Abstract

Physicians engaged in cardiovascular implantable electronic device (CIED)—related practice come from diverse training backgrounds with variable degrees of CIED implant training. The objective of the Canadian Heart Rhythm Society Task Force on CIED Implant Training was to establish a common structure and content for training programs in CIED implantation, related activities and maintenance of competency.

Keywords: Physician training in CIEDs; CIED implantation; Follow-up management; Permanent cardiac pacemakers; Implantable cardioverter-defibrillators; Cardiovascular implantable electronic devices (CIEDs).

Executive Summary

Physician training in the implantation and follow-up management of permanent cardiac pacemakers (PPMs) or implantable cardioverter defibrillators (ICDs), collectively known as cardiovascular implantable electronic devices (CIEDs), is heterogeneous and ill defined. Although there are now published guidelines for adult cardiac electrophysiology training and maintenance of competence that include

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This executive summary presents the essence of the report with key recommendations included, with the complete version made available in a linked supplement. The goals are to ensure that future generations of CIED implanters are better prepared for continuously evolving CIED practice and quality care for all Canadians.

recommendations concerning CIED implantation training, they are applicable in that context only, and there are no national guidelines applicable to the broad range of other programs.

The Canadian Heart Rhythm Society (CHRS) commissioned this task force involving Canadian medical experts from various adult medical disciplines engaged in CIED implantation and follow-up to draft this guidance document, intended to be applicable to CIED training programs not already encompassed by the adult cardiac electrophysiology guidelines. They are intended to supplement, not replace, existing information about the organisation and content of training. Recommendations were based on limited published literature available and consensus expert opinion. This is a high-level summary of the task force report, and the complete report, endorsed by the CHRS, is available in the Supplementary Material.

Eligible Candidates for CIED Implantation Training

Practitioners must possess a comprehensive understanding of patient factors, physiology, and pathophysiology of cardiovascular disease and device technology affecting CIED management. Maintenance of physician knowledge and competency is best assured if the primary focus of a physician’s clinical practice is related to cardiovascular medicine. Trainees and those engaged in cardiology and cardiovascular thoracic surgery practice constitute the best candidates for CIED implantation training.

Recommendation 1: We recommend that CIED implant training programs preferentially select candidates who possess strong background training in cardiac anatomy, physiology, and pathophysiology of cardiovascular disease and whose intended career focus will be the diagnosis and management of patients with cardiac disease.

CIED Implant Training Curriculum

A CIED implant training program must have faculty with the necessary knowledge and skills to teach trainees all aspects of CIED patient care. The trainee needs to acquire a minimum knowledge curriculum (encompassing the patient and cardiovascular disease, CIED hardware and software features, and principles of surgery and surgical techniques applicable to CIEDs (Supplemental Table S1). The trainee builds on this knowledge by learning and practising the technical skills involved in CIED implantation (Supplemental Table S2). The knowledge and technical skill curricula differ depending on the CIED type (pacemaker, ICD, or cardiac resynchronisation therapy [CRT] device) the trainee is learning to implant. Trainees must learn that decisions taken both before and during CIED implantation affect patient care after implantation.

Recommendation 2: Training program curricula must include all components listed in Supplemental Tables S1 and S2, with specific content depending on the particular CIED type.

Recommendation 3: Pacemaker implant trainees must acquire all knowledge and competencies listed in Supplemental Tables S1 and S2, sections A. During training they must successfully perform ≥ 75 new pacemaker implants and 25 pacemaker system revisions as primary operator, in a program ≥ 12 months in duration.

Recommendation 4: ICD implant trainees must acquire all knowledge and competencies and meet all the requirements for PPM implantation in addition to those specific to ICDs (Supplemental Tables S1 and S2, sections B). They must demonstrate competency after performing ≥ 75 new CIED implantations as the primary operator (≥ 50% of which should be new ICDs) and ≥ 25 CIED system revisions (≥ 15 shall be ICD system revisions/generator replacements) as the primary operator. Exposure to defibrillation testing principles and methodology is recommended. The training period must be ≥ 12 months in duration.

Recommendation 5: CRT implant trainees must acquire all knowledge and competencies and meet all the requirements for PPM and ICD implantation in addition to those specific to CRT devices (Supplemental Tables S1 and S2, sections C). The trainee must demonstrate competency after performing ≥ 75 new CIED implantations as the primary operator and ≥ 25 new transcoronary sinus left ventricular (LV) lead implantations and ≥ 5 CRT generator replacements. In addition, ≥ 5 new LV lead implantations must involve upgrade of a preexisting PPM or ICD system to a CRT device system. The training period must be ≥ 12 months in duration.

Recommendation 6: CIED implant training must include experience in CIED follow-up care through attendance in a CIED follow-up clinic. Trainees must demonstrate competency after being involved in patient follow-up management and device programming of ≥ 150 patients, ≥ 50% of which must be of the CIED type that the trainee is being trained to implant.

CIED Training Program Organisation

CIED training programs must plan carefully and execute on delivering a quality educational experience that prepares trainees to fulfill their CanMEDS roles.

Recommendation 7: CIED training programs must establish a clearly defined structure with a director, a training committee, faculty members, training objectives, policies, and
educational, research and quality assurance programs, with ≥ 3 faculty members skilled in CIED implantation. Components of training are outlined in the supplement. Programs must incorporate training and assessment approaches consistent with principles of competency-based medical education as outlined by Royal College of Physicians and Surgeons of Canada framework on Competency by Design. Components of a training program are outlined in the supplement.

**Recommendation 8:** Training programs must have sufficient physical, technical, and human resources and sufficient case volumes to support the requisite CIED implant training.

**Associated CIED Procedures Training**

There are other CIED-related procedures that the Task Force felt were of sufficient importance to include in this document. Additional training specific to these activities will be required for most of these.

1. Extraction of chronically implanted leads

Percutaneous lead extraction uses specialised tools to remove chronically implanted CIED transvenous leads and entails significant patient risks.

**Recommendation 9:** Lead extraction must only be performed by physicians trained adequately at a high-volume centre with efficacy and safety results comparable to published literature. During training, the trainee shall successfully extract ≥ 40 leads as the primary operator under the supervision of an experienced faculty member.

2. Submuscular CIED and subcutaneous ICD (S-ICD) implantation

Most transvenous CIEDs are implanted superficial to the pectoralis major muscle but occasionally need to be implanted in a submuscular pocket. Subcutaneous ICDs (S-ICDs) require an extravascular lead with the generator implanted subcutaneously in the lateral chest wall pocket. These variant procedures require additional knowledge and skills.

**Recommendation 10:** We recommend that physicians interested in performing submuscular CIED system implantation must perform ≥ 5 submuscular procedures supervised by an experienced faculty member.

**Recommendation 11:** We recommend that physicians interested in performing S-ICD system implantation must demonstrate competency after performing ≥ 5 S-ICD implant procedures supervised by an experienced faculty member.

3. CIED follow-up care

Some physicians are not interested in performing CIED implantation but wish to be involved in CIED follow-up care only. These individuals should acquire the same knowledge content as CIED implanting trainees with much less emphasis on implantation procedure-related knowledge and skills. Nonetheless, trainees need sufficient exposure to device implantation procedures so that they can recognise common post-implantation complications and learn approaches to their management.

**Recommendation 12:** We recommend that candidates training for CIED follow-up management only must demonstrate competency after performing ≥ 100 PPM, ≥ 100 ICD, and ≥ 50 CRT direct device interrogations and assessments (with or without reprogramming) over a minimum training period of 6 months.

5. Leadless pacemaker implantation

New pacemaker systems have been introduced that are delivered via transvenous catheter systems directly to the right heart without need for lead hardware. Physicians training for leadless pacemaker implantation should already be competent in percutaneous femoral venous access and right heart catheterisation with manipulation of large-bore sheaths so that training can focus on the skills specific to the leadless pacemaker. Leadless pacemaker training for those with insufficient experience in percutaneous vein access and right heart catheterisation is discussed further in the supplement.

**Recommendation 13:** We recommend that physicians interested in performing leadless pacemaker implantation who have demonstrated competency in percutaneous femoral vein access and right heart catheterisation with manipulation of large-bore sheaths must perform ≥ 4 leadless PPM implant procedures supervised by an experienced faculty member and complete any mandatory training specified by the manufacturer.

**Maintenance of Competence**

Maintenance of competence for practicing implant physicians requires the on-going education and maintenance of skills well after formal training has been completed. See the supplement for more detailed explanation.

**Recommendation 14:** We recommend that implant physicians do ≥ 35 case implant procedures per year of the most complex device type for which they were trained.

**Recommendation 15:** We recommend that CIED-implanting physicians be involved in ≥ 50 direct CIED patient follow-up visits a year involving a device type at or above the level of device complexity that the physician has been trained to implant.

**Recommendation 16:** We recommend that physicians engaged in CIED lead extractions extract ≥ 20 leads per year as the primary operator.

**Conclusion**

Implantation and follow-up of CIEDs is a highly specialised discipline that requires specialised physician training. It is hoped that these recommendations better prepare physicians for CIED practice and result in improved patient care. These recommendations should be updated as new scientific evidence and technology emerges.

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References


Supplementary Material

To access the supplementary material accompanying this article, visit the online version of the Canadian Journal of Cardiology at www.onlinecjc.ca and at https://doi.org/10.1016/j.cjca.2021.09.017.