DEVICE THERAPY

EMERGING TECHNIQUES

Real-Time Remote Interrogation and Guided Reprogramming of Cardiac Implantable Electronic Devices

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ABSTRACT. Background: Cardiac implantable electronic device (CIED) evaluation in a hospital setting is inefficient and leads to delays in patient management. We present a new model, the remote K-viewer, which provides real-time visualization of the CIED programmer screen by a remote iPad. This allows immediate CIED testing, diagnosis, and reprogramming by a remote cardiologist (EP). Methods: Forty-one consecutive patients who presented to Boca Raton Regional Hospital and required urgent CIED evaluation were evaluated. Each CIED was interrogated using both the remote-K-viewer system and the conventional mode using a company representative. Results: Mean response time of remote real-time evaluation using the remote K-viewer was 2.3 min (range 0–8 min). Mean response time for conventional interrogation was 60.9 min (range 10–120 min) (p<0.0001). Conclusion: Real-time remote evaluation of CIEDs using the remote-K-viewer system is efficient and allows for immediate EP directed patient evaluation and management.

KEYWORDS. cardiac implantable electronic devices, programming, remote monitoring.

Introduction

The current model of CIED evaluation in emergency room (ER) and operating room (OR) settings is inefficient and delays patient care. In most hospitals, a company representative is usually contacted to evaluate the patient's CIED. After interrogating the CIED, the company representative discusses the results with the cardiologist (EP) and arranges further CIED programming. The cardiology EP contacts the treating nurse and physician to review the results and discuss the plan of care. This takes time and relies on company representatives to interpret CIED data. We present a new model that provides immediate real-time remote EP evaluation and management of CIEDs.

The remote-K-viewer1–3 is a system that combines hardware and software to allow a real-time visualization of the CIED programmer screen from a remote site using an iPad (Figure 1). This model involves a bedside, non-specialized operator such as an ER nurse or physician and a remote cardiac EP. The bedside operator interacts with the patient and CIED programmer, which is connected to a laptop using its video graphics array (VGA) output. The laptop displays a mirror image of the programmer screen which can be visualized remotely on an iPad (Figure 2). Both operators also maintain a telephone communication. The remote operator controls the pointer of the bedside laptop using the iPad via an encrypted service network. The bedside operator is guided in real time how to operate the programmer. At the end of the device check,
Materials and methods

A dedicated K-card was constructed for this study. It was connected via the VGA output port to a tablet (Acer Iconia Tab 7). The tablet was placed on a table and connected to a power socket. The tablet was controlled via a touch screen (Hewlett-Packard TouchSmart tm2-1000). Both devices were connected to a printer via a switcher for alternation. A separate computer was used for connection to the Internet and the Internet. The K-card was connected to the Internet via a wireless network. The K-card was connected to the Internet via a wireless network.

The study protocol was approved by the institutional review board. The study was conducted in accordance with the principles of the Declaration of Helsinki. The study was approved by the institutional review board. The study was conducted in accordance with the principles of the Declaration of Helsinki.


Figure 4: "K-card" showing set-up of programmer/interrogator, second shelf host computer and UPS units. (A) Close up of programmer and bedside monitor. (B) Close up of programmer and bedside monitor. (C).
operator would then tap on the programmer screen function. The process would then continue in a tagging along fashion where the EP would move the laptop pointer and the bedside operator would replicate it on the programmer (Figure 2). During the process the EP was able to see in real-time all the diagnostic data, do a function test and guide reprogramming as needed. At the end, a report was produced remotely by the EP and printed locally to be added to the patient’s chart. The study protocol was based on a redundancy concept so that every patient was checked using the K-cart and again using the conventional method with a device representative.

Results

Forty-one consecutive patients/devices were successfully evaluated: 29 were ICDs and 12 were pacemakers (DDD ICD: 17; VVI ICD: 5; DDD BIV ICD: 5, VVI BIV ICD: 2; DDD PM; 11 DDD BIV PM: 1). Thirty-three devices were evaluated in the ER and eight in the OR. One patient had two devices, a DDD-BIV-PM and VVI-ICD which were interrogated one after the other. Twenty-seven patients were enrolled at the time of the company representative arrival (the ER/OR physician was unaware of the study and did not contact the EP until the device company representatives arrived).

Fourteen patients were enrolled at time of initial phone call to the company representative.

Twenty-eight devices were interrogated, tested, and required no reprogramming; 13 devices underwent guided reprogramming. Three patients had 6,949 Fidelis lead malfunction with active problems requiring urgent reprogramming. For the 41 patients, the average remote session with the remote cardiac EP and K-cart was 14.5 min (range 5–40 min). The average programmer interaction time was 9.8 min (range 3–28 min). There were no hardware, software, or communication problems. For the 14 patients enrolled at time of the initial phone call, the average time to communication with K-cart was 2.3 min (range 0–8 min). The average time of device company arrival to patient bedside was 60.9 min (range 10–120 min; p<0.0001) (Figure 5).

Limitations

Late enrollment occurring after the device company representative arrival was due to unawareness by medical staff of the study protocol, the patient’s device company, and/or the EP involvement in the patient’s care. Only one company was used for this study. However, the system can work with any company, as presented in a previous experience with a K-cart connected simultaneously to three different programmers.4

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Welcome to Remote Viewer Protocol
If you are a nurse or MD instructed in this protocol and there is a patient to be checked, at this time call:
Dr. Kroesman speed dial.
If you don't know about the protocol please DO NOT touch the computer any further.

Click below to view the programmer screen in this computer.

NOTE: once you click above this presentation will end. A Medtronic representative will assist to reset it.

Thank you for participating.

Figure 3: Dedicated sequence of laptop touch screens encountered by the bedside operator to guide the use of the “K-cart”. Intuitive, user friendly, “kiosk” feeling interface.

Figure 4: Bedside operator following the remotely moving pointer on the laptop operates the programmer (B). Close up of the laptop screen depicting two arrows. Arrow 1 is the one from the programmer (A). Arrow 2 is the one of the laptop which is controlled remotely by the remote operator, indicating the next stop where the bedside operator has to move the programmer arrow to.
tested but its use with other mobile devices like tablets or smart phones is feasible.

Discussion

We present a novel approach to provide real-time physician guided CIED testing and management. By allowing a cardiac EP to remotely evaluate CIEDs, the remote K-viewer system obviates the need to rely on a company representative. In addition, it allows for immediate patient treatment which is critical in patients with ventricular arrhythmias and lead problems. The system was conceived and developed with elements and technology readily available today. The K-cart concept should serve as a platform to explore the challenges of real-time cardiac device interaction and contribute to develop a new generation of programmers and service model.

Conclusion

The remote K-viewer is efficient, safe, and reliable and can be used to improve patient care. This model may help with the future development of a new generation of programmers and service model incorporating the concept of real-time management of patients with cardiac implantable electronic devices.

References

1. EM Kloosterman. First report of real-time remote interrogation and guided reprogramming of cardiac devices in the emergency room and operating room. 2011; 22(Suppl. 1):S74.