RESEARCH ARTICLE

A Travel Alert

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ABSTRACT. We describe a 53-year-old patient who experienced an initially unexplained alert tone from his implantable cardioverter-defibrillator. After a careful review of both time zone changes and the patient’s travel pattern, cosmic radiation resulting in an electrical reset seemed the most likely cause of the alert.

KEYWORDS. cosmic radiation, electrical reset, implantable cardioverter defibrillator, time zones.

Case

A 53-year-old patient who receives his cardiac care in Nashville, Tennessee, called the on-call physician at approximately 4:00 a.m. Central Daylight Time (CDT) to report that he was in Los Angeles and had just been awakened by an alert tone from his EnTrust D154ATG (Medtronic Inc, St. Paul, MN) implantable cardioverter-defibrillator (ICD). He heard a similar tone the day prior but at that time thought the sound was from an alarm clock. He now wondered if he needed to seek medical care. The patient’s past history included successful resuscitation from a ventricular fibrillation (VF) arrest when he was in orthopedic residency training over two decades earlier. At that time he had been diagnosed with an idiopathic dilated cardiomyopathy, and his first ICD system had consisted of epicardial sense/pace leads and epicardial defibrillation patches with an abdominal generator. He was eventually transitioned to his current endocardial dual-chamber ICD with a Medtronic 6945-65 defibrillator lead and an EnTrust D154ATG ICD generator located in the left pre-pectoral subcutaneous region of his chest.

In response to questions from the on-call physician, the patient reported that he flew frequently because of his job. On this particular occasion he had flown from Phoenix to Los Angeles to visit his mother 2 days before calling. Unfortunately, he had not taken his remote monitor with him and worried that the alert tone indicated his ICD might need to be replaced soon. When questioned about possible exposure to electromagnetic interference (EMI), he reported that he had followed his usual travel routine, which included going through the full body scanners (millimeter wave Advanced Imaging Technology (AIT)) at the airport rather than undergoing a wand search to specifically avoid EMI. Since the patient would not be returning to Nashville for several days, arrangements were made for him to have his device interrogated in Los Angeles later that day.

Interrogation of the ICD demonstrated a battery voltage of 2.68 confirming that his device had not reached the elective replacement interval (2.61 V). It also showed that most of the available patient alerts (Figure 1) were programmed on with an “alert time” of 9:00 a.m. The “high-urgency” alert that the patient heard was delivered because of an electrical reset (Figure 2) which had occurred at 12:01 p.m. CDT 2 days earlier. This electrical reset had not altered the patient’s prescribed programming. Though he was reassured, he could not understand why his device had alerted him at 4:00 a.m., since his programmed alert time was 9:00 a.m. This time difference seemed too great to be accounted for by either the seasonal or geographical time zone changes between Nashville, Phoenix, and Los Angeles. Additionally, the patient wondered if his frequent trips through air travel security might have caused the electrical reset.

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Discussion

There are a large number of medical and non-medical sources of electromagnetic signals that can potentially interact with the growing number of cardiovascular implantable electronic devices (CIEDs) in patients whose lives are enhanced and protected by these devices. In fact, sometimes these devices actually interact with each other. In the first generation of ICDs caution was required to manage the problem of pacemaker and ICD interactions. These sensing and tachyarrhythmia detection problems in ICDs were effectively resolved when subsequent generations of ICDs incorporated pacing functions. However, there have been recent reports of interactions between ICDs and left ventricular assist
There are also growing concerns about rogue programming of devices in this current era of remote monitoring and wireless telemetry. All of these issues add to the anxiety of some patients who have received CIEDs.

While the patient presented in this case was initially concerned that the audible alert might have signaled that his device was in need of replacement, his attention turned to the cause of the reset after his device was interrogated and was demonstrated to be far from the elective replacement interval. In the Medtronic EnTrust ICD, electrical reset alerts are not programmable and, therefore, reset alerts neither appear among the listed patient alerts nor do they adhere to the programmed "alert time". Instead the "device immediately sounds a High urgency alert tone that repeats every 20 hours or every 9 hours depending on the type of electrical reset."9

By review of the patient's travel itinerary, the electrical reset coincided with the time he was flying from Phoenix to Los Angeles rather than the time he was going through airport security (Figure 3). He recalled that he had worn his noise-cancelling headphones during the flight. This caused him to wonder if the headphones had both caused the reset and prevented him from hearing the initial alert tone.10 He also recalled hearing what he thought was an alarm clock somewhere in the guest room in which he slept the morning after arriving to Los Angeles. The timing of this event (Table 1) and the timing of the alert tone which prompted his call to the on-call physician were both consistent with the repetition interval of the electrical reset alert tone.

A file of the data downloaded from the interrogation of the patient's ICD was sent to the technical support team at Medtronic. Their analysis confirmed that the electrical reset of the device was a result of an appropriately detected memory corruption resulting from a random collision by an external subatomic particle. They wrote to us that "the electrical reset was due to a memory parity error at the above indicated address and time. This type of error does not imply any permanent damage to the device nor any increased susceptibility to further such events. Memory parity errors are considered random events caused by naturally occurring environmental radiation. Some patients have a greater chance of exposure with radiation treatments using 10 MeV or more linear accelerator voltage or with high altitude airplane travel" (personal communication May 7, 2012).10,11

In short, as we explained to the patient, his reset was most likely a result of "cosmic radiation" during his flight from Phoenix to Los Angeles. This phenomenon has been previously described by Ferrick et al,12 who described electrical resets in three patients with ICDs who were travelling internationally when their events occurred. While our patient's flight was a short domestic flight, we suspect that his frequent air travel increased his chances of being exposed to this random event. When the patient returned to Nashville, we asked him to bring his headphones to our office in order to assess them for evidence of interaction with his ICD or interference with communication between our programmer and his ICD. No problems were detected. Fifteen months after the electrical reset, the patient has continued travelling by air and using his headphones. He has not had another electrical reset, and now regularly takes his remote monitor with him.

Alert tones in ICDs have enhanced our ability to care for patients more efficiently, but still require the patients and the providers to be cognizant of the ubiquitous sources of interactions between CIEDs and the environment within and beyond the patient's body.

### References


### Table 1: Times of relevant events

<table>
<thead>
<tr>
<th>Date</th>
<th>Flight</th>
<th>Departure/Arrival</th>
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<tbody>
<tr>
<td>Wed May 2</td>
<td>1653</td>
<td>Depart PHOENIX AZ (PHX) at 09:40 AM Arrive in LOS ANGELES INTL (LAX) at 11:05 AM Travel Time 1 hrs 25 mins</td>
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<table>
<thead>
<tr>
<th>Phoenix*</th>
<th>Los Angeles</th>
<th>Nashville</th>
</tr>
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<tbody>
<tr>
<td>Take off from Phoenix, May 2</td>
<td>9:40 a.m. MST</td>
<td>9:40 a.m. PDT</td>
</tr>
<tr>
<td>Electrical reset, May 2</td>
<td>10:01 a.m. MST</td>
<td>10:01 a.m. PDT</td>
</tr>
<tr>
<td>&quot;Alarm clock, May 3</td>
<td>~6:00 a.m. PDT</td>
<td>8:00 a.m. CDT</td>
</tr>
<tr>
<td>High-urgency alert, May 4</td>
<td>~2:00 a.m. PDT</td>
<td>~4:00 a.m. CDT</td>
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<td>ICD interrogation, May 4</td>
<td>2:16 p.m. PDT</td>
<td>4:16 p.m. CDT</td>
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*Phoenix does not observe daylight saving time.

CDT: Central Daylight Time; MST: Mountain Standard Time; PDT: Pacific Daylight Time.


