HEART FAILURE

RESEARCH ARTICLE

Clinician Response to Remote Active Monitoring in Patients with Heart Failure: Results of the RAPID-RF Trial

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ABSTRACT. Aims: Advances in remote patient monitoring (RPM) technologies enable automatic wireless transmission of radiofrequency (RF)-enabled implantable device and physiologic data that may allow for more frequent and flexible treatment regimens. We evaluated physician therapeutic interventions in response to daily remote device transmissions and weight measures in heart failure patients after cardiac resynchronization therapy defibrillator (CRT-D) implant.

Methods and results: The RAPID-RF study enrolled 891 patients from 68 US centers receiving a CRT-D device and RPM equipment consisting of a weight scale, blood pressure cuff, and wireless communicator that queried patient symptoms. The number of interventions for RPM alerts was assessed. Interventions were defined as an in-clinic, hospital, or emergency room visit as well as a telephone interaction. A total of 863 patients (male 71%, New York Heart Association (NYHA) Class III 93%, age 70 ± 11 years, body mass index 28.9 ± 6.9 kg/m², ejection fraction 24 ± 7%, median follow-up 9.1 months) had a successful CRT-D implant (97%). A total of 268 device, arrhythmia, and weight alerts resulted in 344 interventions in 126 patients.

Conclusion: Daily RPM of implantable device and weight information in CRT-D patients provides physicians data leading to therapeutic interventions on a frequent basis. Whether such interventions lead to improved patient outcomes will have to await the results of further investigation.

KEYWORDS. cardiac resynchronization therapy defibrillator, heart failure, remote monitoring.

Introduction

Heart failure (HF) is a common disease affecting an estimated 5 million Americans and is one of the leading causes for hospitalization in the United States.1,2 Heart failure affects approximately 1–2% of Europeans, increasing with age, leading to an increasing rate of hospitalizations for heart failure.3,4 Aging of the US and European populations is expected to increase the
prevalence of HF. Although the prognosis of HF has improved significantly in the past 20 years, the risk of death remains unacceptably high, particularly during and following a HF hospitalization. Repeated hospitalizations are an indication of poor quality of life (QOL) and also poor prognosis at an increased economic burden. Rehospitalization remains common following an initial hospitalization for HF, with 25% readmitted within 30 days. The current American College of Cardiology/American Heart Association and ESC treatment guidelines for the management of chronic HF include the use of cardiac resynchronization therapy defibrillators (CRT-Ds) as well as regular monitoring of weight in order to improve patient care. The demand for specially trained health-care individuals will undoubtedly increase along with the demand for technology to monitor these patients and their devices. Telemonitoring or remote patient monitoring (RPM) is seen as a possible novel disease management strategy to improve the care of patients with HF. Earlier detection and notification of clinical or device events has been found to shift health-care visits from the emergency department to the clinic, thereby reducing costs and lowering the burden on the overall health-care system. Moreover, RPM has been shown to safely reduce in-office burden while detecting actionable events more quickly for patients implanted with electronic devices. Disease management programs including RPM provide an alternative to frequent clinic visits. Recent studies have shown improved outcomes associated with home disease management programs for patients with HF. However, some of these studies were predominantly nurse-driven, labor-intensive, and reliant on individual patient compliance. The ability to remotely monitor device function holds promise, and preliminary data indicate high patient and physician satisfaction. Remote monitoring of implantable cardiac devices is recommended by the Heart Rhythm Society, and recent studies have shown a reduction of in-clinic follow-up visits resulting in a cost saving per patient year. The Remote Active Monitoring in Patients with Heart Failure (RAPID-RF) study assessed the type and frequency of prespecified alert notifications, as well as alert-related medical interventions in order to understand whether daily remote monitoring provides actionable data related to device integrity, arrhythmia, and HF management.

Methods

The details of the study design have been previously published. Briefly, RAPID-RF is an open-label, single-arm observational study designed to characterize the type and frequency of alert notifications, time from alert notification to medical intervention, type of medical intervention, and patient compliance with weight and blood pressure monitoring using the LATITUDE® system (Boston Scientific, Natick, MA). Consenting patients were enrolled from 68 US centers, each requiring Independent Review Board approval. After implant, remote device and patient data were collected at daily and weekly intervals. In-clinic visit data were collected at implant and at the 3- and 6-month visits, and thereafter at designated post-6-month follow-up visits. Patient satisfaction with the LATITUDE system was also assessed via a questionnaire at the first in-clinic follow-up. Clinical outcome data collected consisted of mortality, NYHA class and QOL over time, hospitalizations, and the number and duration of HF-related events. Changes in NYHA functional class, QOL as assessed using the Global Assessment Tool, Minnesota Living with Heart Failure Questionnaire, hospitalizations, mortality, and device data were prospectively evaluated.

RAPID-RF Trial Results

A total of 891 patients were enrolled from May 2006 to March 2008, and 863 patients were implanted. Of implanted patients, 736 (85%) transmitted data via the LATITUDE system. The characteristics of the patients were...

Statistical analysis

Descriptive statistics are used for most of the endpoints. Kaplan–Meier analysis was utilized to evaluate survival and a combined freedom from HF hospitalization and mortality endpoint over time. Chi-squared tests and t-tests were utilized to evaluate response to CRT. Analysis was performed using SAS 9.1 (Cary, NC).

Results

Patient population

A total of 891 patients were enrolled from May 2006 to March 2008, and 863 patients were implanted. Of implanted patients, 736 (85%) transmitted data via the remote monitoring system. The characteristics of the...
patients are displayed in Table 1. Of note, 40% of patients were hospitalized for HF in the year prior to enrollment, and the majority of those hospitalizations (82%) occurred within the 6 months prior to enrollment. The median follow up in the RAPID-RF study was 9.1 months.

Patients enrolled and implanted in the trial who later activated on the remote network were prescribed similar medications (Table 1). Patients who did not activate within the protocol-prescribed 90-day window were significantly more likely to be NYHA class IV, hospitalized for HF in the prior year, have atrial fibrillation/atrial flutter at implant, and hypertension; also, marginally more non-RPM patients had diabetes at baseline. Other baseline characteristics were similar between RPM and non-RPM groups. Multivariate regression revealed that NYHA class IV (p = 0.01) and hypertension (p = 0.03) remained significant predictors of failure to successfully transmit data to the network, prior hospitalization was marginally significant (p = 0.06), and diabetes was no longer associated (p = 0.75) after adjusting for other univariate predictors. Of the 127 patients that did not activate within the protocol prescribed 90 days, the reasons for withdrawal are shown in Table 2. A review of withdrawal reasons indicated that 60 withdrawals were related to LATITUDE setup (7% of implants). Patients did not activate the equipment in 41 cases (4.8%), 14 patients (1.6%) did not have a compatible phone line, and in five cases (0.6%) equipment ordering or shipment delays prevented activation within 90 days of implant.

Eighty-six percent of patients had 3-month follow-up visits within the specified follow-up window (598/698 actual/expected), 81% at 6 months (448/555), 93% at both 9 and 12 months (374/401 and 255/274, respectively), and 85% at 18 months (40/47).

**Compliance with blood pressure and weight monitoring**

A significant number of CRT-D patients utilizing the LATITUDE daily patient monitoring system were compliant with weight and blood pressure measurements and this was durable over 18 months (Figure 1).

<table>
<thead>
<tr>
<th>Reason for withdrawal</th>
<th>Number of withdrawals before remote monitoring</th>
<th>Number of withdrawals after remote monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient refused/inability to participate</td>
<td>46</td>
<td>22</td>
</tr>
<tr>
<td>Other</td>
<td>31</td>
<td>32</td>
</tr>
<tr>
<td>Patient deceased</td>
<td>18</td>
<td>35</td>
</tr>
<tr>
<td>Patient withdrawn by physician</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>Study screening failure</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>Patient lost to follow-up</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Device exploded</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Patient not implanted</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>127</td>
<td>129</td>
</tr>
</tbody>
</table>
Patient satisfaction questionnaire

A voluntary patient satisfaction questionnaire was completed by 78% of implanted patients. A scale of very easy, somewhat easy, neither easy nor difficult, somewhat difficult, or very difficult was used for four of the six questions. Patients felt the study components were very easy or somewhat easy to set up in 89.7% of responses. The weight scale and blood pressure cuff were deemed very easy to use by 85.5% and 82.6% of patients, respectively. Further, 93.8% of patients indicated the LATITUDE communicator was very easy or somewhat easy to use. Finally, 90.4% and 88.3% of the patients strongly or somewhat agreed that they felt that continuous monitoring of their implanted device and weight and blood pressure provided them with a sense of security, respectively.

Frequency of alerts

The majority of the alerts (89.6%) in the RAPID-RF trial were weight related. Of the 863 implanted patients, 220 (25%) patients did not have any alerts during the course of the study. The other 643 (75%) patients had an alert and of those 643 patients, 70 patients had one alert, 50 patients had two alerts, and 523 patients had three or more alerts. In contrast, there were 135 patients with one non-weight-related alert, 62 patients with two non-weight-related alerts, and 96 patients with three non-weight-related alerts (Figure 2).

Device alerts and interventions

The frequency of and interventions that accompanied actionable device alerts are displayed in Table 3. The
mean time from device alert event to notification of the alert was 4.7 days, and the time from notification to intervention was 1.7 days. Device alerts prompted an attempt to contact the patient in 10% of alerts. An associated device reprogramming occurred in 22% of the device-related alert interventions.

Four device alerts were documented for high lead impedance events resulting in three in-clinic interventions. The time to intervention for these events was between 4.5 and 20 days (mean=9.7 days), and mean time from alert to notification was 3.3 days. Four Red alerts were initiated during the course of the trial in three patients. Two hospice patients had alerts generated for V-Tachy mode turned off with no intervention. One patient experienced a Red alert for high pacing lead impedance prompting an in-clinic visit where the V-Tachy mode was turned to Monitor Only, prompting a second Red alert for therapy off. The lead was later revised during a hospitalization, where the V-Tachy mode was set to Monitor + Therapy.

Heart failure and arrhythmia alerts and interventions

The frequency of arrhythmia and HF actionable alerts along with the associated interventions are displayed in Table 4. Weight gains and losses were frequent, occurring at a rate of 0.5 alerts per patient per month. However, weight gains were the most common alert that led to intervention, with the most common intervention being medication change. The mean time from HF and arrhythmia alert event to notification of the alert was 0.9 days and the time from notification to intervention was 4.0 days. Overall, 21% of HF and arrhythmia alerts prompted an attempt to contact the patient.

The most frequent arrhythmia alerts were atrial tachycardia response (ATR detected for >24 h) and shock therapy delivery, occurring in 10% and 9% of patients with alert frequencies of 0.05 and 0.03 alerts per patient month, respectively. Atrial arrhythmia alerts led to intervention in 26 alerts or 6.4% of all arrhythmia alerts. The majority of interventions were either medication changes or outpatient clinic visits with few hospitalizations or emergency visits. Shock therapy delivery was associated with an intervention in 23% of all shock alerts. Many of these were managed with either medication changes or in-clinic visits, but 17 hospitalizations did occur following the alerts. Overall, 26% of the atrial and shock arrhythmia alert interventions had an associated device reprogramming.

The study center was also alerted when the percentage of biventricular paced beats dropped below 90%; this alert was incorporated into the LATITUDE system during the final 6 months of the RAPID-RF study. Thus, this alert occurred in a relatively modest number of patients (14, 1.6% of the study population with a frequency of 0.02 alerts per month), with interventions in four alerts.

Clinical outcomes (changes in NYHA Class, Minnesota Living with Heart Failure Questionnaire-QOL) to 3 and 6 months of CRT

Using a symptom response improvement of at least one NYHA functional class at 3 or 6 months, a total of 51% and 59% of patients responded to CRT respectively. Worsened symptoms were observed in only 0.5% and 1% at 3 or 6 months following CRT respectively. QOL improved by a 15-point reduction in 64% of patients following CRT.

All-cause mortality and hospitalization

Sixty-three of the 863 (7.3%) patients died during the course of this study and 12-month Kaplan–Meier survival was 91.2% (95% CI 0.889–0.935). There were 320 total inpatient hospital stays occurring in 207 patients (24.0%) with a mean duration or length of stay (LOS) of 5.6 days. Also, 112 inpatient (74 patients, 8.6%), 20 emergency room/outpatient (15 patients, 1.7%) stays were HF related with a mean LOS of 6.2 days. This was an annualized HF-related event rate of 20.2%. This 20.2% annualized HF-related event rate was significantly reduced by 50% compared to the HF event rate documented the year prior (40.4%) to enrolling in the RAPID-RF study; p<0.001. Of the 74 patients admitted for HF, 70 remote-monitoring patients were at risk of 30 day readmission for any cause following an index admission. Twelve patients (17.1%) were rehospitalized within 30 days, and five deaths occurred within 30 days (7.1%) with one patient experiencing rehospitalization followed by death.

Discussion

The RAPID-RF study was designed to determine the frequency of alerts, interventions, and clinical outcomes. This RPM system and a number of similar systems are already widely used, yet there is limited understanding of how these systems are used in general practice. This experience adds to our knowledge of how clinicians evaluate and use the data provided. The RAPID-RF study demonstrated a high frequency of alerts and interventions, with 75% of patients receiving at least one alert, 24% receiving at least one device alert, and 19.6% of patients with an intervention associated with an alert (Figure 2).

Compliance

A major concern was whether patients could be compliant with measurements of weight and blood pressure, and whether such compliance was durable. In the RAPID-RF study, three or four weight and blood pressure measurements were recorded per week in patients, and this was durable beyond 18 months. Without adequate compliance to weight and blood
Figure 2: Patient alert frequency flow for cardiac resynchronization therapy defibrillator patients from the RAPID-RF study with any overall alert, any non-weight alert, and any weight alert.
pressure, any interventions to improve outcomes based on such measurements will likely be futile. The data obtained also provide an opportunity for further patient education and feedback when they return to their clinician. The compliance findings are consistent with high satisfaction and patient-perceived ease of use. Moreover, this provides evidence that the CRT-D patients in RAPID-RF not only were willing to play a role in their disease management, but that they also remained committed over time. Compliance to voluntary daily weight measurements may also be a surrogate for overall patient engagement in care, including compliance to medications. Of patients that activated on LATITUDE, patients with more than three weight measurements per week had fewer HF hospitalizations than those less compliant with the system (Figure 3).

### Clinical outcomes

The clinical response to CRT was consistent with prior studies, while the frequency of hospitalization and death

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**Table 3: Device alert interventions**

<table>
<thead>
<tr>
<th>Alert</th>
<th>Total number of alerts</th>
<th>Patients</th>
<th>Alerts per patient month</th>
<th>Alerts with patient contact*</th>
<th>Alerts with in-clinic intervention</th>
<th>% of alerts with in-clinic or telephone intervention</th>
<th>% of patients</th>
<th>In-clinic</th>
<th>ER/ outpatient</th>
<th>Hospital visit</th>
<th>Med change</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High intrinsic amplitude</td>
<td>72</td>
<td>52</td>
<td>0.01</td>
<td>2/37</td>
<td>7</td>
<td>15%</td>
<td>6.0%</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Low intrinsic amplitude</td>
<td>245</td>
<td>176</td>
<td>0.03</td>
<td>15/129</td>
<td>17</td>
<td>19%</td>
<td>20.4%</td>
<td>17</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>High lead impedance</td>
<td>4</td>
<td>4</td>
<td>0.00</td>
<td>0/0</td>
<td>3</td>
<td>75%</td>
<td>0.5%</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Low lead impedance</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
<td>0/0</td>
<td>N/A</td>
<td>N/A</td>
<td>0%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Therapy off</td>
<td>3</td>
<td>3</td>
<td>0.00</td>
<td>0/2</td>
<td>0</td>
<td>0%</td>
<td>0.3%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Device total</td>
<td>324</td>
<td>210</td>
<td>0.04</td>
<td>17/168</td>
<td>27</td>
<td>18%</td>
<td>24.3%</td>
<td>27</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>28</td>
</tr>
</tbody>
</table>

*Collection of patient contact introduced during study follow-up.

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**Table 4: Arrhythmia and heart failure actionable alerts**

<table>
<thead>
<tr>
<th>Alert</th>
<th>Total number of alerts</th>
<th>Patients</th>
<th>Alerts per patient month</th>
<th>Alerts with patient contact*</th>
<th>Alerts with in-clinic intervention</th>
<th>% of alerts with in-clinic or telephone intervention</th>
<th>% of patients</th>
<th>In-clinic</th>
<th>ER/ Outpatient</th>
<th>Hospital visit</th>
<th>Med change</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATR episode</td>
<td>405</td>
<td>83</td>
<td>0.05</td>
<td>54/282</td>
<td>26</td>
<td>25%</td>
<td>9.6%</td>
<td>24</td>
<td>4</td>
<td>1</td>
<td>15</td>
<td>44</td>
</tr>
<tr>
<td>Shock delivered</td>
<td>218</td>
<td>78</td>
<td>0.03</td>
<td>53/124</td>
<td>50</td>
<td>65%</td>
<td>9.0%</td>
<td>31</td>
<td>4</td>
<td>19</td>
<td>30</td>
<td>84</td>
</tr>
<tr>
<td>Accelerated arrhythmia</td>
<td>33</td>
<td>11</td>
<td>0.00</td>
<td>10/9</td>
<td>7</td>
<td>74%</td>
<td>1.3%</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>% BiV pacing</td>
<td>53</td>
<td>14</td>
<td>0.01</td>
<td>5/32</td>
<td>4</td>
<td>24%</td>
<td>1.6%</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Weight gain</td>
<td>4,140</td>
<td>529</td>
<td>0.51</td>
<td>641/2,778</td>
<td>116</td>
<td>26%</td>
<td>61.3%</td>
<td>28</td>
<td>0</td>
<td>2</td>
<td>102</td>
<td>132</td>
</tr>
<tr>
<td>Weight loss</td>
<td>4,272</td>
<td>562</td>
<td>0.52</td>
<td>533/2,913</td>
<td>48</td>
<td>19%</td>
<td>65.1%</td>
<td>20</td>
<td>0</td>
<td>1</td>
<td>36</td>
<td>57</td>
</tr>
<tr>
<td>Clinical total</td>
<td>9,121</td>
<td>623</td>
<td>1.12</td>
<td>1,296/6,148</td>
<td>251</td>
<td>24%</td>
<td>72.2%</td>
<td>108</td>
<td>8</td>
<td>26</td>
<td>189</td>
<td>331</td>
</tr>
<tr>
<td>Overall total</td>
<td>9,445</td>
<td>643</td>
<td>1.16</td>
<td>1,313/6,316</td>
<td>278</td>
<td>24%</td>
<td>74.5%</td>
<td>135</td>
<td>9</td>
<td>26</td>
<td>189</td>
<td>359</td>
</tr>
</tbody>
</table>

ATR: atrial tachycardia response; BiV: biventricular.

*Collection of patient contact introduced during study follow-up.

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was lower than in several clinical trials. The study population was older than those typically enrolled in trials of CRT with a mean age of 70 years, whereas patients in the MIRACLE trial had a mean age of 64 years and patients in the COMPANION trial had a mean age of 67 years.\textsuperscript{29,30} However, the COMPANION trial required a hospitalization in the year prior to admission for CRT-D implant.\textsuperscript{30} Only 40\% of the RAPID-RF population had a hospital admission in the year prior to implant, which may be a factor in the lower observed event rate. The older age of this population is more consistent with the age of patients with HF in the community, and, therefore, these patients may be a better representation of a community-based experience. In that regard, it is reassuring that the response rate was similar to previous trials and survival was better than published results.

**Weight change alerts**

Importantly, during the course of the study, the frequency of weight alerts was found to be higher than anticipated, and modifications were made to reduce the frequency of alerts which did not lead to interventions. For example, changing the alert threshold to 2\% of total body weight per day resulted in a 44\% reduction in the number of threshold crossings compared to protocol-defined 2 lbs (907 g) per day. Moreover, changing the alert threshold to 3\% of total body weight per day resulted in a 68\% reduction in the number of threshold crossings compared to protocol-defined 2 lbs (907 g) per day. Delaying the 2\% weight alert by 1 day resulted in a 36\% reduction in alerts compared to protocol-defined 2 lbs (907 g) per day. This change in alert definition was believed to be rational because it was anticipated that most patients would be taught to use a flexible diuretic regimen, and, by applying it, they could be back to baseline within 1 day. It is anticipated that this experience should lead to a more effective and efficient clinical intervention. However, the concern remains that reducing the number of alerts will compromise the sensitivity of the measure, thereby missing some events which may be clinically relevant. Accordingly, changes adopted were based on what were believed to be physiologically logical (indexing weight change to body size) or consistent with treatment algorithms, such as allowing time for patients to utilize their flexible

![Figure 3: Time to first heart failure hospitalization based on weight compliance.](image-url)
algorithms and guidelines. A necessary element to this study is a tool to follow accepted treatment patient outcomes. In that regard, the system evaluated in advances in HF patient disease management to affect devices provide the opportunity to fully leverage communication technologies present in implantable above.

any interventions in this study with reasons described turned off occurred in three patients, but did not lead to those patients. Alerts for tachycardia therapy being lead impedance leading to interventions in three of those patients. The percentage of device-related alerts occurred as a result of the time of discharge. home rather than being sent home with the patient at monitoring equipment was shipped to the patient’s interrogation. In this version of the system the remote monitoring workflow may not have been integrated into clinic practice. A number of implanted study patients (n=127) were withdrawn prior to transmitting any data on the LATITUDE system and thus never had a remote interrogation. In this version of the system the remote monitoring equipment was shipped to the patient’s home rather than being sent home with the patient at the time of discharge.

**Device-related alerts**

The majority of device-related alerts occurred as a result of a change in sensed atrial or ventricular amplitude. It rapidly became evident that the majority of these events were of no clinical relevance, and the high intrinsic amplitude alert was abandoned in later device families while the threshold for the low intrinsic amplitude was modified. The frequency of other device-related alerts was low with only four patients having alerts for high lead impedance leading to interventions in three of those patients. Alerts for tachycardia therapy being turned off occurred in three patients, but did not lead to any interventions in this study with reasons described above.

**Summary**

Communication technologies present in implantable devices provide the opportunity to fully leverage advances in HF patient disease management to affect patient outcomes. In that regard, the system evaluated in this study is a tool to follow accepted treatment algorithms and guidelines. A necessary element to improve outcomes resulting from information transmitted remotely is for physicians and other health-care providers to respond to the information. The RAPID-RF study was designed to provide preliminary data related to disease management of the CRT-D recipient when communication capability placed in the device itself is utilized to monitor and transmit information related to the patient’s overall disease status as well as device integrity. This study was not designed to demonstrate efficacy, but it is reassuring that clinical outcomes are consistent with or better than most published trials of CRT. There was sustained compliance to weight and BP monitoring which demonstrates the compliance and durability of the external HF sensors. This type of remote patient monitoring may allow care providers to extend reach to patients outside of the obvious confines of a patient clinic visit and may permit early diagnosis of clinical problems such as device-detected arrhythmias or delivered therapies, patient symptoms, and weight and blood pressure changes.

**Study limitations**

A control arm is not available for direct comparison. The use of flexible diuretic plans may have offset some interventions leading to underestimated alert response. The study was initiated early in the introduction of networked CRM management and remote patient monitoring workflow may not have been integrated into clinic practice. A number of implanted study patients (n=127) were withdrawn prior to transmitting any data on the LATITUDE system and thus never had a remote interrogation. In this version of the system the remote monitoring equipment was shipped to the patient’s home rather than being sent home with the patient at the time of discharge.

**References**