, 6, 12, 24 and 48 months respectively. In univariate analysis, 1 $^{st}$ degree AV-block and prolonged HV time on EP study were predictors of diagnosis, while QRS duration abnormality borderline missed significance. **Conclusions** Real-world battery longevity of ILRs matched industry projected longevity in 99.5% of patients implanted with ILR for unexplained syncope. A battery longevity of minimum 3.5 years is recommended to maximize the diagnostic yield in this population.

not-yet-known not-yet-known

not-yet-known

unknown

Abstract

**Background/Purpose**

Implantable loop recorders (ILR) are increasingly used in cardiac rhythm monitoring and diagnostic work-up of unexplained syncope. ILR battery longevity according to manufacturers' product performance specifications typically ranges between two to four years, but real-world data in this population are lacking.

**Results**

The study included 309 patients (59 years [38-73], 49% female) with ILR implantation for unexplained syncope. Median battery longevity was 42 [40-45] months. 99.5% of ILR reached prespecified battery longevity. The time to end-of-life varied by up to 33 months among the same ILR models. Overall arrhythmogenic

diagnostic yield counted 27% (73% sick sinus syndrome, 20% atrioventricular block and 7% ventricular tachycardia). Median time to diagnosis was 10 [2-25] months, with the latest event at 43 months. The cumulative diagnostic yield for arrhythmogenic event was 15.7%, 22.9%, 34.9% , 54.2%, 72.3% and 100% at 1, 2, 6, 12, 24 and 48 months respectively. In univariate analysis, 1st degree AV-block and prolonged HV time on EP study were predictors of diagnosis, while QRS duration abnormality borderline missed significance.

**Conclusions**

Real-world battery longevity of ILRs matched industry projected longevity in 99.5% of patients implanted with ILR for unexplained syncope. A battery longevity of minimum 3.5 years is recommended to maximize the diagnostic yield in this population.

**Keywords:** Implantable loop recorder; Battery longevity; Home monitoring

## Introduction

Syncope is a form of non-traumatic, transient loss of consciousness due to hypoperfusion of the brain and can further be divided in cardiac syncope, reflex syncope or syncope due to orthostatic hypotension (1). It is a common condition (30-40% life time prevalence) (2, 3), with around 6 cases per 1000 person-years (4) and has a high rate of recurrence within the same year (up to 43%)(5). Conventional diagnostic work-up results in 30% of syncope cases remaining unexplained (2, 6), with an increased risk of recurrence and therefore trauma, or fatalities (2, 7). Digital wearables are increasingly used by patients, but are expensive (8). Diagnostic yield of Holter monitoring in patients with infrequent symptoms, is low (9). Therefore the early use of an Implantable Loop Recorder (ILR) in the diagnostic work-up of unexplained syncope, thought to be of cardiac etiology, is strongly recommended (1, 10-12). ILRs allow long-term surveillance of a single lead ECG and have been shown to be an effective tool in detecting clinically relevant arrhythmias (13-17), thereby leading to an earlier diagnosis. This early diagnosis results in less burden of further syncope (18), reduction in additional investigations, fewer hospitalization days and significant healthcare cost reduction (13, 19, 20). In a meta-analysis of five randomized controlled trials (RCTs) (660 patients), ILR implantation was 3.7 more probable of finding a diagnosis, compared to the conventional work-up (Holter, tilt testing, EP study) (13-17, 21). This way, ILR have a positive impact on survival of these patients, likely to the higher rate of device therapy (22). The median time to diagnosis, found in a large meta-analysis, is approximately 4 months (23). However, it remains unclear up to what point in time relevant arrhythmogenic diagnoses can be detected. Manufacturers of the latest generation of ILRs claim a minimum battery longevity between 2 and 4 years, but real-world data about ILR battery longevity are lacking. This study explores the battery longevity and the time relationship with the diagnostic yield of ILR implanted for unexplained syncope.

## Materials and methods

### Study population

This observational, prospective, single center study included all consecutive patients with unexplained syncope in whom an ILR was implanted in the period of 10/2007 – 10/2019 at the Ghent University hospital, Belgium. Inclusion was halted in 2019, since the main goal of this study was to focus on battery longevity. Patients were implanted with an ILR if syncope was suspected to be of cardiac origin and remained unexplained after a conventional diagnostic workup, in accordance with recent guidelines. (1).

ILR of different brands (Medtronic, Abbott and Biotronik) were implanted according to the preference of the referring or implanting physician. Programming of ILR was tailored to the individual patient. All ILRs were implanted in a dedicated electrophysiology lab. History, clinical information concerning the syncope event, comorbidities, ECG and laboratory results were retrieved from the electronic patient file. The study was approved by the local Ethics committee.

### Follow-up and endpoints

All ILR patients underwent follow-up by remote home monitoring and regular clinical follow-up at 1 and 6 months after implant. After this initial period, the frequency of in-clinic follow-up varied between 6 to 12

months, depending on physician preference. History, clinical examination and interrogation of the ILR were routinely performed at each of the clinical follow-up consultations.

Remote monitoring alerts were checked five days a week by dedicated staff members experienced in device interrogation and follow-up. All arrhythmogenic events, potentially cause related with syncope, such as prolonged pauses (>3 seconds), type 2 2$^{nd}$degree atrioventricular (AV) block or 3$^{rd}$ degree AV-block as well as fast supraventricular tachycardia (SVT) or ventricular tachycardia (VT) were registered and adjudicated by an electrophysiologist. Appropriate therapy was guided by the nature of the arrhythmogenic event in relation the presence or absence of symptoms. Indications for pacemaker or implantable cardioverter-defibrillator (ICD) implantation were guided by international guidelines (1, 10). Remote monitoring was also used to detect the end-of-life (EOL) status of the ILR.

**Statistical analysis**

Categorical variables are presented as absolute numbers (percentage). Continuous variables are expressed as mean ± standard deviation in case of Gaussian distribution or median [1st,3rd quartile] in case of non-Gaussian distribution. Normality was tested using the Shapiro-Wilk test. To compare means and medians of continuous variables among groups, the independent Student's t-test and Mann-Whitney U test were used, respectively. In case of >2 groups, the one-way ANOVA or Kruskall-Wallis test was used where appropriate. Categorical variables were compared among groups using the Chi Squared test. Statistical significance was set at a 2-tailed probability level of <0.05. All statistical analyses were performed using SPSS software (version 28.0, IBM, Armonk, NY, US).

**Results**

**3.1 Baseline patient characteristics and ILR implants in follow-up**

The study included 348 patients who were implanted with an ILR for unexplained syncope. Follow-up data were available in 309 patients (88% out of total implanted patients), figure 1. The mean age was 59 years (range 4-93 years), 49% was female. The median number of syncope was 3 [1-3]. Baseline patient and electrocardiographic findings are summarized in table 1. Baseline conduction abnormalities on ECG were present in 13% of the patients. 8.7% had a first degree atrioventricular block, 2.3% left bundle branch block (LBBB), 7.4% right bundle branch block (RBBB), 2.3% bifascicular block and 0.6% had a trifascicular block. During work-up for syncope, all of the patients had a negative 24h Holter monitoring, and 46% underwent head up tilt testing, which was negative. Electrophysiologic (EP) study was performed in 59% of the patients (and negative), before implantation of the ILR. Numbers of patients implanted with different ILR models and according to different manufacturers are specified in figure 2. Two out of three patients (67%) received an ILR manufactured by Medtronic, 29% Abbott and 3% Biotronik.

**3.2 Battery longevity**

During follow-up, 206 (59%) of patients reached ILR EOL (Table 2), with precise longevity determined in 1175 of these cases. Overall, the median battery longevity measured 42 [40-45] months with minimum and maximum battery longevity spanning a range of 24-72 months among patients. Battery longevity according to ILR model and manufacturer is displayed in figure 2.

Of interest, the time to EOL range varied among patients, as displayed in figure 3: from 28 to 61 months for model Reveal 9529, 36 to 51 months for model Reveal Linq II, from 24 to 51 months for model Confirm ILR 2102 and from 24 to 41 months for model Confirm Rx 3500. As such, maximum difference in time to EOL among patients implanted with same ILR models was: 33 months for Reveal 9529, 15 months for Reveal Linq II, 27 months for Confirm ILR 2102 and 17 months for Confirm ILR.

Premature end-of-life, here defined as time to EOL less than the prespecified manufacturers battery longevity, occurred in one patient (0.5%). In this particular patient EOL was reached after 28 months, while a battery longevity of at least 36 months was guaranteed according the manufacturer product performance specifications. No clear explanation was found for this premature end-of-life. In patients exceeding the pre-

defined battery longevity, a median additional battery longevity was seen of 6 [2-9] months for the Reveal 9529, 7 [5-8] months for the Reveal Linq, 19 [16-21] months for the Confirm ILR 2102 and 1 [0-12] month for the Confirm RX DM 3500.

### 3.3 Diagnostic yield

Arrhythmogenic diagnosis, clinically relevant to the index syncope was diagnosed in 83 of 309 (27%) of patients (Table 2). Type of arrhythmogenic diagnosis in those patients are listed in Table 2. Sick sinus syndrome was present in 60 (72%) of these 83 patients, atrioventricular block (being Mobitz type 2 2$^{nd}$ degree AV block or 3$^{rd}$ degree AV block) in 17 patients (20%) and ventricular tachycardia in 6 (7%). Of those patients with an arrhythmogenic diagnosis, 66 patients (79%) received a pacemaker, and 7 patients (8%) an ICD. The remaining 10 patients (12%) did not receive device implantation based on clinical decision making. Besides etiologic diagnoses explaining syncope, additional diagnoses (mostly atrial fibrillation or atrial flutter) were found as well in 58 patients (18.8% of the study population).

### 3.4 Time relationship between arrhythmogenic diagnosis and time of monitoring

Cumulative diagnostic yield of ILR among patients with syncope is given in figure 4. The cumulative diagnostic yield for arrhythmogenic event explaining syncope was 15,7%, 22,9%, 34,9% , 54,2%, 72,3% and 100% at 1, 2, 6, 12, 24 and 48 months respectively. After 43months, a plateau in diagnostic yield could be observed, with the last arrhythmogenic diagnosis made at 43 months of follow-up. The mean time to diagnosis was 10 [2-25] months. Among patients with an arrhythmogenic diagnosis (n=83), this diagnosis was established in 15.7% of patients in the first month, 7.2% in the second month 4.8% in the third month, 8.4% in the period between 3 and 6 months, 19.2% in the period between 6 months and 1 year, 16.8% in the second year, 17.5% in the third year and finally 10.4% in the fourth year. Of all arrhythmogenic episodes, 90% were diagnosed within 3 years of ILR monitoring.

### 3.5 Reasons for ILR extraction before reaching EOL

Of all implanted loop recorders, 92 (30%) were extracted before reaching EOL. In 73 (24%) of patients this was due to the diagnosis of an arrhythmogenic episode requiring pacemaker or ICD implantation. In 14 patients (5%), the ILR was extracted prematurely due to the finding of an alternative diagnosis, 4 (1%) due to localized pain at the insertion place and 1 (<1%) because of skin protrusion.

### Acknowledgement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

### Figure legend:

Figure 1:

Patient flow chart and diagnostic yield

Figure 2:

Figure 2 summarizes the median battery longevity of every individual model, with interquartile range, as well as the manufacturer self-reporter battery longevity. Range (min – max) of battery longevity is listed too. ILR = implantable loop recorder.

Figure 3:

Figure 3 depicts the five different Implantable Loop recorder models, manufactured by three different companies, used in this trial. The blue line indicates the self-reported minimal battery longevity by Medtronic (being 3 years, or 36 months), while the red line indicates that of Abbott (St Jude Medical) (being 2 years, or 24 months). ILR = implantable loop recorder.

Figure 4:

Figure 4. In this figure a survival curve is depicted. It shows the number of arrhythmogenic diagnoses in relation to time. After 43 months no arrhythmogenic diagnoses were made.



**References**

1. Brignole M, Moya A, de Lange FJ, Deharo JC, Elliott PM, Fanciulli A, et al. 2018 ESC Guidelines for the diagnosis and management of syncope. Eur Heart J. 2018;39(21):1883-948.2. Soteriades ES, Evans JC, Larson MG, Chen MH, Chen L, Benjamin EJ, et al. Incidence and prognosis of syncope. N Engl J Med. 2002;347(12):878-85.3. Colman N, Nahm K, Ganzeboom KS, Shen WK, Reitsma J, Linzer M, et al. Epidemiology of reflex syncope. Clin Auton Res. 2004;14 Suppl 1:9-17.4. Kapoor WN, Peterson J, Wieand HS, Karpf M. Diagnostic and prognostic implications of recurrences in patients with syncope. Am J Med. 1987;83(4):700-8.5. Linzer M, Pontinen M, Gold DT, Divine GW, Felder A, Brooks WB. Impairment of physical and psychosocial function in recurrent syncope. J Clin Epidemiol. 1991;44(10):1037-43.6. Krahn AD, Klein GJ, Yee R, Takle-Newhouse T, Norris C. Use of an extended monitoring strategy in patients with problematic syncope. Reveal Investigators. Circulation. 1999;99(3):406-10.7. Rose MS, Koshman ML, Spreng S, Sheldon R. The relationship between health-related quality of life and frequency of spells in patients with syncope. J Clin Epidemiol. 2000;53(12):1209-16.8. Svennberg E, Tjong F, Goette A, Akoum N, Di Biase L, Bordachar P, et al. How to use digital devices to detect and manage arrhythmias: an EHRA practical guide. Europace. 2022;24(6):979-1005.9. Bass EB, Curtiss EI, Arena VC, Hanusa BH, Cecchetti A, Karpf M, et al. The duration of Holter monitoring in patients with syncope. Is 24 hours enough? Arch Intern Med. 1990;150(5):1073-8.10. Shen WK, Sheldon RS, Benditt DG, Cohen MI, Forman DE, Goldberger ZD, et al. 2017 ACC/AHA/HRS Guideline for the Evaluation and Management of Patients With Syncope: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society. J Am Coll Cardiol. 2017;70(5):e39-e110.11. Goldberger ZD, Petek BJ, Brignole M, Shen WK, Sheldon RS, Solbiati M, et al. ACC/AHA/HRS Versus ESC Guidelines for the Diagnosis and Management of Syncope: JACC Guideline Comparison. J Am Coll Cardiol. 2019;74(19):2410-23.12. Rogers G, O'Flynn N. NICE guideline: transient loss of consciousness (blackouts) in adults and young people. Br J Gen Pract. 2011;61(582):40-2.13. Farwell DJ, Freemantle N, Sulke N. The clinical impact of implantable loop recorders in patients with syncope. Eur Heart J. 2006;27(3):351-6.14. Krahn AD, Klein GJ, Yee R, Skanes AC. Randomized assessment of syncope trial: conventional diagnostic testing versus a prolonged monitoring strategy. Circulation. 2001;104(1):46-51.15. Edvardsson N, Frykman V, van Mechelen R, Mitro P, Mohii-Oskarsson A, Pasquié JL, et al. Use of an implantable loop recorder to increase the diagnostic yield in unexplained syncope: results from the PICTURE registry. Europace. 2011;13(2):262-9.16. Podoleanu C, DaCosta A, Defaye P, Taieb J, Galley D, Bru P, et al. Early use of an implantable loop recorder in syncope evaluation: a randomized study in the context of the French healthcare system (FRESH study). Arch Cardiovasc Dis. 2014;107(10):546-52.17. Sulke N, Sugihara C, Hong P, Patel N, Freemantle N. The benefit of a remotely monitored implantable loop recorder as a first line investigation in unexplained syncope: the EaSyAS II trial. Europace. 2016;18(6):912-8.18. Parry SW, Matthews IG. Implantable loop recorders in the investigation of unexplained syncope: a state of the art review. Heart. 2010;96(20):1611-6.19. Moya A, García-Civera R, Croci F, Menozzi C, Brugada J, Ammirati F, et al. Diagnosis, management, and outcomes of patients with syncope and bundle branch block. Eur Heart J. 2011;32(12):1535-41.20. Sun BC, Emond JA, Camargo CA, Jr. Direct medical costs of syncope-related hospitalizations in the United States. Am J Cardiol. 2005;95(5):668-71.21. Da Costa A, Defaye P, Romeyer-Bouchard C, Roche F, Dauphinot V, Deharo JC, et al. Clinical impact of the implantable loop recorder in patients with isolated syncope, bundle branch block and negative workup: a randomized multicentre prospective study. Arch Cardiovasc Dis. 2013;106(3):146-54.22. Perings C, Wolff C, Wilk A, Witthohn A, Voss R, Rybak K. Do implantable loop recorders impact the survival of patients with recurrent unexplained syncope? J Comp Eff Res. 2021;10(4):285-94.23. Solbiati M, Casazza G, Dipaola F, Barbic F, Caldato M, Montano N, et al. The diagnostic yield of implantable loop recorders in unexplained syncope: A systematic review and meta-analysis. Int J Cardiol. 2017;231:170-6.24. Kreimer F, Aweimer A, Backhaus JF, Pflaumbaum A, Mügge A, Gotzmann M. Predictors for the detection of arrhythmia requiring pacemaker/ICD implantation-Results from a loop recorder study. Pacing Clin Electrophysiol. 2022;45(9):1106-14.25. Huemer M, Becker AK, Wutzler A, Attanasio P, Parwani AS, Lacour

P, et al. Implantable loop recorders in patients with unexplained syncope: Clinical predictors of pacemaker implantation. Cardiol J. 2019;26(1):36-46.26. Smith A, Perdue M, Vojnika J, Frisch DR, Pavri BB. The diagnostic yield of implantable loop recorders stratified by indication: "real-world" use in a large academic hospital. J Interv Card Electrophysiol. 2021;61(2):303-11.27. Mueller-Leisse J, Hillmann HAK, Iserloh L, Fruehauf B, Duncker D. Diagnostic Yield and Clinical Implications of Implantable Loop Recorders in Patients with Syncope in Germany: A National Database Analysis. J Clin Med. 2024;13(6).28. Lau DH, Pierre B, Cabanas P, Martens E, Bisignani G, Hofer D, et al. Diagnostic yield of an insertable cardiac monitor in a large patient population. Heart Rhythm O2. 2023;4(2):97-102.29. Maines M, Zorzi A, Tomasi G, Angheben C, Catanzariti D, Piffer L, et al. Clinical impact, safety, and accuracy of the remotely monitored implantable loop recorder Medtronic Reveal LINQTM. Europace. 2018;20(6):1050-7.30. Entem FR, Enriquez SG, Cobo M, Expósito V, Llano M, Ruiz M, et al. Utility of implantable loop recorders for diagnosing unexplained syncope in clinical practice. Clin Cardiol. 2009;32(1):28-31.31. Magnusson PM, Olszowka M, Wallhagen M, Koyi H. Outcome of implantable loop recorder evaluation. Cardiol J. 2018;25(3):363-70.32. O'Shea CJ, Middeldorp ME, Hendriks JM, Brooks AG, Lau DH, Emami M, et al. Remote Monitoring Alert Burden: An Analysis of Transmission in >26,000 Patients. JACC Clin Electrophysiol. 2021;7(2):226-34.33. De Coster M, Demolder A, De Meyer V, Vandenbulcke F, Van Heuverswyn F, De Pooter J. Diagnostic accuracy of R-wave detection by insertable cardiac monitors. Pacing Clin Electrophysiol. 2020;43(5):511-7.34. Ibrahim OA, Drew D, Hayes CJ, McIntyre W, Seifer CM, Hopman W, et al. Implantable loop recorders in the real world: a study of two Canadian centers. J Interv Card Electrophysiol. 2017;50(2):179-85.35. Ebrille E, Crea P. Implantable loop recorder for syncope: essential tool or double-edged weapon? Minerva Cardiol Angiol. 2021;69(4):417-8.36. Ahmed N, Frontera A, Carpenter A, Cataldo S, Connolly GM, Fasiolo M, et al. Clinical Predictors of Pacemaker Implantation in Patients with Syncope Receiving Implantable Loop Recorder with or without ECG Conduction Abnormalities. Pacing Clin Electrophysiol. 2015;38(8):934-41.37. Glikson M, Nielsen JC, Kronborg MB, Michowitz Y, Auricchio A, Barbash IM, et al. 2021 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy. Eur Heart J. 2021;42(35):3427-520.38. Scheinman MM, Peters RW, Suavé MJ, Desai J, Abbott JA, Cogan J, et al. Value of the H-Q interval in patients with bundle branch block and the role of prophylactic permanent pacing. Am J Cardiol. 1982;50(6):1316-22.39. Lacunza-Ruiz FJ, Moya-Mitjans A, Martínez-Alday J, Barón-Esquivias G, Ruiz-Granell R, Rivas-Gándara N, et al. Implantable loop recorder allows an etiologic diagnosis in one-third of patients. Results of the Spanish reveal registry. Circ J. 2013;77(10):2535-41.40. Lee SH, Kim TH, Oh YS, Oh S, Choi JI, Kim JB, et al. Usefulness of an Implantable Loop Recorder in Diagnosing Unexplained Syncope and Predictors for Pacemaker Implantation. J Korean Med Sci. 2020;35(2):e11.41. Palmisano P, Accogli M, Zaccaria M, Luzzi G, Nacci F, Anaclerio M, et al. Predictive factors for pacemaker implantation in patients receiving an implantable loop recorder for syncope remained unexplained after an extensive cardiac and neurological workup. Int J Cardiol. 2013;168(4):3450-7.42. Krahn AD, Klein GJ, Fitzpatrick A, Seidl K, Zaidi A, Skanes A, et al. Predicting the outcome of patients with unexplained syncope undergoing prolonged monitoring. Pacing Clin Electrophysiol. 2002;25(1):37-41.43. Deneke T, Cabanas P, Hofer D, Gaspar T, Pierre B, Bisignani G, et al. New-generation miniaturized insertable cardiac monitor with a long sensing vector: Insertion procedure, sensing performance, and home monitoring transmission success in a real-world population. Heart Rhythm O2. 2022;3(2):152-9.44. Yeung B, McLeod K. The implantable loop recorder in children. Heart. 2008;94(7):888-91.

**Table 1. Relevant baseline patient characteristics**

| | *Patients, No./total No. (%)* |
|---|---|
| **Demographics** | **Overall (n=309)** |
| Age at time of implant, years | 59 [38-73] |
| Female (%) | 150 (49) |
| Height (cm) | 170 [162-175] |
| Weight (kg) | 72 [66-84] |
| BMI (kg/m$^2$) | 25,3 [22,6-28,6] |
| Risk factors | |
| Hypertension | 112 (36) |

| | *Patients, No./total No. (%)* |
|---|---|
| Dyslipidemia | 141 (46) |
| Diabetes | 30 (10) |
| Heart failure | 13 (4) |
| Current smoker | 34 (11) |
| Ex-smoker | 49 (16) |
| Number of syncope | 3 [1-3] |
| Trauma related to syncope | |
| Any QRS conduction abnormality | 40 (13) |
| Head-up Tilt test | 143 (46) |
| Holter monitoring | 309 (100) |
| Electrophysiology study | 181 (59) |
| Lost to follow-up during monitoring | 26 (8) |
| Died | 21 (7) |
| 1st degree AV block | 27 (8,7) |
| LBBB | 7 (2,3) |
| RBBB | 23 (7,4) |
| Bifascular block | 7 (2,3) |
| Trifascicular block | 2 (0,6) |

not-yet-known not-yet-known

not-yet-known

unknown

Table 2. ILR follow-up and diagnostic yield

| | *Patients, No./total No. (%)* |
|---|---|
| **Demographics** | **Total number n=309** |
| ILR follow-up | |
| End of battery life | 206 |
| Early extraction | 92 |
| Not yet EOL | 1 |
| Lost to follow-up | 10 |
| Arrhythmogenic diagnosis | 83 (27) |
| Type arrhythmogenic diagnosis | |
| Higher degree AV block | 17/83 (20) |
| Sick sinus syndrome | 61/83 (73) |
| VT | 6/83 (7) |
| Additional ILR findings | |
| AF/AFL/AT | 58 (19) |

Table 2 ILR = follow-up characteristics and types of arrhythmogenic diagnosis. EOL = End-of-life. Higher degree AV block: type 2 2nd degree AV block or 3rd degree AV block. VT = Ventricular tachycardia. AF = Atrial fibrillation. AFL = Atrial flutter. AT = Atrial tachycardia.

**Table 3. Univariate analysis: predictors of syncope**

| **Demographics** | *No arrhythmogenic diagnosis (n=221)* | *Arrhythmogenic diagnosis (n=83)* | *P-va* |
|---|---|---|---|
| **Female (%)** | **115 (51)** | **35 (42)** | **0.13** |
| **Age at time of implant, years** | **58 [36-71]** | **61 [46-74]** | **0.10** |
| **BMI (kg/m²)** | **25,4 [22,3-28,7]** | **25,1 [22,8-28,2]** | **0.97** |
| **Risk factors** | | | |
| **Hypertension** | **78 (35)** | **34 (41)** | **0.34** |
| **Dyslipidemia** | **101 (45)** | **40 (48)** | **0.66** |
| **Diabetes** | **23 (10)** | **7 (8)** | **0.61** |
| **Heart failure** | **9 (4)** | **4 (5)** | **0.76** |
| **Current smoker** | **24 (11)** | **10 (12)** | **0.75** |
| **Ex-smoker** | **34 (15)** | **15 (18)** | **0.55** |
| **Baseline ECG characteristics** | | | |
| **PR interval** | **156 [142-176]** | **166 [143-202]** | **0.10** |
| **1st degree AV block** | **14 (6)** | **13 (16)** | **0.01** |
| **QRS duration** | **94 [84-104]** | **94 [84-110]** | **0.80** |
| **QTc time** | **423 [402-440]** | **423 [394-441]** | **0.59** |
| **Any BBB** | **18 (8)** | **12 (14)** | **0.09** |
| **RBBB** | **15 (7)** | **8 (10)** | **0.39** |
| **LBBB** | **3 (1)** | **4 (5)** | **0.09** |
| **Any QRS conduction abnormality** | **24 (11)** | **16 (19)** | **0.05** |
| **RBBB** | **15 (7)** | **8 (10)** | **0.39** |
| **LBBB** | **3 (1)** | **4 (5)** | **0.09** |
| **NIVCD** | **6 (3)** | **4 (5)** | **0.46** |
| **Bifasc. block** | **5 (2)** | **2 (2)** | **1.00** |
| **Trifasc. block** | **1 (1)** | **1 (1)** | **0.47** |
| **Number of syncope** | **1 [1-3]** | **1[1-3]** | **0.37** |
| **Trauma** | **46 (20)** | **15 (18)** | **0.61** |
| **Traffic Accident** | **13 (6)** | **6 (7)** | **0.65** |
| **During sports** | **12 (5)** | **4 (5)** | **0.84** |
| **EP study** | **138 (61)** | **43 (51)** | **0.10** |
| **AH interval** | **110 [94-131]** | **116 [94-151]** | **0.37** |
| **HV interval** | **42 [38-50] N=128** | **46 [40-50] N=38** | **0.04** |
| **Abnormal HV interval (>55 ms)** | **8 (6)** | **3 (8)** | **0.71** |
| **SNRT** | **1053 [918-1250]** | **1170 [945-1250]** | **0.43** |
| **Wenckebach punt** | **370 [320-420]** | **380 [335-423]** | **0.81** |
| **2:1 block** | **320 [290-370]** | **330 [290-360]** | **0.99** |

Table 3. Predictors of arrhythmogenic diagnosis.

In nominal variables the Chi-Squared test was used. In continuous variables the Independent Samples Student t-test or Mann Whitney U test was used where appropriate.

BMI= body mass index. ECG: Electrocardiogram, EP study = electrophysiological study. First degree AV block = PR segment branch block. Bifascicular block = RBBB + LAFB (left anterior fascicle block). Trifascicular block = 1st degree AV block + LAFB + RBBB. NIVCD = Non-specific intraventricular conduction delay. EP study = electrophysiological study. AH interval: Atrium His interval. HV interval = His ventricle interval. SNRT = Sinus node recovery time.

not-yet-known not-yet-known

not-yet-known

unknown

Figure 1. Patient flow chart and diagnostic yield

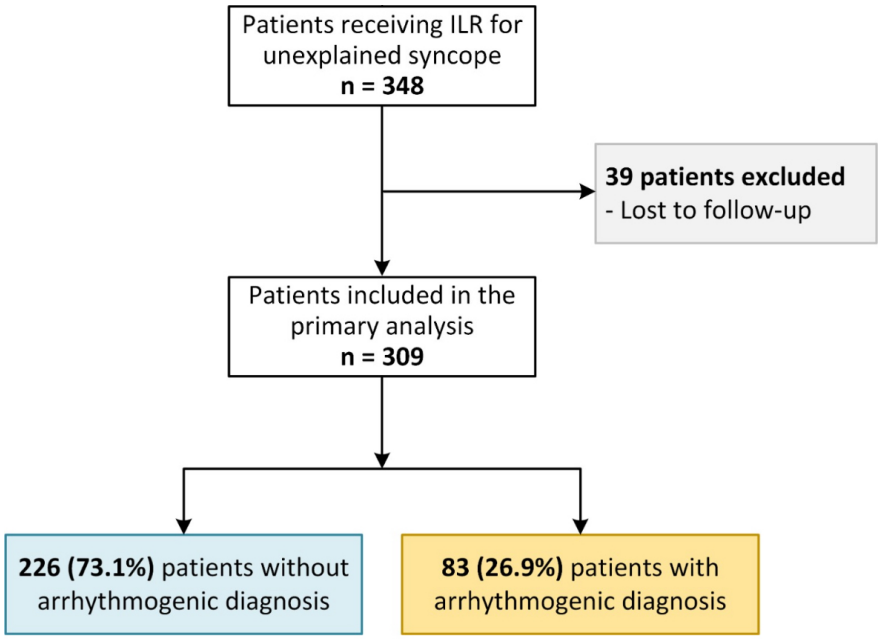
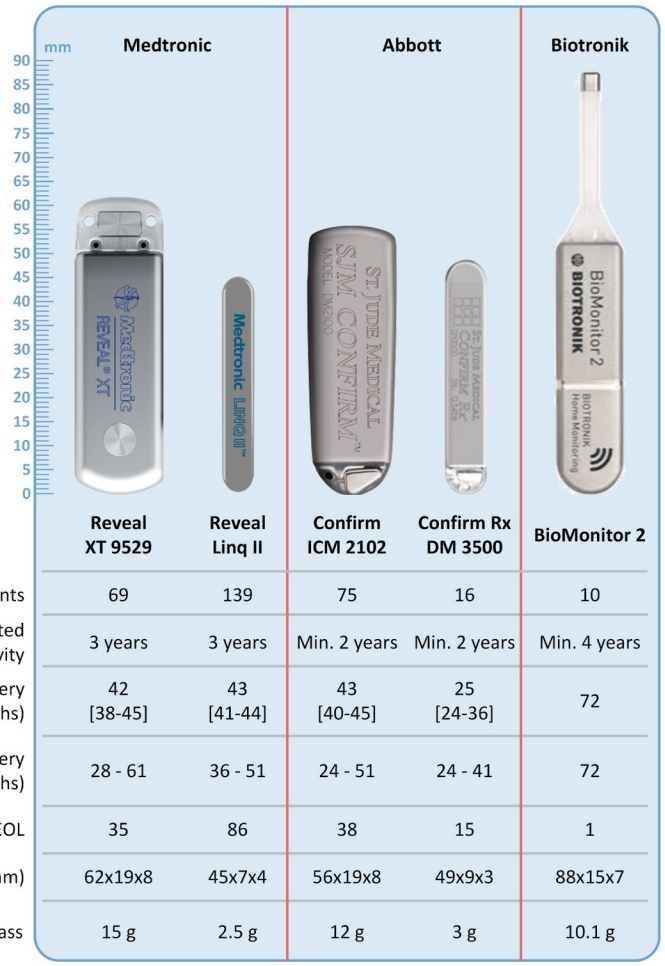



**Figure 2. Comparison between ILR manufacturers**




| | Reveal XT 9529 | Reveal Linq II | Confirm ICM 2102 | Confirm Rx DM 3500 | BioMonitor 2 |
|---|---|---|---|---|---|
| Number of patients | 69 | 139 | 75 | 16 | 10 |
| Manufacturer reported battery longevity | 3 years | 3 years | Min. 2 years | Min. 2 years | Min. 4 years |
| Real-life ILR battery longevity (months) | 42 [38-45] | 43 [41-44] | 43 [40-45] | 25 [24-36] | 72 |
| Range of ILR battery longevity (months) | 28 - 61 | 36 - 51 | 24 - 51 | 24 - 41 | 72 |
| Number of ILR reached EOL | 35 | 86 | 38 | 15 | 1 |
| Size (mm) | 62x19x8 | 45x7x4 | 56x19x8 | 49x9x3 | 88x15x7 |
| Mass | 15 g | 2.5 g | 12 g | 3 g | 10.1 g |

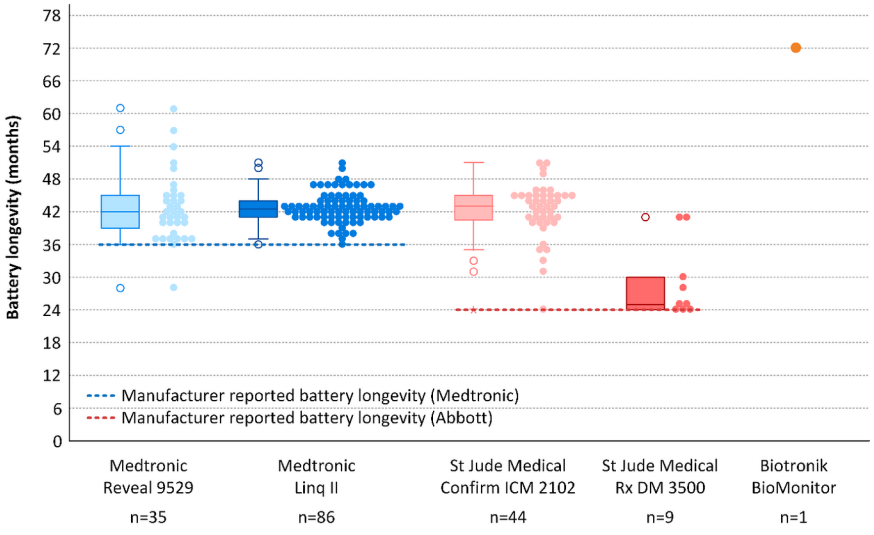



**Figure 3. Battery longevity by ILR manufacturer**

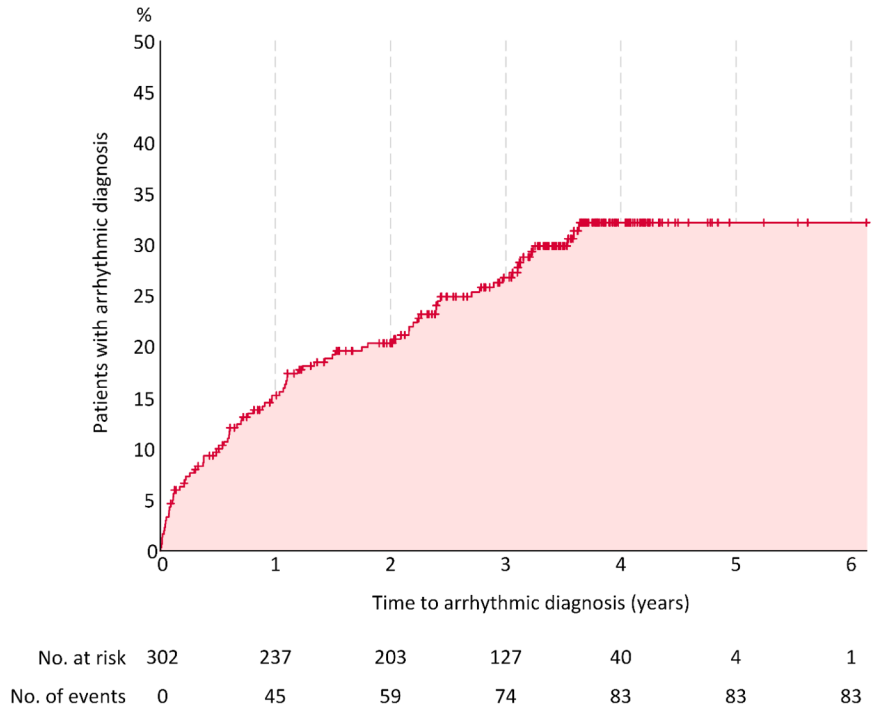



**Figure 4. Cumulative diagnostic yield and time to arrhythmogenic diagnosis**