INNOVATION CATALYST REPORT

‘Laundry That Never Stops’

INSIGHTS FROM ALLIED HEALTH PROFESSIONALS ON THE **OPERATIONAL REALITIES OF REMOTE CIED MONITORING** AND OPPORTUNITIES FOR THE HEART RHYTHM SOCIETY

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KEYWORDS

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Alerts

INNOVATION CATALYST REPORT: AT A GLANCE

Remote Monitoring at an Operational Inflection Point

Remote CIED monitoring is now a standard part of care.
Operational systems have not kept pace.

What Allied Health Professionals Report:

- **Alert volume is overwhelming.** Continuous transmissions create more work than simply the number of enrolled patients would suggest.
- **Staffing models are strained.** Existing benchmarks do not fully account for role mix and day-to-day workload complexity.
- **Connectivity requires constant follow-up.** Keeping patients connected is ongoing, labor-intensive work.
- **Heart failure monitoring lacks clear ownership.** Responsibility between EP and HF teams is often undefined.
- **Clinicians worry about missed alerts.** Unclear thresholds increase medico-legal anxiety.

Top-Ranked Challenges:

1. **Alert burden and alert management**
2. **Staffing constraints**
3. **Connectivity and patient engagement**

Bottom Line

Remote monitoring programs now operate like virtual wards, managing continuous patient data rather than occasional check-ins. To remain safe and sustainable, programs need clearer alert standards, better-aligned staffing models, and defined clinical ownership.

1 ABSTRACT

Remote monitoring of cardiac implantable electronic devices (CIEDs) using wireless technology has demonstrated clinical benefit through early access to actionable patient data. This paradigm and the rapid increase in implantation of loop recorders have generated an unprecedented volume of scheduled and unscheduled remote transmissions. Allied health professionals (AHPs) perform most of the operational work of remote monitoring, yet their perspectives remain underrepresented in the literature.

Focus groups were conducted to explore AHPs' experiences with remote CIED monitoring, identify key operational challenges, and define areas where guidance and support from the Heart Rhythm Society (HRS) are most needed. Transcripts underwent inductive qualitative content analysis, supplemented by descriptive content analysis of theme-related keywords. Following completion of the focus groups, participants completed a survey ranking the most prominent challenges and key actions HRS could take to support AHPs.

The focus groups identified eight major themes: (1) structural and staffing challenges; (2) alert burden and alert management; (3) connectivity, patient engagement, and compliance; (4) documentation, billing, and financial/ethical tension; (5) heart failure (HF) remote monitoring and care integration; (6) third-party platforms and artificial intelligence (AI) as force multipliers; (7) expectations, communication, and medico-legal anxiety; and (8) the role of HRS and professional societies. In the follow-up survey, participants ranked alert burden, staffing constraints, and connectivity as the

top three challenges, and identified standardized alert guidance and updated role-specific staffing recommendations as the highest-priority actions for HRS.

AHPs view remote CIED monitoring as clinically indispensable. However, growth has outpaced existing staffing and operational structures. AHPs have identified specific opportunities for HRS to provide additional support to facilitate safe and scalable remote monitoring programs.

2 INTRODUCTION

Remote CIED monitoring has shifted from episodic follow-up to continuous operational surveillance.

Remote monitoring of cardiac implantable electronic devices (CIEDs) with wireless technology has transformed follow-up care from episodic, in-person checks to continuous surveillance. Multiple studies have demonstrated that early access to actionable information provided through remote monitoring is associated with significant clinical benefits. As a result, the Heart Rhythm Society (HRS) has endorsed remote monitoring as a Class 1A indication for post-implant care.

At the same time, the exponential growth in implantable loop recorder (ILR) use has driven a rapid expansion in both the number of remotely monitored patients and the volume of scheduled and unscheduled device transmissions. As a result, contemporary remote monitoring programs now function as large

"virtual wards" of patients. Allied health professionals (AHPs), including device nurses and technicians, registered nurses, and advanced practice providers (APPs), bear the responsibility of patient education and enrollment, connectivity management, and patient communication. They also manage alert triage, documentation, and coordination with electrophysiologists and heart-failure specialists, frequently with the support of third-party service providers.

In 2023, HRS published detailed, task-based guidelines to address the operational demands of remote monitoring and proposed approximate staffing ratios. However, guidance remains limited regarding how these ratios perform across diverse practice settings; the optimal role mix (technicians vs. nurses vs. APPs); alert and heart-failure diagnostic programming and triage strategies; and the integration of third-party platforms and emerging artificial intelligence (AI) tools. Importantly, the lived experiences and priorities of allied health professionals, the individuals performing the majority of this work, are underrepresented in the literature. We undertook a qualitative study to address this gap.

3 METHODS

We examined frontline experience to identify operational gaps.

STUDY DESIGN

We conducted a qualitative descriptive study using semi-structured focus groups and an inductive qualitative content analysis, supplemented by descriptive analysis of responses.

The study was designed to elicit detailed accounts of day-to-day work in remote CIED monitoring clinics and to generate practice-oriented themes that could inform future HRS guidance and initiatives. Key themes were identified and further explored through a brief survey, used to characterize the most pressing operational challenges and to identify specific areas where additional HRS guidance and support may be needed. Participation was voluntary, and verbal informed consent was obtained at the beginning of each focus group.

SETTING AND PARTICIPANTS

Four focus groups were conducted over a five-month period. The first and fourth groups were held in person at national HRS-affiliated meetings; the second and third were conducted virtually using videoconferencing. Participants were recruited via HRS Leadership and Education for Allied Professionals (LEAP) participant mailing lists and professional networks to capture variation in geographic region, practice setting, and program size.

Eligible participants were AHPs with direct responsibility for remote monitoring of CIEDs. Participant roles included device nurses and technicians, registered nurses, nurse practitioners, physician assistants, and program coordinators or clinic managers. Participating sites represented academic medical centers, community hospitals, private practices, and Veterans Affairs (VA) or other government-affiliated facilities.

DATA COLLECTION

A semi-structured focus group guide was developed by the investigator team. Core discussion topics included staffing and role mix; workload and burnout; alert volume and alert programming; patient connectivity and compliance; documentation and billing; heart-failure diagnostics; the use of third-party platforms and AI; and experiences with existing HRS guidance and desired areas of future support. Each focus group session lasted 60–90 minutes, was moderated by an electrophysiologist and experienced allied health professional, and was audio-recorded and professionally transcribed.

Transcripts were reviewed for accuracy against original audio recordings and subsequently cleaned. Timestamps and transcription artifacts were removed, speaker labels were standardized, and obvious speech-recognition errors were corrected without altering the meaning of the content.

DATA ANALYSIS: INDUCTIVE QUALITATIVE CONTENT ANALYSIS

Transcripts were analyzed using an inductive qualitative content analysis approach. A large language model (ChatGPT, OpenAI) was used as an analytic assistant to support initial coding. Transcripts were first reviewed by the investigator team to establish familiarity with the data. ChatGPT was then used to generate preliminary line-by-line open codes and candidate thematic groupings based on participants' descriptions of challenges, workflows, and the unmet needs in remote CIED monitoring.

A codebook was iteratively developed and updated after each focus group, with previously analyzed transcripts re-reviewed to ensure consistent application of emerging codes and themes. Final themes were determined through investigator consensus. The codebook of themes, subthemes, definitions, and illustrative data segments is shown in Table 1.

DESCRIPTIVE CONTENT ANALYSIS

After the final thematic framework was established, a descriptive content analysis was conducted to characterize the relative emphasis of themes across focus groups. Theme-specific keyword lists were derived from the finalized coded data. Cleaned transcripts from each focus group were then electronically searched using these keyword lists, and the total number of keyword occurrences per theme was tabulated within each transcript. See Table 2 for theme frequency across the four focus groups.

Because individual discussion segments could legitimately relate to multiple themes, keyword occurrences were permitted to overlap. These counts are reported as approximate indicators of how frequently each thematic domain was discussed, rather than as precise measures of coded units or unique speakers, and were used to support, but not determine, the qualitative interpretation.

FOLLOW-UP QUESTIONNAIRE

After completion of the focus groups, participants were invited to complete a brief, two-question survey, asking participants to identify the three most significant challenges in RM and the top three actions HRS could take to better support AHPs.

4 RESULTS

Eight themes define the realities of remote monitoring today.

Participant Characteristics

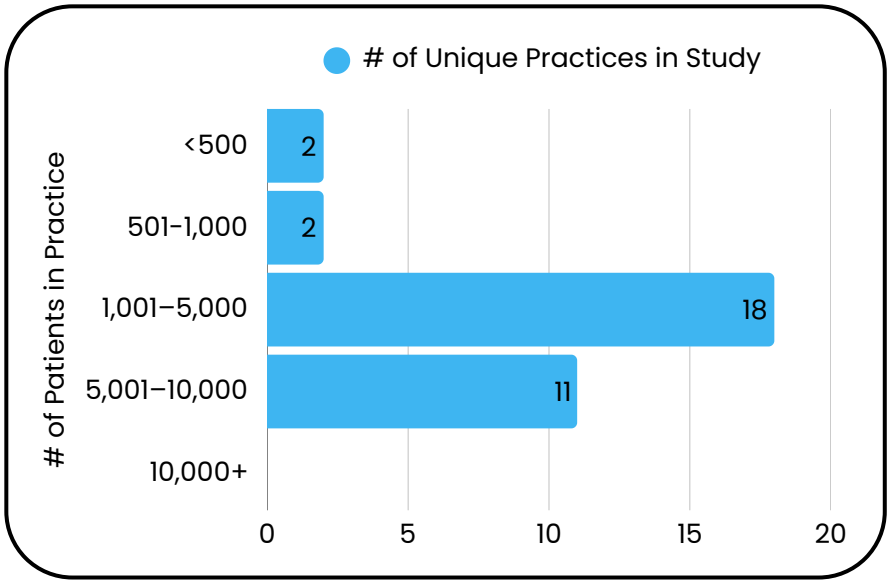
Across four focus groups, 37 AHPs participated from 30 unique practice sites. Seventy percent of participants were Advanced Practice Providers (APPs); the remainder included registered nurses, device technicians, and AHPs in administrative, research, and education roles. Participants represented a range of practice settings, including large academic centers, multi-hospital health systems, community practices, and VA settings. Remote monitoring panel sizes varied widely, ranging from several hundred to 10,000 patients per program. Of the participants, 23 of the 37 reported using third-party software plus or minus personnel for their remote monitoring. Participants were geographically diverse, including representation from 13 states within the United States as well as two participants from Canada and one from the Netherlands.

37
AHPs at **30** Unique Practices

Geographic Diversity

13
States within U.S.

1 Netherlands **2** Canada



Themes Identified

Inductive qualitative analysis identified eight major themes, consistent across all four focus groups. Structural and staffing challenges, alert burden and alert management, and the role of HRS were raised in all four focus groups and by participants in every role category. Connectivity and compliance, heart-failure remote monitoring, third-party platforms, and AI were highly salient in all four focus groups and expectations; medico-legal issues were discussed less frequently but still present in every group.

In the follow-up questionnaire, participants identified alert burden, staffing constraints, and connectivity as the top three challenges. The most frequently cited areas where HRS could provide additional guidance and support included updated role-specific staffing guidance and standardized alert programming and triage recommendations.

EIGHT THEMES AT A GLANCE

1. **Structural and staffing challenges**
2. **Alert burden, alert management and risk**
3. **Connectivity, patient engagement and "compliance"**
4. **Documentation, billing and financial/ethical tension**
5. **Heart-failure remote monitoring and care integration**
6. **Third-party platforms and AI as "force multipliers"**
7. **Expectations, communication and medico-legal anxiety**
8. **Role of HRS and professional societies**

THEME:
Structural and Staffing Challenges

Structural and staffing issues were among the most prominent themes, raised in all four focus groups and by participants across all role types. Participants consistently described a misalignment between the scale and complexity of remote monitoring work and available staffing resources. Many referenced the current HRS recommendation of approximately three full-time equivalents (FTEs) per 1,000 remotely monitored patients. While some programs reported staffing levels at or near this benchmark, they nevertheless described feeling "underwater" due to increasing alert complexity, rising patient volumes, and substantial non-billable work. Others acknowledged staffing levels well below the recommended ratio.

Participants emphasized that role mix was as important as the absolute number of FTEs. Across all four groups, allied health professionals distinguished between technical tasks, such as connectivity troubleshooting and routine documentation, and higher-acuity clinical tasks, including arrhythmia interpretation, medication adjustments, and communication of clinically significant findings. Several participants expressed frustration when APP time was consumed by low-complexity connectivity issues, noting that such work could be managed by technicians working under standardized protocols, thereby allowing nurses and APPs to focus on clinical decision-making.

The organization of remote monitoring programs also emerged as a critical factor. In three of the four focus groups, participants contrasted earlier models in which remote monitoring was performed opportunistically during in-clinic days ("we were told, just do it between patients") with newer centralized or dedicated remote monitoring teams. Participants working within centralized models reported greater standardization, improved training, and more reliable coverage. Remote and hybrid work options were highlighted, particularly in the virtual groups, as important strategies for retaining experienced staff and enabling cross-coverage during absences.

THEME:
Alert Burden, Alert Management and Risk

Alert burden and alert management were discussed extensively in all four focus groups and emerged as the most frequently referenced theme in the descriptive content analysis. Participants described high volumes of alerts and scheduled transmissions, often disproportionately generated by a small subset of "frequent flyer" patients. The continuous work of reviewing, classifying, and responding to alerts was repeatedly characterized as "laundry that never stops."

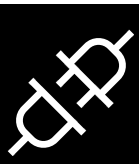
> **"It feels like the laundry that never stops."**

To manage workload, many programs reported adopting dynamic alert programming strategies. In three focus groups, participants described standardized protocols that included initial alert programming at the time of implant, early post-implant review and reprogramming, and periodic (often annual) reassessment. Examples included disabling atrial fibrillation alerts in patients with established permanent atrial fibrillation (AF) when no management changes were anticipated and deprioritizing brief nonsustained ventricular tachycardia (NSVT) episodes in low-risk patients. These approaches were framed as necessary to reduce non-actionable alerts and maintain a sustainable workload.

Despite these efforts, alerts related to NSVT and device-detected pauses remained a significant source of uncertainty and anxiety, particularly in the in-person focus groups. Participants described relying on informal, locally derived thresholds to determine clinical significance, while acknowledging that these criteria were often arbitrary and varied by provider, practice, and patient age. Some participants expressed concern about over-investigation and repeated low-yield testing, whereas others worried about under-recognition of clinically important arrhythmias.

Across all four groups, participants explicitly called for HRS-led guidance, potentially in the form of consensus statements or white papers, addressing the management of device-detected nonsustained ventricular arrhythmias, atrial fibrillation, and pauses. Desired guidance included recommendations for alert programming, triage thresholds, and standardized management pathways.

Alert workflows varied by site and practice size. In three focus groups, participants described tiered models in which third-party platforms, device technicians, or nurses performed initial triage, escalating only higher-risk events to APPs and a smaller subset to physicians. In contrast, participants from smaller practices more commonly reported routing most alerts directly to providers. Regardless of workflow structure, AHPs consistently characterized alert management as safety-critical work that requires explicit, defensible strategies rather than ad hoc decision-making.



THEME:
Connectivity, Patient Engagement and "Compliance"

Connectivity and "patient compliance" were also discussed prominently. Across practice settings, connectivity was described as the foundational prerequisite for remote monitoring: "if they're not connected, we have nothing." Maintaining connectivity, however, was characterized as a continual and largely invisible source of workload. Participants described repeated phone calls, electronic messages, and mailed letters to patients whose monitors were unplugged or whose mobile applications had stopped transmitting.

Approaches to persistent non-connection varied across programs. In two focus groups, participants described formal policies in which patients were removed from remote monitoring after a predefined number of unsuccessful contact attempts over a 60–90-day period. In contrast, participants working

with vulnerable populations, including pediatric patients, expressed moral discomfort with discharging patients whose lack of connectivity might be due to socioeconomic barriers rather than disengagement.

Structural barriers to connectivity were also emphasized. One pediatric group shared internal quality-improvement data indicating that some families labeled “non-compliant” with loop monitoring were unable to afford transmission-related costs under their insurance plans. Other participants described patients who lacked reliable internet access, were unable to maintain smartphone applications, or were distrustful of third-party vendors contacting them regarding connectivity issues.

> **“Half my day is chasing unplugged boxes.”**

To better align patient expectations, several programs reported using remote monitoring agreements or standardized education at the time of device implantation. These materials outlined the scope and limitations of remote monitoring, anticipated response timeframes, and patient responsibilities. Participants perceived such agreements as improving understanding, reducing frustration, and providing medico-legal reassurance for clinical teams.

THEME:
Documentation, Billing and Financial/Ethical Tension

Documentation and billing were identified as major challenges, particularly in the virtual sessions and the HRX in-person group. Participants described documentation requirements, especially for routine remote monitoring reports, as lengthy and repetitive, often driven more by billing requirements than clinical value. In contrast, complex alert review was perceived as under-compensated relative to the time required for thorough chart review, patient outreach, and complex clinical decision-making, which frequently exceeded 30–60 minutes per patient.

The structure of reimbursement also generated ethical tension. Monthly or quarterly billing cycles for CIED monitoring and implantable loop recorders were often perceived as misaligned with clinical need, particularly for patients with low event rates. Participants recounted patient concerns about repeated charges for normal reports, especially among those with high-deductible insurance plans, and described occasional instances in which patients considered device explantation to avoid ongoing financial burden.

Clinicians at times expressed a desire to continue monitoring without billing, particularly for high-risk patients experiencing financial hardship. However, participants reported that administrative and compliance teams emphasized that monitoring without billing was not permissible, requiring programs to either bill in accordance with the applicable codes and billing periods or discontinue remote monitoring. Administrative participants also raised

concerns about the ethical implications of inconsistent billing practices.

At the same time, several participants, particularly those from private practices and large health systems, acknowledged that well-structured remote monitoring programs with complete billing capture could be financially favorable and help justify additional staffing. Third-party platforms were frequently credited with improving billing capture by standardizing documentation and tracking eligible services.

THEME:
Heart Failure Remote Monitoring and Care Integration

Heart failure (HF) remote monitoring emerged as a recurring topic in all four focus groups, with approximately one-third of participants commenting on it. AHPs generally viewed device-based HF diagnostics and dedicated HF remote monitoring pathways as clinically valuable, citing earlier detection of congestion and proactive diuretic titration.

Despite the perceived value, responsibility for HF alerts was frequently described as ambiguous. Across multiple focus groups, participants reported uncertainty regarding whether device-generated HF diagnostics fell under the purview of EP, HF, or general cardiology services. EP teams were often hesitant to titrate HF medications based solely on device-based diagnostics, while HF teams did not view themselves as responsible for alerts originating from devices they had not implanted or ordered. This ambiguity extended to billing

practices. Some programs reported that HF physicians reviewed and signed HF-specific reports and billed using HF remote monitoring codes, whereas others lacked formal workflows or shared accountability.

One focus group described a structured HF remote monitoring pathway in detail. In this model, HF nurses monitored device-based HF diagnostics within the remote platform, contacted patients, adjusted diuretics according to protocol, arranged follow-up, and completed standardized documentation that supported billing by HF providers. Participants from other centers expressed strong interest in similar standardized HF pathways, developed jointly by EP and HF teams, and endorsed by professional societies. Desired guidance included recommendations on patient selection, alert triage and escalation, and the division of clinical and billing responsibilities.

THEME:
Third-Party Platforms and Artificial Intelligence as “Force Multipliers”

Third-party platforms and AI-supported tools were discussed in all four focus groups and were widely characterized as “force multipliers” that enabled relatively small clinical teams to safely manage large remote monitoring populations.

Participants described a spectrum of third-party services, ranging from solutions focused primarily on connectivity management and data aggregation to more comprehensive platforms offering end-to-end alert triage, standardized reporting, AI-enablement, advisory management, and

clinical coverage. Programs that had transitioned from fragmented or manual workflows to integrated, clinically supervised third-party platforms reported substantial reductions in non-actionable alerts requiring clinician review, as well as improvements in documentation consistency and billing completeness. One large center reported a decrease in weekly alert reports from approximately 2,000–3,000 to roughly 500 after implementing a vendor-supported triage model.

At the same time, participants emphasized variability in vendor practices and raised safety concerns. In one focus group, AHPs recounted a prior vendor arrangement without weekend coverage, in which multiple shocks were not discovered until the following business day. This experience was regarded as unacceptable and contrasted with their current clinical arrangement, where third-party staff call the on-call electrophysiologist for critical alerts. Participants emphasized that any future guidance on remote monitoring must address minimum expectations for clinical coverage, alert escalation pathways, and time to response.

> **“AI is a filter, not a replacement.”**

AI-assisted triage was discussed, and where implemented, within supervised workflows, participants emphasized AI’s ability to reduce non-actionable alerts and prioritize clinically relevant events, adding value to their workflow. At the same time, there was

strong consensus that AI must demonstrate at least non-inferior performance compared to human interpretation and should remain embedded in human-in-the-loop workflows. Participants emphasized the importance of transparency, validation, and ongoing clinical oversight, noting that AI should complement, not replace, clinical judgment. Many expressed interest in HRS-level guidance addressing safety standards, validation requirements, and best practices for integrating AI-enhancement into remote monitoring programs.

THEME:
Expectations, Communication and Medico-Legal Anxiety

Expectations and medico-legal concerns were raised most prominently in the pediatric-heavy and national conference groups. Participants described widespread expectations among patients and families that remote monitoring equates to continuous, real-time surveillance and immediate clinician response. When adverse events occurred during inevitable gaps, such as periods of lost connectivity, scheduled upload intervals, or overnight processing delays, clinicians reported difficulty explaining these limitations to patients retrospectively.

AHPs also expressed expectations from physicians and administrators who assumed that alerts were being continuously monitored, without fully appreciating the volume and complexity of the work. When alerts were missed or responses delayed, participants frequently reported a strong sense of personal responsibility, even when system-level constraints were the primary contributing factors.

Some programs responded by implementing non-punitive incident review processes, similar to morbidity and mortality conferences, to examine cases where remote monitoring failed or responses were delayed. These reviews emphasized identification of system-level vulnerabilities and opportunities for improvement. Participants expressed interest in HRS-developed frameworks to support transparent, learning-oriented incident review processes and to assist with communicating the inherent limitations of remote monitoring in patient education and medico-legal contexts.

THEME:
Role of HRS and Professional Societies

Across all four focus groups and participants in every role category, there was a clear call to action for HRS and related professional societies. Allied health professionals viewed existing HRS guidance, particularly the suggested staffing ratio, as helpful but incomplete. Participants consistently requested more granular, role-specific staffing recommendations, including illustrative models specifying the number of technicians, nurses, APPs, and physicians required per 1,000 remotely monitored patients under different organizational structures, including the use of third-party services.

Participants also called for more detailed guidance on alert programming and arrhythmia management. Requested areas include

consensus recommendations on which alerts should be enabled by default, standardized severity and escalation frameworks, and evidence-based thresholds for alert management. Several participants explicitly suggested that HRS develop focused scientific statements or white papers on device-detected ventricular arrhythmias and HF remote monitoring.

In addition, AHPs expressed a strong desire for administrator- and patient-facing resources developed by HRS. Suggested resources included economic modeling and business-case tools to support requests for adequate staffing and infrastructure, standardized remote monitoring agreements and patient education materials to clarify expectations, and structured frameworks for incident review. Participants emphasized that such guidance would not only support patient safety and program sustainability but also formally recognize the expertise, accountability, and workload of the AHPs who are largely responsible for remote monitoring programs.

Follow-Up Questionnaire Results

Following completion of the four focus groups, 18 participants completed a brief follow-up survey to quantify priority themes identified during qualitative analysis. Alert burden, alert management, and risk were ranked as the most significant challenges in RM, followed by structural and staffing challenges, and then patient connectivity, engagement, and compliance.

When asked to rank actions HRS could take to better support AHPs, respondents identified updated role-specific staffing recommendations as the highest priority, followed closely by standardized guidance on alert programming and arrhythmia management. The development of patient-facing education and administrator-facing advocacy and economic modeling tools were closely matched for third priority. Overall, the survey results reinforced the qualitative findings and helped prioritize specific areas for potential action by HRS.

> **“Without a national standard, we’re terrified that any decision could be questioned later.”**

5 DISCUSSION

Infrastructure has not kept pace with monitoring growth.

The implementation of continuous RM of CIEDs in real-world practice has introduced substantial operational challenges that have outpaced existing staffing models, workflows, and reimbursement structures. AHPs constitute the primary workforce sustaining RM programs, and their perspectives provide critical insight into the day-to-day realities of this service. While HRS published task-based operational guidance in 2023, participants in these focus groups described persistent gaps in practical implementation strategies and in administrative recognition of the resources required to safely and sustainably perform RM.

The volume of continuous data is the central challenge of remote monitoring. In an environment of limited staffing and financial constraints, it is necessary to implement strategies to reduce non-actionable data. AHPs articulated a preference for an alert-based remote monitoring model that eliminates non-actionable scheduled transmissions, providing more time to address clinically actionable data.

Although the 2023 HRS guidelines acknowledge the importance of dynamic alert reprogramming, participants reported that the absence of specific recommendations creates uncertainty in practice. Without clearer definitions of what constitutes a clinically actionable alert, efforts to reduce alert burden may paradoxically increase anxiety regarding missed events and medico-legal exposure. Many AHPs also highlighted the importance of improved collaboration

with the implanting physicians, particularly at the time of device implantation and subsequent reprogramming, to individualize alert settings as clinical circumstances evolve.

Differences across device manufacturers further compound these challenges. Variability in the number and type of programmable alerts, alert notification pathways, and the ability to reprogram alerts remotely versus in person introduces additional operational complexity for RM clinics. Participants expressed a desire for HRS advocacy to promote greater standardization across manufacturers in order to reduce unnecessary variation and administrative burden.

AHPs identified staffing structures as a major priority. Although the 2023 HRS guidelines specified 3 FTEs per 1,000 remotely monitored patients, they fail to delineate roles for these FTEs. This lack of role specificity was perceived as limiting its usefulness in operational planning and budget justification. The widespread use of third-party services further complicates workforce calculations, contributing to persistent underestimation of RM resource needs by hospital administrators.

Most participating clinics reported employing third-party services to help manage remote monitoring operations. AHPs generally viewed these services as effective in addressing workflow challenges, particularly in connectivity management, patient outreach and compliance, standardized reporting, and billing support. Participants described meaningful reductions in administrative burden through consolidation of multiple manufacturer portals, more consistent documentation within the electronic medical record, using a uniform report

structure, and efficient alert triage. Third-party services were also credited with reducing transmission burden by using trained technicians who screen incoming data and triage non–clinically relevant transmissions prior to escalation to clinic staff.

Despite these efficiencies, AHPs emphasized that clinical responsibility remains firmly within the clinic. Final review of reports, clinical decision-making, patient communication, documentation, and escalation to physicians continued to rest with AHPs, underscoring that workflow support does not eliminate clinical workload.

AHPs expressed cautious skepticism regarding AI-based tools to reduce transmission burden. While acknowledging potential benefits, AHPs emphasized the need for robust safety and performance data, and strongly preferred human-in-the-loop workflows.

Ethical and medico-legal concerns were pervasive. AHPs described moral distress related to patients who struggle to afford the cost of remote monitoring and struggle with policies that resulted in disconnected patients for financial reasons. Participants also expressed concern about personal accountability for delayed or missed alerts in the context of overwhelming data volume and chronic understaffing. The perceived exposure to legal risk was described as a significant contributor to occupational stress.

Heart failure remote monitoring emerged as an area of unmet need and persistent ambiguity. Participants described uncertainty regarding patient selection, alert ownership, clinical responsibility, and billing pathways. Ambiguity spanned the spectrum of who should be monitored, who should perform the

monitoring, and what to do with findings. AHPs working in EP clinics frequently reported managing heart failure alerts in the absence of clear protocols or shared ownership with heart failure teams. Participants expressed a strong desire for joint guidance with HF societies to clarify workflows, responsibilities, and escalation pathways.

Taken together, these findings position HRS as a critical stakeholder in shaping the future of remote CIED monitoring. Participants did not seek reaffirmation of remote monitoring's value; rather, they called for concrete, operational guidance that reflects frontline realities. The follow-up questionnaire further reinforced these priorities, highlighting role-specific staffing recommendations, standardized alert guidance, and creation of administrator and patient-facing resources as the most impactful actions HRS could take to support RM programs and the AHPs who sustain them.

What This Means for Remote Monitoring Programs

OPERATIONAL REALITIES

Alert Volume Drives Workload
Workload is driven more by alert complexity than by the total number of enrolled patients. Reducing non-actionable alerts requires structured programming and tiered triage.

Role-Optimized Staffing Is Essential
Headcount alone is insufficient. Technicians, nurses, APPs, and physicians must work at the top of their license to sustain scale.

Connectivity Is Infrastructure
Disconnected patients create blind spots. Connectivity requires defined outreach workflows, tracking metrics, and escalation policies.

Documentation Shapes Behavior
Billing requirements influence documentation length and monitoring cadence. Standardized templates and integrated workflows reduce friction and missed reimbursement.

HF Monitoring Needs Clear Ownership
Heart failure diagnostics are clinically valuable but often lack defined responsibility between EP and HF teams. Clear pathways are required.

RISK EXPOSURE

Medico-Legal Uncertainty
NSVT, AF, and pause thresholds vary across programs. Without standardized guidance, local rules may be vulnerable to scrutiny.

System Overload Risk
High alert volume combined with understaffing increases the likelihood of delayed review and missed escalation.

Ethical & Financial Tension
Billing cycles, affordability barriers, and disconnection policies may create patient dissatisfaction and reputational exposure.

6 CALL TO ACTION FOR HRS

Structural clarity and national guidance are urgently needed.

Based on these findings, allied health professionals recommend that HRS:

1. **Publish a consensus statement** defining clinically actionable alerts, including device-detected AF, NSVT, and pauses with recommended management pathways.
2. **Provide implementation guidance** for dynamic alert reprogramming, including population-based strategies and shared accountability with implanting physicians.
3. **Update staffing recommendations** to specify role mix (technicians, nurses, APPs, physicians) and explicitly account for third-party partners.
4. **Develop administrator-facing resources**, including educational materials and economic models, to support appropriate staffing and infrastructure investment.
5. **Advocate for greater standardization** of alert notification, programmability, and communication across device manufacturers.
6. **Produce standardized patient education and remote monitoring agreements** to align expectations and mitigate medico-legal risk.
7. **Collaborate with heart failure societies** to develop joint guidance on patient selection, ownership, workflows, and billing for HF remote monitoring.

7 CONCLUSION

Sustainable monitoring requires aligned infrastructure and accountability.

Remote CIED monitoring has outpaced the staffing models and operational frameworks available in many programs. AHPs, who serve as the frontline workforce for this essential clinical service, offer critical insight into the challenges of delivering safe and sustainable remote monitoring. Across diverse settings, AHPs described consistent operational gaps and articulated clear priorities for professional societies' support. HRS is uniquely positioned to translate these frontline perspectives into practical, scalable guidance on role-specific staffing models, alert management, HF workflows, AI integration standards, and administrator- and patient-facing resources to support the long-term safety, efficacy, and sustainability of remote monitoring programs.

8 TABLES

Table 1. Codebook of themes, subthemes, definitions, and illustrative data segments

Theme	Subtheme	Definition	Illustrative Data Segment*
1. Structural and staffing challenges	1.1 Understaffing vs HRS benchmark	Descriptions of remote monitoring staffing levels falling below the HRS suggestion (≈3 FTE per 1,000 patients) and perceived mismatch between guideline and reality.	"We've got over six thousand devices and about five and a half FTEs plus a vendor. On paper that sounds okay, but day-to-day we are still underwater." (Program manager, academic center)
	1.2 Role mix and "top of license" practice	Discussion of the importance of the types of staff (techs, nurses, APPs, physicians) and aligning tasks with training and licensure.	"I don't want my nurse practitioners calling people to plug in boxes. That's something a tech or MA can do so the APPs can focus on clinical decisions." (NP, private practice)
	1.3 Dedicated RM teams vs distributed work	Experiences comparing remote monitoring as a side-task in clinic versus centralized, dedicated RM teams (often remote/hybrid).	"When device checks were squeezed in between clinic patients, it was chaos. Once we built a dedicated remote team, everything became more predictable." (Device nurse, community hospital)
	1.4 Recruitment, retention and remote work	Challenges recruiting and retaining experienced RM staff; use of remote/hybrid work to improve retention and cross-coverage.	"Letting people work remotely has been huge. We can cover each other when someone's on leave and we're not losing burned-out senior nurses to other departments." (RM nurse, health system)

Theme	Subtheme	Definition	Illustrative Data Segment*
2. Alert burden, alert management, and risk	2.1 Alert volume and "frequent flyers"	Descriptions of high alert volume, repetitive alerts from a small subset of patients, and the resulting fatigue.	"Three percent of our patients generate a quarter of our alerts. It feels like the laundry that never stops—you're always trying to empty the basket." (Device tech, academic center)
	2.2 Dynamic alert programming	Efforts to systematically reprogram alerts (at implant and follow-up) to reduce non-actionable events, based on indication and patient status.	"We reprogram everyone to our clinic standards at implant and revisit at 30 days and annually. If someone is permanently in AF and rate-controlled, those AF alerts come off." (EP NP, large system)
	2.3 NSVT and pause alerts	Uncertainty and anxiety around what duration/burden of NSVT or pause should trigger action, acknowledging local but arbitrary thresholds.	"For NSVT, what is the line? Ten beats? Thirty seconds? It depends on age and history, but our rules are still mostly homegrown and that worries us." (PA, private practice)
	2.4 Ownership and workflows	Description of alert triage structures (e.g., third-party intake, tech review, APP/MD escalation) and who is responsible for which decisions.	"Our vendor screens everything first, then our nurses see a curated list. Only certain pre-defined events go to an APP or physician." (Clinic manager, academic center)
	2.5 Desire for alert guidance from HRS	Explicit calls for HRS to define which alerts must be on, how to categorize severity (red/yellow/green), and how quickly to respond.	"We need a national baseline—what alerts are non-negotiable, which can be off, and what counts as red, yellow, green. Right now everyone is inventing their own." (NP, national conference group)

Theme	Subtheme	Definition	Illustrative Data Segment*
3. Connectivity, patient engagement, and "compliance"	3.1 Connectivity as constant workload	Accounts of the ongoing effort required to keep patients connected (calls, messages, letters) and the sense that this work is invisible but essential.	"If they're not connected, we have nothing. Half my day is chasing people with unplugged boxes or phones that dropped the app." (Device nurse, academic center)
	3.2 Policies for repeated non-connection	Clinic rules for how many attempts are made to re-establish connection and when a patient is removed from remote monitoring.	"We do three phone calls, then a letter, then certified mail. If there's still no response thirty days after the certified letter, we remove them from our remote panel." (Program coordinator, academic center)
	3.3 Ethical discomfort about discharge	Expressions of moral distress about removing patients from RM when the reasons for disconnection may be structural (cost, literacy, trust).	"On paper, yes, we can discharge them from remote, but it feels wrong to stop watching someone just because we can't reach them. We don't always know why they're not connecting." (NP, academic center)
	3.4 Structural barriers and inequities	Recognition that "non-compliance" often reflects cost, technology access, or health literacy rather than willful behavior.	"Our pediatric QI project showed families weren't ignoring us—they literally couldn't afford the transmission charges with their insurance." (Pediatric NP, children's hospital)
	3.5 Remote monitoring agreements	Use of written agreements or education materials to define RM capabilities and patient responsibilities.	"We give them a remote monitoring agreement from day one: what we do, what we don't do, and what they're responsible for. It helps with expectations and with risk." (EP NP, academic center)

Theme	Subtheme	Definition	Illustrative Data Segment*
4. Documentation, billing, and financial/ethical tension	4.1 Documentation length and complexity	Perception that documentation required for billing is lengthy and often misaligned with clinical value.	"Documentation is one of our top headaches. The note is long, repetitive, and we spend more time proving we did the work than actually doing it." (Device nurse, large system)
	4.2 Monitoring frequency vs billing rules	How monthly or q90 billing cycles drive monitoring patterns and workload, sometimes beyond what clinicians see as clinically necessary.	"For loops, monthly billing is how the practice stays afloat. But some patients probably don't need monthly eyes on them—it's just how the codes are written." (PA, private practice)
	4.3 Patient financial burden	Concerns about patients' out-of-pocket costs and perceived unfairness when reports are consistently "normal."	"Patients with high deductibles ask, 'Why am I paying every month to hear everything looks fine?' A few have even asked about taking the device out." (NP, HRX group)
	4.4 Monitoring without billing	Tension between wanting to monitor high-risk patients without charging them and rules that this is non-compliant or fraudulent.	"We've asked if we can keep certain patients on without billing because they can't afford it, and compliance said absolutely not—you either monitor and bill, or you stop." (Administrator, academic center)
	4.5 RM as business model	Recognition that well-structured RM programs (often with third parties) can be financially favorable and support staffing.	"In private practice, every customer we've moved to a structured remote model with a vendor has made more money, not less. The problem is getting staffed appropriately to start." (EP physician, national conference group)

Theme	Subtheme	Definition	Illustrative Data Segment*
5. Heart failure remote monitoring and care integration	5.1 Value of HF diagnostics	Perceived benefits of device-based HF diagnostics (e.g., HeartLogic, TriageHF) for early detection and proactive management.	"When our HF team uses the diagnostics, we can adjust diuretics before patients wind up in the ER. It's a powerful tool when someone owns it." (HF NP, academic center)
	5.2 Ambiguous ownership of HF alerts	Uncertainty about whether EP, HF, or general cardiology should manage and bill for HF alerts and interventions.	"Is that a device issue or a heart failure issue? EP doesn't want to manage diuretics, but HF doesn't always feel responsible for device alerts they didn't order." (Device nurse, health system)
	5.3 Desire for HF pathways and billing models	Calls for clear protocols for HF-specific alerts, including clinical steps and billing frameworks.	"We need a playbook for HF diagnostics—who gets notified, what's the algorithm for meds and follow-up, and how the HF docs bill for their part." (NP, HRX group)

Theme	Subtheme	Definition	Illustrative Data Segment*
6. Third-party platforms and AI as "force multipliers"	6.1 Third-party scope and benefits	Use of vendors/software to handle connectivity, triage, documentation and billing; perceived as essential for scale.	"With our third-party platform, they chase disconnections and pre-screen alerts. We went from two to three thousand weekly reports down to about five hundred we actually need to touch." (Program manager, large center)
	6.2 Variability and safety concerns	Differences in what vendors provide (e.g., weekend coverage, HF views, advisory tagging) and worries about gaps.	"Our old vendor did nothing on weekends. We'd come in Monday and find out about shocks from Friday. Now, if there's a shock or ATP, they call the on-call EP immediately." (NP, academic center)
	6.3 AI-assisted triage	Experiences with AI tools that reduce noise or prioritize alerts, and views on their appropriate role.	"The AI layer does a nice job cutting out the garbage, but we still review anything it flags. It's a filter, not a replacement." (NP, virtual group)
	6.4 Non-inferiority bar and oversight	Belief that AI must be at least non-inferior to human interpretation and embedded within human-in-the-loop workflows.	"I'm okay with AI helping, but it has to be at least as good as us, and a clinician still needs to own the final call." (PA, virtual group)
	6.5 Education to avoid "autopilot"	Need for staff education on AI limitations to prevent uncritical acceptance of automated outputs.	"If we don't train people, they'll just accept whatever the algorithm says. We need them to understand when to question it." (Clinical lead, health system)

Theme	Subtheme	Definition	Illustrative Data Segment*
7. Expectations, communication, and medico-legal anxiety	7.1 Patient expectations of 24/7 surveillance	Misperceptions that remote monitoring is constant real-time monitoring and that any event will trigger an immediate call.	"Families think someone is sitting there watching a screen all night. When something slips through, it's very hard to explain there's a delay in how data comes in." (Pediatric NP)
	7.2 Clinician expectations and moral load	Feelings of personal responsibility for missed alerts or technical failures despite structural limitations.	"Even when I know the system is under-resourced, if we miss an alert, I carry that. It feels like my failure." (Device nurse, academic center)
	7.3 Medico-legal fears	Worries about legal scrutiny of missed alerts and desire for defensible standards of care.	"Without a national standard, we're terrified that any decision to turn off an alert could be questioned in court later." (NP, national conference group)
	7.4 Incident review and learning	Approaches to reviewing adverse events or misses in a learning-focused rather than punitive way.	"We treat misses like an M&M—what went wrong, what can we fix—rather than immediately blaming someone, unless there's gross negligence." (Clinic leader, large system)

Theme	Subtheme	Definition	Illustrative Data Segment*
8. Role of HRS and professional societies	8.1 Updated, role-specific staffing guidance	Desire for HRS to refine staffing recommendations by role and model (centralized vs distributed, use of vendors/AI).	"The three FTE per thousand is a start, but we need to know how many techs, how many nurses, how many APPs, and how that changes if you use a third party." (Program manager, academic center)
	8.2 Alert and arrhythmia guidance	Calls for HRS to issue detailed guidance or white papers on alert programming, NSVT management, and HF diagnostics.	A best-practice statement on device-detected VT and HF alerts would be huge. We're all improvising right now." (EP NP, national conference group)
	8.3 Administrator-facing advocacy and economics	Requests for HRS to provide tools and statements that help justify staffing and infrastructure to hospital leadership.	"Admins listen when there's a national society document and financial modeling. We need HRS to say, 'This is what a safe clinic looks like and what it costs." (Clinic manager, large system)
	8.4 Templates and education materials	Need for standardized patient-facing education, RM agreements, and frameworks for incident review.	"If HRS had standard consent language and patient videos about remote monitoring, we'd all be on the same page from day one." (NP, HRX group)

*Quotes are lightly paraphrased and anonymized to protect confidentiality and readability.

Table 2. Theme frequency table across the 4 focus groups (FG)					
Theme	**HRS in-person (FG1)**	**Virtual #1 (FG2)**	**Virtual #2 (FG3)**	**HRX in-person (FG4)**	**Total across 4 FGs**
Structural / staffing	69	57	29	32	187
Alerts / alert management	119	100	106	70	395
Connectivity / "compliance"	51	47	19	51	168
Documentation / billing / finance	52	20	6	44	122
HF remote monitoring	43	38	21	46	148
Third-party platforms & AI	105	16	50	61	232
Expectations & medico-legal issues	16	10	2	12	40
Role of HRS / professional societies	47	39	35	51	172

(Counts are approximate keyword mentions per transcript; themes overlap, so totals are not mutually exclusive.)

9 **TRANSLATING FINDINGS INTO PRACTICE**
Operational design must match clinical demand.

ENABLING SUSTAINABLE REMOTE CIED MONITORING AT SCALE:
An Operational Model Aligned with Allied Health and HRS Priorities

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Remote monitoring of cardiac implantable electronic devices (CIEDs) is now a foundational component of electrophysiology practice and a Class I–endorsed standard of care. However, as highlighted by recent allied health professional (AHP) focus group findings, the operational infrastructure supporting remote monitoring has not evolved at the same pace as clinical adoption. Alert burden, staffing constraints, fragmented technology, documentation demands, and unclear accountability have emerged as limiting factors in program sustainability.

These findings highlight a clear need for operational models that translate HRS guidance and frontline experience into scalable, defensible workflows. Octagos was designed to address these challenges by aligning technology, clinical oversight, and operational efficiency within real-world electrophysiology practices.

INTEGRATED, BIDIRECTIONAL WORKFLOWS ANCHORED IN THE MEDICAL RECORD

AHPs consistently identified fragmented systems and manual documentation as sources of inefficiency and error. Multiple manufacturer portals, redundant data entry, and limited continuity between remote and in-clinic care increase cognitive load and introduce risk.

Octagos supports bidirectional integration with the patient's electronic medical record (EMR), allowing remote interrogation data, triage outcomes, and finalized reports to flow directly into the clinical record while providing relevant clinical context (medications, past medical history, demographics) to inform triage decisions. Billing and rescheduling are also automated. This integration reduces transcription errors, improves documentation consistency, and supports seamless transitions between remote surveillance and in-clinic care.

REDUCING ALERT BURDEN THROUGH SUPERVISED AI-ENABLED TRIAGE

Alert burden—rather than patient volume—was identified as the dominant driver of inefficiency, burnout, and perceived medico-legal risk. AHPs described spending substantial time reviewing non-actionable transmissions while navigating uncertainty around arrhythmia thresholds and escalation criteria.

Octagos addresses this challenge through rapid interpretation of remote interrogations using the Atlas AI™ engine. Atlas AI prioritizes clinically meaningful events and suppresses non-actionable noise, significantly reducing the volume of alerts requiring clinician review. Importantly, this occurs within a Human-in-the-Loop™ framework, where clinically significant findings are reviewed by IBHRE-certified professionals, preserving clinical judgment, accountability, and patient safety.

Real-world evidence supports the effectiveness of Atlas AI in reducing data volume while maintaining clinical safety. In a multicenter analysis of more than 690,000 cardiac device transmissions across 78 U.S. clinics, Atlas AI forwarded a smaller

proportion of transmissions than device technicians (22.8% vs. 38.5%), while demonstrating higher sensitivity (99.1% vs. 70.8%) and comparable overall accuracy (93.8% vs. 95.4%). These findings indicate effective suppression of non-actionable data without loss of clinically relevant events.

The analysis further demonstrated that optimal performance was achieved when AI outputs were reviewed within a Human-in-the-Loop framework incorporating IBHRE-certified oversight. Under this Two-Brain Approach, combined Atlas AI and human review achieved 99.5% accuracy, 99.1% sensitivity, and 99.8% specificity, exceeding the performance of human review alone. Collectively, these results support the use of AI as an adjunct to clinical expertise in high-volume CIED monitoring environments.

AUTOMATION THAT IMPROVES RELIABILITY AND REDUCES ERROR

Manual workflows were repeatedly described as vulnerable to error, particularly during periods of high alert volume or limited staffing. Missed alerts, inconsistent documentation, and delayed escalation contribute to clinician anxiety and operational risk.

Octagos leverages automation to standardize alert routing, documentation, scheduling, and escalation pathways. By reducing reliance on individual workarounds and decreasing variability, this approach lowers cognitive burden and supports more consistent, defensible clinical decision-making across programs of varying size and complexity.

SUPPORT FOR IN-CLINIC, REMOTE AND HYBRID CARE MODELS

Focus group participants emphasized that effective remote monitoring must integrate with in-clinic workflows rather than function as a parallel system. Centralized and hybrid models were associated with improved coverage, standardization, and staff satisfaction.

Octagos is designed to support in-clinic, remote, and hybrid workflows, enabling consistent processes across care settings. In-clinic workflows are supported through cloud-based direct data transfer from the programmer to Octagos. This flexible architecture facilitates coordination among technicians, nurses, advanced practice providers, and physicians, and supports continuity of care across the patient journey.

IMPROVING FINANCIAL SUSTAINABILITY THROUGH BILLING OPTIMIZATION

Documentation and reimbursement were described as sources of ethical and operational tension. Complex alert review and patient management were often under-recognized, while incomplete documentation resulted in missed billing opportunities.

Octagos improves financial sustainability by standardizing documentation and optimizing billing capture in alignment with applicable remote monitoring codes. By reducing missed billable services and improving documentation completeness, Octagos helps practices support appropriate staffing investments without adding administrative burden to clinical teams.

IMPACT ON CLINICAL, OPERATIONAL, AND FINANCIAL OUTCOMES

By combining bidirectional EMR integration, AI-assisted triage, workflow automation, and billing optimization, Octagos delivers improvements across clinical, operational, and financial domains. Practices using Octagos report reduced alert burden, fewer workflow errors, improved staff efficiency, and stronger program sustainability—allowing electrophysiology teams to focus on timely, high-quality patient care. Clinicians can use Octagos' provider mobile application to review alerts and sign off on fully annotated reports from virtually anywhere.

In addition, Octagos' analytics layer transforms remote monitoring data into actionable insights that support proactive resource allocation and care optimization. These analytics enable clinics to identify device utilization patterns, anticipate upcoming elective replacement indicators (ERI), recognize patients who may benefit from device upgrades or therapy optimization, and flag patients at risk of falling out of guideline-directed medical therapy, supporting earlier intervention and more coordinated longitudinal care.

CONCLUSION

The allied health perspective underscores that the future of remote CIED monitoring depends not only on access to data, but on operational infrastructure that aligns technology with clinical judgment and HRS-aligned best practices. Octagos was built in response to these frontline realities, offering an integrated platform that supports safe, scalable, and sustainable remote monitoring programs as electrophysiology care continues to evolve.

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