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# Interference at work: a case report of a malfunctioning insulin pump

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**Abstract** Insulin pumps operate almost universally in the work environment. Tubeless insulin pumps are a relatively recent development for management of insulin-dependent diabetes. This is the first report of location-dependent failure of insulin pump function, possibly due to external interference, occurring only in the setting of a medical center. A successful solution to this problem was designed and implemented. In conclusion, heightened awareness of this possibility in individuals who use tubeless insulin pumps in a medical environment would seem prudent, as when identified, it can be easily corrected.

**Keywords** Insulin Pump · Glycemic control · Insulin delivery

## Introduction

Insulin pumps, referred to as a "continuous subcutaneous insulin infusion" (CSII), provide diabetic patients with the opportunity to titrate their insulin doses to their individual needs without interfering with day-to-day living [1, 2]. In general, insulin pumps use rapid-acting insulin with several basal rate programs and a variety of bolus options based on the patient's individual carbohydrate to insulin ratio and sensitivity. Most insulin pumps consist of the pump itself, which stores the insulin, a thin tube connecting to the site of insulin delivery on a patient's body, and a subcutaneous short catheter, usually located on the abdomen, upper arms, back, or thighs although alternative sites can be utilized [3].

More recently, a tubeless insulin pump has been developed, which works with a wireless hand-held device called the "Personal Diabetes Manager" (PDM) that controls the delivery of insulin. The device located on the patient's body, which includes the stored insulin, is referred to as a "pod". The PDM then communicates with the pod for effective insulin delivery. The PDM needs to be within two feet of the pod whenever an insulin delivery function needs to be performed. At all other times, the pod can deliver the basal rate without being in proximity to the PDM [4].

> Warnings regarding pump malfunction in certain settings, such as MRI facilities, are stated in the manufactures instruction information [5]; however, potential problems of pump malfunction in a hospital environment outside of the MRI have not been published.

## Research design and methods

We recently had an unusual experience with this insulin pump system and wish to alert others utilizing this device to the possibility of electromagnetic interference. Our patient had been successfully using an insulin pump for more than 5 years. She was a medical resident at the time of this incidence, and had found CSII to be invaluable during medical school and residency for obtaining optimal glycemic control. In the summer of 2007, she began utilizing the tubeless pump and PDM with excellent results and was extremely satisfied. Approaching the end of her second year of residency at a large metropolitan academic medical

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center hospital; however, she began to notice unexplained, intermittent difficulty with the pump's ability to deliver insulin. The first occasion occurred while entering orders on her hospital's electronic medical record, when her PDM abruptly stopped working and an error appeared on the PDM display. She was able to resolve the issue by resetting the PDM, but had to go through the process of replacing her pod each time. This occurred twice more that week, always in the same location (in the proximity of the emergency room, near a recently opened addition to the hospital, and the cafeteria). A new PDM was requested and sent at that time. Shortly after, on three consecutive days while at work, her new PDM repetitively malfunctioned in the same manner. Excluding these consistent problem areas, the system worked reliably at home and virtually everywhere else. Confused, she sought assistance from the manufacturer but no one was able to explain these unusual occurrences. She began to experience 10–12 errors PDM malfunctions per day. She found that after a malfunction, she could leave the old pod on until just before eating, so that the basal rate would still work, although she was not able to adjust the basal rate since the pod was unable to communicate with the PDM. She would change the pod right before eating, quickly administer a bolus for a meal, and the PDM would promptly malfunction again, sometimes before the bolus was completed. Frustrated, she turned to her radiology colleagues for advice. Given the location-dependent nature of the dysfunction, occurring only in certain parts of the hospital, and considering how the PDM device communicates with the pod located on the skin (which operates at a radiofrequency of 13.56 MHz), it seemed plausible that some source of external electromagnetic interference (EMI) could be playing a role. As a formal survey for potential sources of EMI in and around the hospital was not feasible, they decided to preemptively shield the PDM by wrapping it in aluminum foil, essentially creating a Faraday cage. The utility of a Faraday cage (Fig. 1) borrows from electromagnetic theory stating that electrons of a hollow conductor (aluminum foil), when subjected to an external electric field (electromagnetic interference), will redistribute to create an internal electric field that cancels the effect of the external field. A device dwelling within a hollow conductor will not experience the applied, external electric field.

## Results

The homemade Faraday cage instantly resolved her problems. However, the patient needed to keep her PDM wrapped in aluminum foil while at work, and *unwrap* the PDM for a bolus or when using the PDM as a glucometer. It was important to do this in an area "safe" from presumed external interference. Although a culprit source of potential EMI was not identified, it may have been related to the recent construction project at her hospital, or other devices brought into or around the hospital (radio transmitters, etc). *The following 4 month period has been uneventful with no*

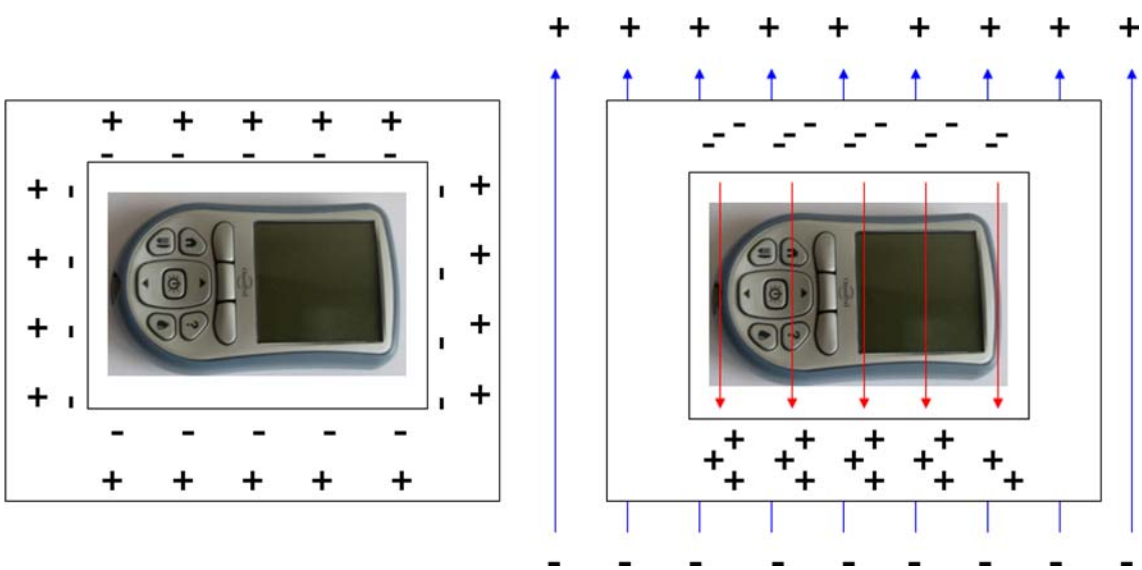

**Fig. 1** Schematic representation of the Faraday cage for the PDM. In the absence of an external electric field (figure on left), a Faraday cage (depicted as rectangular boxes surrounding the PDM) has its charges arranged symmetrically and no current flows within the aluminum. In the presence of an external electric field (or electromagnetic interference) (right, depicted by blue arrows), electrons within the aluminum Faraday cage flow toward the positive end of the field leaving positive charges at the negative end of the field. In doing so, the new configuration of charges within the aluminum have set up their own electric field (red arrows) that precisely opposes the external field. The net electric field experienced by the PDM inside the Faraday cage is zero

*further pump malfunctioning*. The engineers at the manufacturing plant are aware of this incident, and hopefully will devise a more permanent solution in the near future. While this is the first case of an insulin pump malfunctioning due to presumed external interference, it is likely that similar cases will arise as the patient base for tubeless CSII expands. This is also potentially important for glucose sensing devices as well.

## Conclusion

The possibility of external electromagnetic radiation interfering with the functionality of a tubeless insulin pump is an important consideration for individuals who wear this device. If a problem were detected, simply wrapping the PMD in aluminum foil could insulate the device from interference. While this is the first case of an insulin pump malfunctioning due to presumed external interference, it is likely that other similar cases will arise as the patient base for Omnipod expands.

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