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Reducing the Electrogram Review Burden Imposed by Insertable Cardiac Monitors

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Abstract

Background: Insertable cardiac monitors (ICMs) are essential for ambulatory arrhythmia diagnosis. However, definitive diagnoses still require time-consuming, manual adjudication of electrograms (EGMs). **Objective**: To evaluate the clinical impact of selecting only key EGMs for review. **Methods**: Retrospective analyses of randomly selected Abbott Confirm Rx ™ devices with [?]90 days of remote transmission history was performed, with each EGM adjudicated as true or false positive (TP, FP). For each device, up to 3 "key EGMs" per arrhythmia type per day were prioritized for review based on ventricular rate and episode duration. The reduction in EGMs and TP days (patient-days with at least 1 TP EGM), and any diagnostic delay (from the first TP), were calculated vs. reviewing all EGMs. **Results**: In 1,000 ICMs over a median duration of 8.1 months, at least one atrial fibrillation (AF), tachycardia, bradycardia, or pause EGM was transmitted by 424, 343, 190, and 325 devices, respectively, with a total of 95716 EGMs. Approximately 90% of episodes were contributed by 25% of patients. Key EGM selection reduced EGM review burden by 43%, 66%, 77%, and 50% (55% overall), while reducing TP days by 0.8%, 2.1%, 0.2%, and 0.0%, respectively. Despite reviewing fewer EGMs, 99% of devices with a TP EGM were ultimately diagnosed on the same day vs. reviewing all EGMs. **Conclusions**: Key EGM selection reduced the EGM review substantially with no delay-to-diagnosis in 99% of patients exhibiting true arrhythmias. Implementing these rules in the Abbott patient care network may accelerate clinical workflow without compromising diagnostic timelines.

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Results : In 1,000 ICMs over a median duration of 8.1 months, at least one atrial fibrillation (AF), tachycardia, bradycardia, or pause EGM was transmitted by 424, 343, 190, and 325 devices, respectively, with a total of 95716 EGMs. Approximately 90% of episodes were contributed by 25% of patients. Key EGM selection reduced EGM review burden by 43%, 66%, 77%, and 50% (55% overall), while reducing TP days by 0.8%, 2.1%, 0.2%, and 0.0%, respectively. Despite reviewing fewer EGMs, 99% of devices with a TP EGM were ultimately diagnosed on the same day vs. reviewing all EGMs.

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Keywords: Insertable cardiac monitor, electrogram, arrhythmia, atrial fibrillation, tachycardia, bradycardia, pause, diagnosis

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Conflicts of Interest: NB, FD, LS, KD, FQ, and KR are employees of Abbott.

Introduction

Since their inception, insertable cardiac monitors (ICMs) quickly became established as an invaluable tool for ambulatory diagnosis of cardiac arrhythmias, specifically atrial fibrillation (AF), tachycardia (including SVT and VT), bradycardia, and asystole (i.e., pause).[1–6] ICMs continually monitor the subcutaneous electrogram

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(EGM), store EGM clips to memory when arrhythmia episodes of interest are detected, and transmit those EGMs to an online patient care network for clinician review and patient diagnosis. However, many EGMs do not present new or actionable information. For example, recurring arrhythmias may result in redundant EGMs of similar rate and/or duration; diagnostically, the same information could be conveyed by a single EGM along with the total episode count and duration. Suboptimal device placement, improper programming, or arrhythmia detection algorithm imperfections may also trigger EGMs that are not associated with a true arrhythmia.[7–10] Consequently, clinicians may be forced to manually adjudicate more EGMs than necessary to reach the same diagnosis.

In response to the growing volume of ICMs implanted, and thus EGMs to review, efforts have been made to limit the burden of EGMs transmitted to clinicians. This study describes the retrospective analysis of a novel EGM prioritization strategy that can be enabled on the manufacturer's patient care network, with the goal of reducing the unnecessary EGM review burden imposed on ICM customers while minimizing any delay to diagnosis.

Methods

Study Design

This was a retrospective study of all Merlin.net transmissions associated with 1,000 randomly selected U.S. Abbott Confirm Rx^{TM} devices with SharpSense^{TM}technology (Abbott, Abbott Park, IL) implanted between April 2018 and March 2020, with transmission data downloaded from Merlin.net in June 2020. The population included all reasons for monitoring reported at implant: AF management, cryptogenic stroke, palpitations, post-AF ablation, seizures, suspected AF, syncope, ventricular tachycardia, and other. To capture a patient population with a representative monitoring experience, devices with fewer than 90 days of transmission history (i.e., from implant to last available transmission) were excluded.

For each transmission, all episode EGMs and associated data were extracted, and each EGM was adjudicated as either true or false. Key EGM selection rules were then retrospectively applied, and the clinical impact was evaluated relative to reviewing all available EGMs, as described in the sections that follow.

Data Description

Confirm Rx provides three types of transmissions: scheduled, alert, and patient-initiated. All transmissions associated with the randomly selected devices were downloaded from Merlin.net, redacting all Health Insurance Portability and Accountability Act (HIPAA)-related identifiers for patient anonymity. Each transmission contained all new EGMs since the last transmission and corresponding episode metadata, including episode duration and arrhythmia-specific representative rate. Each EGM signal typically includes approximately 30 sec pre-detection and 2 min post-detection for AF, with 30 sec pre-detection and 30 sec post-detection for tachycardia, bradycardia, and pause.

EGM Adjudication

Each transmitted EGM was manually adjudicated as either a true positive (TP) or a false positive (FP) episode. For each arrhythmia type, a TP day was defined as any patient-day that included at least one TP EGM.

Bradycardia and pause EGMs were adjudicated by a single reviewer, as their relatively objective classification resulted in negligible inter-observer discrepancies. As AF and tachycardia rhythms were more complex and often required further scrutiny, those EGMs were adjudicated by two independent reviewers. If agreement was not reached, a third reviewer was consulted. All EGM reviewers were blinded to patient demographics and clinical events.

Key EGM Selection Criteria

Each arrhythmia episode was characterized by the episode duration and representative rate, defined as follows. The episode duration was defined as the time from device detection to end-of-episode for AF, tachy-

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cardia, and bradycardia episodes; and the duration of the pause itself for pause episodes. The representative rate was defined as the mean ventricular rate over the entire episode (i.e., mean rate, number of ventricular beats divided by AF episode duration) for AF; the minimum R-R interval during the episode (i.e., maximum rate) for tachycardia; and the maximum R-R interval during the episode (i.e., minimum rate) for bradycardia.

For each arrhythmia type, up to 3 "key EGMs" per day (starting at 12 AM in the patient's local time zone) were prioritized for review, as follows. For AF, the EGMs with the fastest mean rate, longest duration, and 2nd longest duration were selected. For tachycardia, the EGMs with the fastest maximum rate, longest duration, and 2nd longest duration were selected. For bradycardia, the EGMs with the fastest minimum rate, longest duration, and 2nd longest duration were selected. For pause, the EGMs with the shortest duration, longest duration, and 2nd longest duration were selected.

If 3 or fewer EGMs of one arrhythmia type were detected on a particular day, all of those EGMs would be prioritized for review. Exceptions include cases in which a single EGM satisfies more than one criterion; in such cases, fewer than 3 EGMs may be prioritized for review. For example, if there were 3 AF EGMs on a single day, but one EGM had both the fastest mean rate and the longest duration, only 2 EGMs would be selected for transmission. Patient-initiated "symptom" EGMs were not impacted by the prioritization rules, and all symptom EGMs were prioritized for review.

Clinical Impact Analysis

To assess the downstream clinical impact of selecting a subset of EGMs for review, the following primary measures were calculated for each arrhythmia type:

(1a) *Total EGM burden reduction* (count of key EGMs, as a percent of all EGMs). (1b) *EGM burden reduction per patient per month* (count of key EGMs, as a percent of all EGMs, calculated per patient per month of transmission history). (1c) *TP day reduction* (patient-days with at least one TP key EGM, as a percent of all patient-days with at least one TP EGM). (1d) *Proportion of patients with no diagnostic delay* (count of patients in which a TP key EGM occurred on the first day that any TP EGM was exhibited, as a percent of all patients with at least one TP EGM).

While the total EGM burden reduction may be translated to clinics with large patient populations, the per patient EGM burden reduction can help characterize the EGM volume distribution across the population.

As expected, reviewing fewer EGMs comes with the risk of potentially neglecting diagnostically valuable TP EGMs. However, multiple, redundant TP EGMs captured on the same day may not speed up the diagnosis. Therefore, the risk of reviewing fewer EGMs was quantified by the loss of patient-days when at least one TP EGM was prioritized for review and, thus, a diagnosis could have occurred (i.e., TP day reduction), rather than directly quantifying the reduction in total TP EGM count.

The clinical impact of lost TP days, however, ultimately depends on their distribution across the population and within each patient. In other words, if a patient's diagnosis is assumed to occur on the first TP day at the earliest, failing to prioritize any TP EGM that day would delay that diagnosis. In contrast, prioritizing a TP EGM on the first day a TP EGM exists (i.e., the first TP day), but skipping subsequent TP days for that patient, would not delay the diagnosis. In addition to the proportion of patients with no diagnostic delay, the following secondary measures were calculated for patients with a diagnostic delay introduced by selecting key EGMs:

(2a) *Proportion of patients experiencing a diagnostic delay*(count of patients in which a TP EGM was eventually prioritized for review, but not on the first day a TP EGM was exhibited, as a percent of all patients with at least one TP EGM). (2b) *Diagnostic delay value* (for all patients with a diagnostic delay, the number of days between the first TP EGM exhibited and the first TP key EGM).

Schematics illustrating the EGM reduction, TP day reduction, and potential diagnostic delay resulting from key EGM selection are provided in **Figure 1** .

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To further explore the clinical impact of selecting key EGMs for review, the above metrics were also calculated for the subpopulation of "high EGM-volume patients", defined as the subgroup of patients in the top 25th percentile of EGMs/patient/month (EGMs/pt/mo) for each arrhythmia type.

Statistical Analysis

Data processing and statistical analyses were performed using MATLAB (Statistics Toolbox, The Mathworks, Natick, MA). Total population-wise EGM and TP day volumes were expressed by count, while patient-wise EGM volumes were expressed as count per patient per month using median and interquartile range [25th percentile, 75th percentile]. Differences in EGM volumes per patient per month between all vs. key EGMs were tested using the Wilcoxon signed-rank test. Differences in freedom from arrhythmia diagnosis between reviewing all vs. key EGMs were displayed using Kaplan-Meier estimator curves and tested using the log-rank test. $P < 0.05$ was considered statistically significant.

Results

Patient Characteristics

Of Confirm Rx devices implanted in the U.S. between April 2018 and March 2020, 1,000 devices were randomly selected in June 2020 (48.5% male, age 71 [61, 78] years). Of those, 869 devices with at least 90 days of transmission history were included in the analysis. Of those 869 devices, 644 devices transmitted a total of 95,716 arrhythmia EGMs, 177 devices transmitted only symptom EGMs, and the remaining 48 devices transmitted no EGMs. The number of EGMs corresponding to each arrhythmia type, and the number of devices that transmitted those EGMs, are provided in **Table 1** . The 644 devices associated with at least one arrhythmia EGM transmitted 4.1 [0.7, 19.3] EGMs/patient/month of all arrhythmia types across a follow-up duration of 8.1 [5.5, 10.9] months, for a total of 34.0 [5.0, 141.5] EGMs/patient. The patient distribution by reason for monitoring is provided in **Table 2** . Devices were predominantly implanted due to syncope (34.3%), suspected AF (22.0%), or cryptogenic stroke (18.6%).

EGM Burden Reduction

By selecting up to 3 key EGMs of each arrhythmia type per day for review, the total arrhythmia EGM burden of this patient population reduced by 55.1%, from 95,716 to 42,930. Specifically, 35,723 AF EGMs were reduced by 43.2% to 20,295; 12,239 tachycardia EGMs were reduced by 66.5% to 4,104; 19,752 bradycardia EGMs were reduced by 76.9% to 4,558; and 28,002 pause EGMs were reduced by 50.1% to 13,973, as shown in **Figure 2** (top panel). The subpopulation of "high EGM-volume patients" were identified as those in the top 25thpercentile of EGMs/patient/month for each arrhythmia type (i.e., patients with [?]7.9 AF, [?]2.6 tachycardia, [?]6.4 bradycardia, or [?]6.7 pause EGMs/pt/mo). Interestingly, these 263/869 patients contributed 89.7% of the total arrhythmia EGM burden (85,830/95,716 EGMs). As expected, the EGM burden reduction was more pronounced in these high EGM-volume patients, and reduced by 59.6%, from 85,830 to 34,707. Specifically, 30,801 AF EGMs reduced by 47.8% to 16,071; 10,959 tachycardia EGMs reduced by 72.0% to 3,072; 18,262 bradycardia EGMs reduced by 80.8% to 3,506; and 25,808 pause EGMs reduced by 53.3% to 12,058 on these high EGM-volume patients, as shown in **Figure 2** (bottom panel).

On a per-patient, per-month basis, AF median EGMs/pt/mo reduced from 1.8 [0.4, 7.9] by 14.0% (patient-wise median reduction) to 1.5 [0.4, 6.7]; tachycardia median EGMs/pt/mo reduced from 0.6 [0.2, 2.6] by 20.4% to 0.5 [0.2, 1.5]; bradycardia median EGMs/pt/mo reduced from 1.3 [0.3, 6.4] by 25.7% to 0.9 [0.3, 3.7]; and pause median EGMs/pt/mo reduced from 0.9 [0.2, 6.7] by 6.7% to 0.9 [0.2, 4.5], as shown in **Figure 3** (top panel, $P<0.001$ for each arrhythmia type). These median reductions in the EGMs/patient/month magnified in the top 25th percentile EGM-contributing patients for each arrhythmia type. In these high EGM-volume subgroup, AF median EGMs/pt/mo reduced from 24.2 [14.4, 48.9] by 37.7% to 15.1 [9.4, 27.0]; tachycardia median EGMs/pt/mo reduced from 7.5 [4.8, 15.7] by 53.0% to 3.5 [2.0, 5.6]; bradycardia median EGMs/pt/mo reduced from 26.1 [12.4, 53.0] by 70.8% to 7.6 [5.1, 13.5]; and pause median EGMs/pt/mo reduced from 26.7 [12.7, 53.7] by 48.1% to 13.8 [7.7, 26.0], as shown in **Figure 3** (bottom panel, $P<0.001$ for each arrhythmia type).

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Diagnostic Impact

By applying the key EGM selection rules, the 2,964 TP AF days were reduced by 0.8% to 2,940; the 1,572 TP tachycardia days were reduced by 2.1% to 1,539; the 1,438 TP bradycardia days were reduced by 0.2% to 1,435; and the 645 TP pause days were unchanged, as shown in**Figure 4** (top panel). For high EGM-volume patients, the 2,242 TP AF days were reduced by 0.9% to 2,222; the 1,089 TP tachycardia days were reduced by 3.0% to 1056; the 1,141 TP bradycardia days were reduced by 0.3% to 1,138; and, again, the 368 TP pause days were unchanged, as shown in **Figure 4** (bottom panel).

Ultimately, using this key EGM selection strategy introduced no delay in the diagnosis of AF, tachycardia, bradycardia, and pause in 99.3% (145/146), 98.8% (247/250), 99.1% (115/116), and 100.0% (106/106) of patients who exhibited at least one TP EGM of each arrythmia, respectively, as shown in **Figure 5** . In other words, despite limiting the EGMs to review, the first day when a TP EGM was reviewed remained the same in the vast majority of patients (99.2% for all arrhythmias combined). Of patients with a TP AF EGM, the single patient with a diagnostic delay resulting from key EGM selection did not exhibit any TP EGMs after the first TP day within the patient's follow-up period (i.e., no calculable delay). Of patients with a TP tachycardia EGM, 0.8% (2/250) were associated with a diagnostic delay of 9.5 [6.0, 13.0] days; the remaining 1 patient did not exhibit any TP EGMs after the first TP day within the patient's follow-up period. Of patients with a TP bradycardia EGM, 0.9% (1/116) were associated with a diagnostic delay of 6.0 [6.0, 6.0] days. No patients with a TP pause EGM experienced a diagnostic delay resulting from key EGM selection.

The impact of key EGM selection on time-to-diagnosis is also shown in**Figure 6** . Reviewing only key EGMs did not significantly impact the freedom from arrhythmia diagnosis in the first-year of follow-up, as evident by the nearly overlaid trends within each arrhythmia type, as well as the near-unity P values: 0.933 for AF, 0.946 for tachycardia, 0.999 for bradycardia, and 1.000 for pause.

Discussion

Major Findings

In this study of 1,000 randomly selected Abbott Confirm Rx devices monitored on Merlin.net, 644 devices transmitted 95,716 arrhythmia EGMs (i.e., AF, tachycardia, bradycardia, or pause) over a median follow-up duration of 8.1 months. EGMs were transmitted at a median rate of 4.1 EGMs/pt/mo across the entire population. However, the top 25% of patients transmitted a median of 24.4 total EGMs/pt/mo, and accounted for roughly 90% of all EGMs. Key EGM selection reduced the EGM review burden by 55.1%, with no delay-to-diagnosis in 99.2% of patients exhibiting true arrhythmias.

Reducing Review Burden with Key EGM Selection

The key EGM selection tool evaluated in this study reduced the total number of EGMs to review for each arrhythmia type, and by 55.1% across all arrhythmias. Looking at patient EGM rates per month, rather than entire population totals, provides an informative view of how a minority of patients can overwhelm the patient care system. Key EGM selection resulted in a significant drop in median EGMs/pt/mo across the entire population. As expected, this reduction was even greater for patients in the top 25^{th} percentile of EGMs/pt/mo, who accounted for almost 90% of all EGMs to review. In these high EGM-volume patients, the median EGMs/pt/mo dropped by 37.7%, 53.0%, 70.8%, and 48.1% for AF, tachycardia, bradycardia, and pause, respectively.

Resource Utilization Benefit

In a recent study of 1,811 ICMs (over 90% Medtronic), with nearly 1,500 total transmissions over a 4-week period, 15 ± 6 min was spent by clinic personnel and 1.5 ± 1 min by electrophysiologists per transmission.[11] Based on the number of EGMs per transmission in that study, clinic personnel can be estimated to spend 0.6 min to review each EGM, plus a fixed time of 11.0 min per transmission for pre-review preparation and post-review record/patient processing, with an additional review time by electrophysiologists of 0.2 min per

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EGM. Applying these estimates to the current study, in which the EGM burden was reduced by 55.1% while maintaining the number of transmissions, the expected time saved per 100 patients in this cohort would be 120 hours/year for clinic personnel (28.7% reduction) and 36 hours/year for electrophysiologists (55.1% reduction).

Diagnostic Impact

Despite the significant EGM burden reduction achieved by this key EGM selection tool, the number of days with a TP EGM available for review did not drop significantly: 0.8%, 2.1%, 0.2%, and 0.0%, respectively. As a consequence, 99.2% of patients diagnosed with an arrhythmia were diagnosed on the same day as they would have been if all EGMs were reviewed. Of the remaining patients with more than one TP day, but their first TP day was missed by key EGM selection, no diagnostic delay for AF, 9.5 day delay for tachycardia, 6.0 day delay for bradycardia, and no diagnostic delay for pause was observed. Note that these diagnostic delays assume a daily EGM review, with a diagnosis occurring on the first day a TP EGM is available. Therefore, such delays may not be observed if transmitted EGMs were reviewed monthly. The rarity and negligible magnitude of diagnostic delays was also supported by Kaplan-Meier analysis, which demonstrated nearly identical freedom from diagnosis trends in the first-year post-implant when reviewing all vs. key EGMs.

Rationale for Key EGM Selection

For each transmission, the key EGM selection rules select up to 3 EGMs per day of each arrhythmia type. The limit of 3 EGMs/day, according to the arrhythmia-specific prioritization criteria described in the methods section, resulted in an optimal balance of maximal EGM burden reduction with minimal TP day reduction. For AF, the EGMs with the fastest mean rate, longest duration, and 2nd longest duration were selected, as faster mean ventricular rates and longer durations are both more likely to be associated with true episodes, as recently reported in a similar study[11], and more likely to be clinically valuable. For tachycardia, the EGMs with the fastest maximum rate, longest duration, and 2nd longest duration were selected by the same rationale.

For bradycardia, the EGMs with fastest minimum rate, longest duration, and 2nd longest duration were selected. Although including the fastest bradycardia episode may seem counterintuitive, bradycardia episodes with a faster minimum rate are less likely to be false positive detections due to R-wave undersensing, which commonly results from suboptimal implant orientation or sensing threshold programming. For pause, the EGMs with the shortest duration, longest duration, and 2nd longest duration were selected by the same rationale. Although longer pause episodes may be more clinically actionable, shorter pause episodes are less likely to be false positive detections due to R-wave undersensing, so a balanced approach was taken. It is important to note that, although bradycardia episodes with fastest minimum rates were selected, all such episodes must still exhibit rates slower than the programmed bradycardia detection threshold to be recorded. Likewise, although the shortest duration pause episodes were selected, all such episodes must still exhibit pause durations beyond the programmed pause detection threshold to be recorded.

Future Directions

In the future, arrhythmia-specific key EGM selection strategies may be implemented as a feature on the manufacturer's ICM patient care network (e.g. Merlin.net), without changes at the device level. For example, clinicians may choose to streamline ICM patient management and automatically view only key EGMs by enabling the feature for individual patients contributing the most EGMs (e.g. top 25thpercentile), for subpopulations by reason for monitoring, or site-wide across the entire clinic.

In this study, EGMs were prioritized for review based only on ventricular rate and episode duration. In the future, key EGM selection may also be guided by additional metrics that may better identify TP episodes and/or more clinically actionable episodes. Examples may include episode time of day, frequency of repeated episodes, similarity to other episodes, or clinician adjudication history. Artificial intelligence may also be used to identify arrhythmia episodes that are more likely to be true.[12]

Limitations

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This retrospective analysis relied on the assumption that all EGMs would have been reviewed, and the EGM review burden could be directly quantified by the number of EGMs presented on the patient care network. Prospective studies are needed to demonstrate the real-world impact of key EGM selection on clinical review burden.

All TP episodes were assumed to be diagnostically equivalent for calculations of diagnostic delay, with the earliest possible diagnosis of each patient occurring on the first day a TP EGM was recorded. In a real-world clinic, a single EGM snapshot of one true arrhythmia episode may not be sufficient for a definitive diagnosis, as its diagnostic value is subjective and may vary among clinicians. However, by quantifying the time-to-diagnosis using key EGMs relative to all recorded EGMs, and doing so across a random population, any qualitative differences in diagnostic value are not expected to significantly alter the conclusions.

Conclusions

Key EGM selection reduced the EGM burden by 55%, with no delay-to-diagnosis in 99% of patients who exhibited a true arrhythmia. Implementing these rules by enabling a feature on the manufacturer's patient care network may accelerate clinical workflow without compromising diagnostic timelines, ultimately streamlining ICM patient management.

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Tables

Table 1. Distribution of EGMs and devices transmitting those EGMs for each arrhythmia type. Note that a single device may transmit EGMs of multiple arrhythmia types.

Arrhythmia Type	EGMs, n (%)	Devices, n (%)
All	95,716 (100.0%)	644 (100.0%)
Atrial Fibrillation	35,723 (37.3%)	424 (65.8%)
Tachycardia	12,239 (12.8%)	343 (53.3%)
Bradycardia	19,752 (20.6%)	190 (29.5%)
Pause	28,002 (29.3%)	325 (50.5%)

Table 2. Patient distribution by reason for monitoring, as indicated at device implant.

Reason for Monitoring	Devices with Arrhythmia EGMs, n (%)
All	*644 (100%)*
Syncope	221 (34.3%)
Suspected AF	142 (22.0%)
Cryptogenic Stroke	120 (18.6%)
Palpitations	60 (9.3%)
AF Management	49 (7.6%)
Post-AF Ablation	22 (3.4%)
Other	16 (2.5%)
Ventricular Tachycardia	14 (2.2%)

Figures

Figure 1. Schematics illustrating EGM burden reduction achieved by key EGM selection, with and without a resulting diagnostic delay. Days with at least one TP EGM are classified as TP Days, and a diagnosis is assumed to occur on the first TP Day. When the first TP Day using all EGMs (i.e., day of diagnosis) is captured as a TP Day using only key EGMs, there is no diagnostic delay (top). However, if key EGMs did not include a TP on that day, the diagnosis is delayed until the next key TP Day (bottom).

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Figure 2. Total EGM burden across for each arrhythmia type across the entire population (top) and high EGM-volume patients (bottom). High EGM-volume patients are those in the top 25^{th} percentile of EGMs/patient/month for each arrhythmia type. Bars show burden when reviewing all EGMs (grey) vs. key EGMs (blue). Percent changes are shown in red text.

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Figure 3. Patient EGM burden per month for each arrhythmia type across the entire population (top) and high EGM-volume patients (bottom). Box plots show burden when reviewing all EGMs (grey) vs. key EGMs (blue). Median [25^{th}, 75^{th} percentile] is shown as text, with median reductions shown in red. For clarity, outliers beyond 1.5x the interquartile range (99^{th} percentile whiskers) are not shown.

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Figure 4. Total TP days for each arrhythmia type across the entire population (top) and high EGM-volume patients (bottom). Bars show TP days when reviewing all EGMs (grey) vs. key EGMs (blue). Percent changes are shown in red text.

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Figure 5. Proportion of patients with at least one TP EGM who experienced no diagnostic delay for each arrhythmia type when only key episodes were reviewed.

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Figure 6. Kaplan-Meier analysis showing freedom from diagnosis over the first-year post-implant for each arrhythmia type. Note that all EGMs (solid grey line) vs. key EGMs (dotted color line) are nearly overlaid for each arrhythmia type.

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