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CASE REPORT

Clinical use of real-time remote programming in pacemakers during the COVID-19 pandemic: A case report

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Abstract

We report a case in which real-time remote interrogation and reprogramming of the parameters of a dual-chamber pacemaker was performed during the COVID-19 pandemic. The described case demonstrated the safety and effectiveness of CIED remote programming based on the 5G cloud technology support platform (5G-CTP), and showed that the application of real-time remote programming would help in reducing the risk of cross-infection between doctors and patients.

KEYWORDS
CIED, COVID-19, follow-up, remote programming, ventricular pacing

1 | CASE REPORT

We report the case of a 75-year-old man who was diagnosed with sick sinus syndrome and was treated with an implanted dual-chamber pacemaker (St Jude, Medical, St Paul, MN, USA, Zephyr XL DR 5826) at a prefecture-level hospital in Sichuan province in July 4, 2019. Due to the distance to the cardiovascular implantable electronic device (CIED) follow-up center and the outbreak of coronavirus disease 2019 (COVID-19), the patient did not attend routine follow-up after the initial pacemaker implantation. He went to the prefecture-level hospital for the first pacemaker follow-up in June 10, 2021. Due to the unavailability of a clinical device specialist, after obtaining informed consent from the patient, a clinical device specialist at the CIED follow-up center of the Third People's Hospital of Chengdu remotely completed pacemaker interrogation and programming using the 5G cloud technology support platform (5G-CTP) technology.

First, the cardiologist on the patient's side connected the programmer and a 5G signal terminal, and confirmed that the network signal was stable. After the programmer wand was applied to the patient's device, the cardiologist communicated remotely with the clinical device specialist through a video call. The specialist at the CIED Follow-up Centre logged in to the 5G-cloud follow-up APP based on 5G-CTP via a tablet and started programming the patient's pacemaker of the prefecture-level hospital, which is located 285 km away from the Third People's Hospital of Chengdu remotely.

Remote interrogation demonstrated 100% ventricular pacing (VP), pacing atrioventricular/sensed atrioventricular (PAV/SAV) interval 200/150 ms, and intrinsic atrioventricular (AV) conduction; thus, the device was reprogrammed remotely. To extend the AV interval, PAV/SAV intervals were fixed at 225/220 ms, ventricular intrinsic preference (VIP) mode was turned on, and VIP extension of 50 ms, which encourages intrinsic AV conduction and decreases the percentage of VP. After the pacemaker parameters were programmed, the specialist saved and printed reports of the programming parameters remotely through the tablet.

The entire remote follow-up took 10 min, and the patient had no discomfort. The pacemaker's parameters were successfully reprogrammed, and there was no delay or interruption in signal transmission

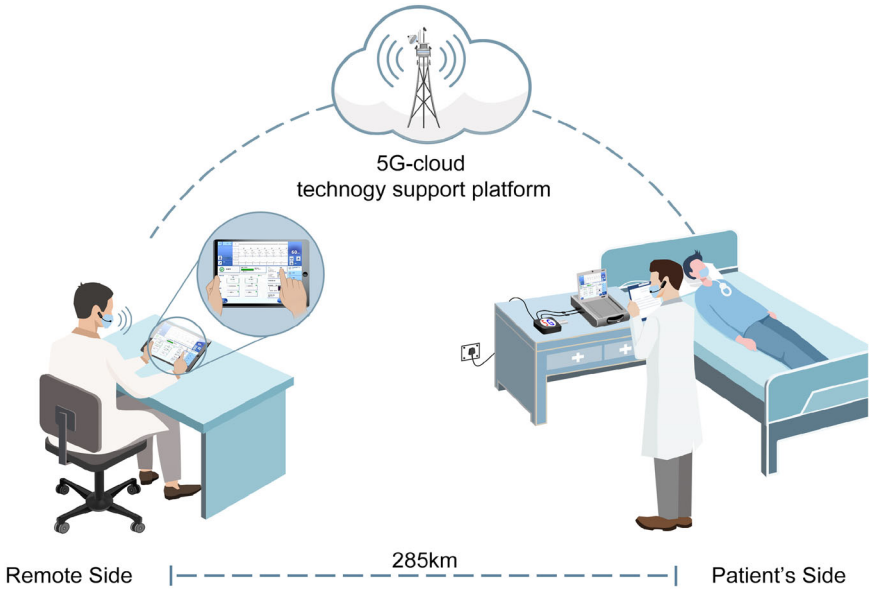

FIGURE 1 Schematic representation of real-time remote programming for pacemaker follow-up through the 5G cloud technology support platform [Color figure can be viewed at wileyonlinelibrary.com]

from the tablet on the remote side to the programmer on the patient's side.

2 | DISCUSSION

Patients with CIEDs should undergo regular follow-up to ensure proper CIED functioning and programming.[1] The patient in this case did not receive routine follow-up after pacemaker implantation due to the impact of the COVID-19 epidemic, which led to unnecessary VP. This may have increased the risk of heart failure and atrial fibrillation,[2] and unnecessary power consumption of the pacemaker. To reduce unnecessary VP, the specialist used the CIED remote programming technology based on "5G-CTP" to program the pacemaker parameters of the patient who was 285 km away, and extended the AV interval successfully. This case demonstrates the feasibility and effectiveness of real-time remote programming in pacemaker interrogation and parameters reprogramming.

Furthermore, during the COVID-19 pandemic, clinic visits and in-person cardiac CIED checks increase the risk of cross-infection between doctors and patients, which made follow-up more difficult. Currently, multiple expert consensus and guidelines recommend using telehealth and remote checks, to reduce or delay unnecessary in-office visits and treatment.[3] Studies have shown a significant increase in the use of remote monitoring (RM) in patients with CIED during the COVID-19 pandemic. This significantly reduced the number of in-office visits, and could effectively identify adverse events, which allow patients to receive appropriate treatment.[4,5] However, CIED parameters cannot be reprogrammed through RM; therefore, when CIED parameters need to be adjusted, doctors and patients still face the elevated risk of exposure to COVID-19.

Through the 5G cloud follow-up APP, a 5G-CTP for CIED remote interrogation and programming was developed by Abbott Laboratories and China Telecom Corporation Limited. The platform connects the "patient's side" (programmer and "5G signal terminal") with the "remote side" (tablet/desktop/phone equipped with "5G cloud follow-up APP") through a dedicated communication network (5G or below network signals) (Figure 1). Thus, the remote side can obtain the programming operation of the programmer on the patient's side, enabling real-time remote interrogation and programming of the CIED.

To ensure the security of the 5G-CTP permissions, specialists need to use a designated account, login password, and dynamic password authentication code to log into the app, and it is necessary to put the programmer wand on the patient's device to achieve remote programming. Additionally, the 5G-CTP uses 2048-bit RSA asymmetric key exchange and autonomous P2P data transfer protocol building on AES encryption mechanism to guarantee security of communication data. The platform can provide stable and secure network transmission through 4G network, data latency in 5G transmission can be reduced to a minimum of 0.001 s. Furthermore, if the network is unexpectedly disconnected during remote programming, the programmer wand can be removed from the patient and the CIED parameters of the patients would revert to the original settings before the inquiry. Therefore, such an interruption would not have deleterious effect, although no network disruptions were recorded.

5G-CTP was first applied to implantable cardioverter-defibrillator intraoperative parameter testing in September 2020,[6] and has been applied to patients with postoperative CIED programming. Additionally, the technology can be applied to patients with confirmed or suspected COVID-19 pneumonia and patients with sudden CIED-related adverse events that require immediate device programming.

3 | CONCLUSION

CIED real-time remote programming based on the 5G-CTP can be used to achieve remote parameters programming safely and effectively. During the COVID-19 pandemic, the application of this technology

could help reduce the risk of cross-infection between patients and healthcare providers. Further studies with large sample sizes, multiple centers, and long-term follow-up are required to verify the safety and effectiveness of real-time remote programming during CIED follow-up.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare that are relevant to the content of this case.

AUTHOR CONTRIBUTIONS

Xu Chen: concept/design; drafting article; critical revision of article; approval of article. Han-xiong Liu: funding secured by; critical revision of article, approval of article. Lin Tong, Si-qi Yang, Ling-yao Qi, Shi-qiang Xiong, and Yan Luo: critical revision of article, approval of article. Lin Cai: concept/design; funding secured by; critical revision of article; approval of article.

CONSENT TO PARTICIPATE

Informed consent was obtained from the patient who was described in the case report.

CONSENT TO PUBLISH

The participant has consented to the submission of the case report to the journal.

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