The increased use of catheter ablation for the treatment of patients with arrhythmias has fostered the development of new tools that enhance the safety and efficacy of these procedures [1,2]. After the revolution of three-dimensional (3D) electroanatomical mapping, remote catheter navigation (RCN) is now setting the pace and keeping “spoiled” electrophysiologists in a fascinating era. In most procedures, the systems operate under the supervision of the electrophysiologist, not alone; thus, “cooperative robotic” rather than “robotic” appears to be best suited for describing this technique.

Manual control of the ablation catheter can be challenging and is dependent on operator skill and experience as well as cardiac anatomy. Various active catheters have improved physicians’ ability to intervene. All of the catheters can actively select direction in three dimensions and conform to the shape of the heart chambers. Potential advantages of active catheters include enhanced accessibility to areas that are difficult to reach manually and the ability to go back to the target of interest. In the past 7 years, two FDA-approved RCN systems have been used. The Niobe II magnetic navigation system (Stereoaxis, Inc., St Louis, Missouri) is based on magnets that produce a field strength of 0.08 T and allow the complex movement of a magnet tip ablation catheter [3]. The latest on the market is the Sensei system (Hansen medical, Mountain view, California), which uses an electromechanical master/slave system with a long specialized 14F steerable guide catheter [4]. A third system is under development but has not been used in humans [5].

This topic is investigated by Latcu et al. in this issue of the journal [6]. The purpose of the study was to evaluate the efficacy of remote magnetic navigation in 84 patients with various arrhythmias. The literature is rather poor on this matter and such studies are much needed. The overall success rate was quite good, at 81%. A major benefit of RCN comes from the remarkable decrease in fluoroscopic time. The operator radiation exposure to fluoroscopy was only $1.5 \pm 0.6$ min. This low exposure undoubtedly takes some pressure off the electrophysiologist and allows them to focus on the electrophysiological information.


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In the study by Latcu et al., in accord with previous publications, the result was excellent for slow pathway ablation. This latter procedure represents a privileged indication for RCN. Davis et al. showed that, compared to manual catheter navigation, slow pathway ablation with RCN results in less temperature variability during ablation, suggesting greater stability than with the manually guided catheter [7]. As for left-sided accessory pathway ablation, owing to good catheter manoeuvrability, RCN seems also to be an advantageous approach. On the contrary, in the report by Latcu et al., cavo-tricuspid isthmus and right-sided accessory pathways are poor candidates for RCN. As explained by the authors, the peculiar anatomy underlying these arrhythmogenic substrates is likely to explain the failure rate observed in their study.

Latcu et al. suggest that procedure time may decrease with increasing operator experience. Kim et al. reported on 127 cases of ablation with remote magnetic catheter navigation [8]. When compared with conventional procedures, the authors found a significant increase in the average procedure time in patients with atrial fibrillation (+36 min) or atypical atrial flutter (+117 min). These results may be explained by the high number of operators in Kim et al.’s study, and thus a learning curve different from what is expected in the series by Latcu et al., where there were only two operators. Davis et al., in a study of atrio-ventricular nodal re-entry tachycardia ablation, compared 16 patients who underwent magnetic-assisted ablation with 16 patients who underwent a conventional approach [7]. It was found that the procedure time was significantly increased with remote assisted ablation (174 ± 43 min versus 143 ± 24 min). In a randomized multicenter study involving 71 patients, Wood et al. found no difference in procedure time between manual or RCN [9]. Interestingly, pre-randomization “skill-building” cases with RCN were mandatory for the operators entering in the study. This design intended to erase the learning curve experience effect for the comparison of the two techniques. For atrial fibrillation ablation, Katsiyanis et al. evaluated magnetic navigation in 20 patients and compared them to 20 patients treated with the manual approach [10]. The mean procedure time was significantly lower in the RCN group (209 ± 56 min) compared with the conventional group (279 ± 56 min). In summary, if the use of RCN does not always translate into a shorter procedure time than the conventional approach, this technique has the potential to decrease the impact of skill differences among operators. Thus, it may improve the efficiency and the safety of the procedure.

Remote catheter ablation can also rescue the operator in difficult cases. Recently, Haghigho et al. published the first report of the use of an irrigated tip magnetic catheter with RCN for the ablation of scar-related ventricular tachycardia [11]. It appears that the accessibility to critical sites in the left ventricular cavity was improved with RCN compared to conventional intervention. Owing to the often complex anatomy, patients with congenital heart disease may also benefit from RCN. Wu et al. performed successful catheter ablation using this technique in four patients after the atrial Switch procedure [12]. The authors found that manoeuvrability of the catheter was easy in the case of retrograde access through two valves. Schwagten et al. performed retrograde pulmonary venous atrium catheterization with RCN in 12 children with arrhythmias complicating congenital heart disease. It was concluded that RCN is safe and effective in paediatric patients [13]. The same authors demonstrated that the magnetic navigation system allows avoidance of puncturing a baffle during ablation of a postincisional macroreentrant tachycardia [14]. In addition, RCN has been used successfully via upper extremity venous access [15].

High-tech ablation has a cost; even technology optimists cannot deny this. Only one centre in France is equipped with a magnetic remote navigation system. Do electrophysiologists have to wait for the next generation to be more efficient and less expensive in order to acquire a distant-navigation system? Health policy makers have to support medicoeconomic studies. The return on investment is likely to be good if the catheter cost does not exceed that of conventional catheters. If confirmed, decreased procedure time and complication rates will also favour the extensive use of remote-controlled ablation.

Although the technique is already both useful and safe in daily practice, we are still expecting more from remote navigation. Automated ablation with a fast procedure time is warranted for perpetually busy electrophysiologists. The Sensei system will soon be equipped with a tactile sensation generator capable of transmitting vibration that reacts proportionally to endocardial contact pressure. The next generation of RCN will also have to free the physicians from the operation site, allowing telementoring and a remote presence in the operating room. Finally, there is no doubt that the pioneering work of Latcu et al. will encourage other centres to perform remote navigation studies.

**Conflict of interests**

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**References**


