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Pacemaker and defibrillator management in medical assistance in dying: Review for the primary care provider

Development of an interdisciplinary, collaborative, patient-focused care plan is vital for successful medical assistance in dying for patients with pacemakers or implantable cardioverter defibrillators.

ABSTRACT: Cardiovascular conditions are highly prevalent in patients who are eligible for medical assistance in dying. Within this population, cardiac implantable electronic devices are common. Thus, there is a need to understand the physiological effects of these devices in patients who choose medical assistance in dying, and the role and scope of reprogramming, deactivation, and other management strategies for the devices. The drugs used in medical assistance in dying result in a cascade of physiological effects that result in loss of myocardial contractility. The cardiac implantable electronic device may continue to electrically activate the heart, but a contraction will not result, and the heart will not effectively pump blood. These devices have adjustable parameters to optimize performance, which may be changed with special computers or can be reprogrammed with unique magnets. At the time of medical assistance in dying, a permanent pacemaker will electrically stimulate the heart, but eventually, the myocardium will no longer contract. Placing a magnet over an implantable cardioverter defibrillator disables the device's ability to detect ventricular arrhythmia and helps avoid any defibrillation during dying. Understanding the consequences of deactivating the defibrillating function of the device is important. If it is deactivated prematurely, the patient may die prior to their planned time and location. The process and options regarding cardiac implantable electronic devices deactivation or reprogramming, and potential manifestations at the time of medical assistance in dying should be discussed with the recipient, with the advice and support from the medical assistance in dying provider and cardiac implantable electronic devices clinic team member.

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In June 2016, the Parliament of Canada passed federal legislation that allows eligible Canadian adults to request medical assistance in dying (MAID). In Canada, two methods of assisted dying are available: self-administration and ingestion of oral medications that cause death, or more commonly, clinician administration of prescribed intravenous medications that cause death. At least 13 946 Canadians have received MAID since Quebec law and the federal legislation was introduced.[1] The number of reported cases increased 26.1% between 2018 and 2019, and all provinces have experienced a steady year-over-year increase in numbers since the law was introduced in 2016.[1]

Cardiovascular conditions are present in 10.1% of individuals in Canada who are eligible for medical assistance in dying. Within this population, cardiac implantable electronic devices (CIEDs) such as permanent pacemakers and implantable cardioverter defibrillators (ICDs) are common: more than 200 000 of these patients are currently living with such a device.[2]

Every year, approximately 30 000 Canadians receive a new pacemaker or ICD, resulting in a significant cumulative number of individuals living with CIEDs, especially in the 55 to 80 year age group, which also constitutes the largest proportion of medically assisted deaths. Thus, there is a need to understand the physiological effects of these devices in

patients who choose medical assistance in dying. There is also a need to understand the role and scope of reprogramming, deactivation, and other management strategies for pacemakers and defibrillators in this group of patients.

Throughout Canada, provincial laws outline individuals' rights in relation to health care decision making and consent, including the right to accept or refuse health care treatments. Individuals who are capable of making decisions have a legal right to refuse health care treatments. This includes the discontinuation or withdrawal of medical treatments or interventions, even if it results in natural death. A CIED constitutes medical treatment, and thus can be discontinued, regardless of the nature of illness and whether the device prevents natural death from the underlying pathology.

Pacemaker deactivation is a withdrawal of therapy, not a mechanism of assisted dying. If a person who has requested medical assistance in dying also specifically asks to have their permanent pacemaker deactivated, this decision/conversation should be explored as a parallel process, which is typically defined by a region or pacemaker clinic. The Heart Rhythm Society outlined the process of deactivating ICDs and pacemakers,[3] and the Canadian Heart Rhythm Society recently embarked on a process to define pacemaker deactivation, which is expected to be completed in the near future.

We review CIEDs for primary care providers and any other provider who is involved in the care planning and management of patients who are seeking an assisted death. An explanation of the physiological implications of pacemakers and ICDs in the context of assisted dying is reviewed. Device deactivation, reprogramming, and other management issues for these devices are also explicated. Our goals are to:

1. Focus on the patient-centred management of patients with pacemakers and ICDs who are seeking medical assistance in dying.
2. Define the scope and role of the cardiology and device care teams in providing support to the MAID recipient, primary care providers, and MAID provider(s).
3. Provide a management scheme to guide the primary care and MAID provider team in caring for a patient who is pursing medical assistance in dying and who has a pacemaker or ICD.

Overview of cardiac implantable electronic devices

Cardiac implantable electronic devices are a group of regulatory therapies that support cardiac function by restoring the body's homeostatic equilibrium. They include implantable cardioverter defibrillators, which correct life-threatening arrhythmias. Other devices provide constitutive therapies that help restore lost function but do not replace the original organ or body part. They include permanent pacemakers, which restore or back up a patient's heart rate to normal range.

We review cardiac implantable electronic devices for primary care providers and any other provider who is involved in the care planning and management of patients who are seeking an assisted death.

CIEDs, which are surgically implanted and managed by specialized cardiology teams, are used to improve and extend the patient's quality and duration of life by preventing or treating arrhythmia-related sudden death. Conversely, medical assistance in dying is a life-ending procedure. Therefore, it is vital to have a collaborative approach between the patient, primary care, cardiology, and MAID program team members.

Pacemakers

Permanent pacemakers are cardiac implantable electronic devices that correct pathological bradycardia. A pacemaker works primarily by increasing the heart rate by delivering a small electric energy pulse of typically short duration (0.4 to 1.0 millisecond) to activate the myocardium to contract.

Of the various types of pacemakers, implantable ones are the most commonly used to correct symptomatic bradycardia. Other pacemakers function as cardiac resynchronization therapy pacemakers, which can improve heart failure in select patients in the presence or absence of a symptomatic bradycardia.

Most patients who receive pacemakers have an intrinsic underlying heart rhythm. In one study, 59% of patients who were deemed to be pacemaker "dependent" during follow-up had some form of an underlying electrical cardiac rhythm.[4] When the pacemaker was temporarily deactivated, only 13% of patients had a true dependency on the device. Those patients had no intrinsic heart rate at all, and the pacemaker provided complete circulatory support; that is, constitutive replacement therapy.[4]

Implantable cardioverter defibrillators

Implantable cardioverter defibrillators are cardiac implantable electronic devices that deliver a defibrillation shock to the heart during a life-threatening ventricular arrhythmia, such as ventricular tachycardia or ventricular fibrillation. The defibrillators are implanted in patients who have a high risk of cardiac arrest, or after resuscitation from life-threatening ventricular arrhythmias. Most ICDs also have cardiac pacing capability; therefore, they can provide simultaneous treatment of bradycardia. However, the uncommon subcutaneous ICD does not have traditional pacing capability. Some ICD recipients also have bradycardia or heart failure and use the ICD pacemaker or resynchronization function.

Physiological response to pharmaceuticals used in medically assisted deaths

A medically assisted death involves administration or ingestion of medications that induce several physiological effects that result in sedation and amnesia, then complete loss of consciousness and deep coma, followed by paralysis, subsequent cardiorespiratory arrest, and ultimately, death.

In clinician-administered medical assistance in dying, a provider administers various medications intravenously. The goal of these medications is to induce coma, neuromuscular muscle paralysis, and cardiac arrest while also

providing the recipient complete loss of consciousness. Medications include a sedative and amnesic (e.g., midazolam), a coma-inducing agent (e.g., propofol) or a barbiturate (e.g., phenobarbital), followed by a neuromuscular blocking agent (e.g., rocuronium or cisatracurium). Self-administered medical assistance in dying involves the ingestion of oral medications that result in a deep coma and eventually cardiopulmonary arrest.

The pharmacological impacts of the drugs used in medical assistance in dying result in a cascade of physiological effects that occur in a very predictable order. Following the onset of deep coma, subsequent respiratory depression and ultimately apnea produce severe acidosis and hypoxemia with resultant loss of myocardial contractility. With the loss of the physiological ability to achieve myocardial contraction, any electrical pacing impulse delivered via pacemaker or ICD will fail to achieve myocardial contraction with cardiac output, with or without pulseless electrical activity or cardiac electromechanical dissociation.[5] That is, the CIED may continue to electrically activate the heart, but a contraction will not result, and the heart will not effectively pump blood.

Propofol can cause hypotension, which does not affect CIED function. Ingested barbiturates reduce mean arterial pressures, venous tone, and cardiac output but usually do not have direct myocardial effects. However, in the dose administered, they result in respiratory depression with severe hypoxemia and acidosis, with the consequent effect on the myocardium. In certain instances, bupivacaine has been used to induce asystole in medical assistance in dying.

In general, neuromuscular blocking agents have no discernible cardiovascular effects in the dosages used.

Deactivating and reprogramming cardiac devices

All cardiac implantable electronic devices have adjustable parameters to optimize performance, which may be changed with special computers (programmers) **[Figure 1]**. These are usually available in pacemaker clinics, emergency rooms, or inpatient settings in specialized hospitals that offer the CIED clinic services.

Pacemakers and ICDs can also be temporarily reprogrammed with unique CIED magnets **[Figure 2]**, which are available in emergency departments, pacemaker clinics, and resuscitation crash carts. The magnets influence the electronic circuits of the CIED when held close to the device. They are usually applied directly on the skin that overlies the CIED, which is typically implanted in the infra-clavicular area but may be implanted in the axillary or subcostal region in some individuals **[Figure 3]**.

Pacemakers

Placing a device magnet over a pacemaker does not deactivate the device but makes it deliver pacing at a fast rate of 80 to100 beats per minute due to temporary reprogramming. Pacemakers do not give any alerts when a magnet is applied to them.

At the time of medical assistance in dying, the permanent pacemaker will electrically stimulate the heart with or without temporary reprogramming by a magnet, but eventually, the myocardium will no longer contract.

FIGURE 1. Permanent pacemaker/implantable cardioverter defibrillator programmer.

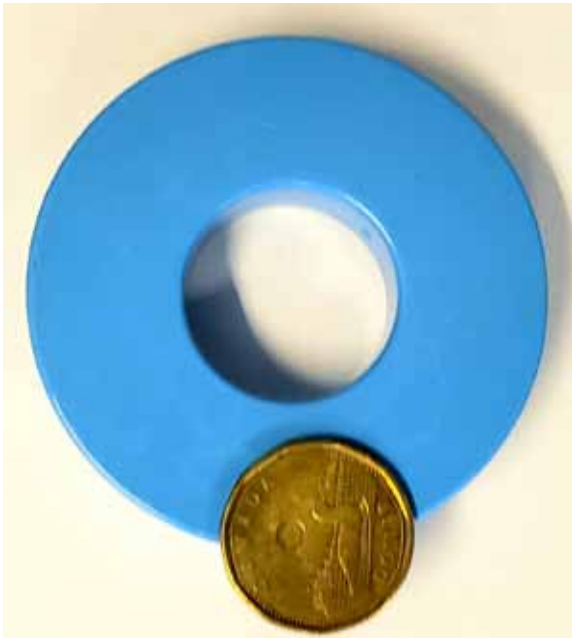

FIGURE 2. Cardiac implantable electronic device magnet (shown at actual size, $1 coin for size reference).

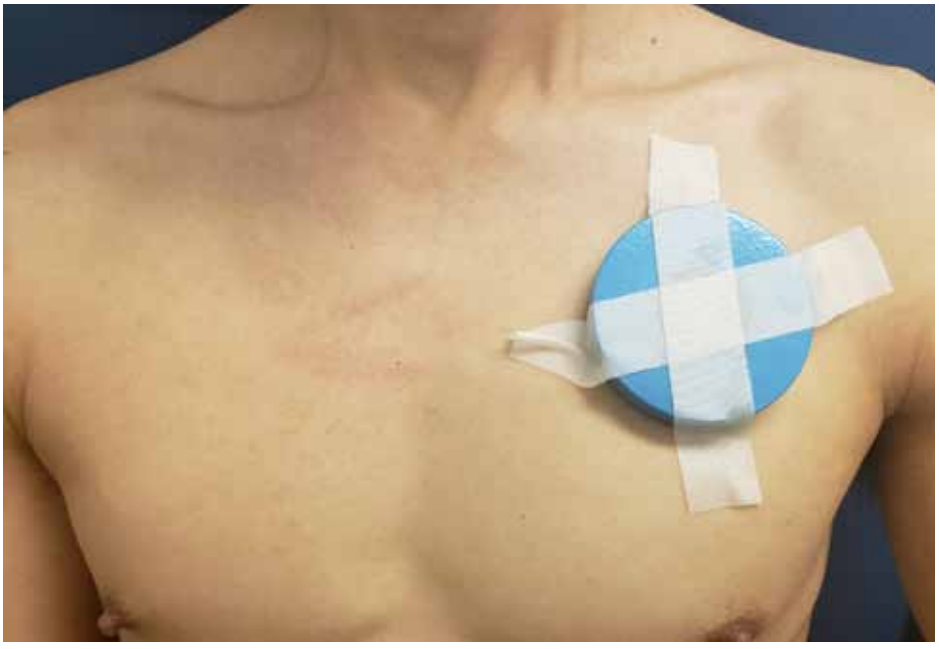

FIGURE 3. Magnet taped over cardiac implantable electronic device.

Consequently, the use of a magnet is not indicated in a patient with an existing permanent pacemaker who undergoes a medical assistance in dying procedure.

Implantable cardioverter defibrillators

Placing a magnet over an implantable cardioverter defibrillator disables the device's ability to detect ventricular arrhythmia, thus inactivating the function while keeping the pacing programming active. On establishing contact with the magnet, the ICD responds with an alert (auditory beep or vibration). Thus, a key implication for supporting dying patients who have these defibrillators is to ensure that all persons involved are aware that a beep may be audible, which will stop after several seconds. The defibrillation function stays off as long as the magnet remains on the defibrillator. At the moment the magnet is removed, the defibrillation function will resume. Taping the magnet will ensure it remains in place and will help avoid any defibrillation during dying.

Several mechanisms may cause cardiac arrest during medical assistance in dying: severe bradycardia/asystole, loss of myocardial contractility with intact electrical activation (pulseless electrical activation), or rapid ventricular arrhythmia. If ICD shock therapy is not deactivated, the device will deliver multiple defibrillation shocks to the heart when there is a ventricular arrhythmia-related cardiac arrest, which may be disturbing to all who are present. After ICD shock therapy has been deactivated, the pacemaker function of the defibrillator may try to pace the heart but eventually will not be able to activate the heart muscle as medical assistance in dying is being completed.

Understanding the consequences of deactivating the defibrillating function of the ICD is important. Should the defibrillator be deactivated prematurely, the patient who has requested medical assistance in dying may experience a ventricular arrhythmia (for which the ICD was originally placed) and suffer death prior to their planned time and location. Consequently, a balance must be achieved between deactivating the defibrillator too early and too late. One option is to wait until the patient experiences unconsciousness but prior to the establishment of deep coma during the medical assistance in dying procedure, at which time the magnet would be applied. Once the defibrillator is deactivated (audile beep), the remainder of the MAID medications may be administered to complete the medical assistance in dying procedure.

Patient experience during medical assistance in dying

Most patients do not experience or sense any pacemaker activity during dying. The MAID provider may note a steady pulse initially, but the loss of myocardial perfusion and contraction will result in pulselessness. Others present at the time of death will also not experience or sense any activity from a permanent pacemaker. At the time of cardiac arrest, the pacemaker may attempt to pace the myocardium if bradycardia/asystole is part of the mechanism, but it will not create a cardiac contraction. Depending on the heart rhythm, the permanent pacemaker may also enter into standby mode during a cardiac arrest.

In an active implantable cardioverter defibrillator, multiple defibrillation shocks are delivered after detection of ventricular arrhythmias. In a dying person who is awake or semiconscious, these shocks would be distressing. A patient who is semiconscious or in a deep coma is not likely to experience physical sensations. However, shocks are visible to others because defibrillation causes multiple chest wall movements, which may be disturbing. Anyone touching a patient's skin during an ICD shock might also receive a small shock. After ICD

shock therapy has been deactivated, as long as the magnet is in place, the device will not deliver shocks, and neither the patient nor anyone present will feel any discomfort.

Care after death

Funeral homes follow protocols for all patients who die with a pacemaker or ICD in situ. If the patient's plan is to be cremated, it is important to inform the funeral home about the existence of the device. If a pacemaker or ICD is not removed prior to cremation, it could explode.

Regulatory bodies such as the College of Physicians and Surgeons of Ontario have identified effective referral requirements for providers who may wish to opt out of providing care to individuals who are planning to receive medical assistance in dying. Cardiologists and pacemaker clinics should understand existing professional and legal obligations and their duty to refer if the provider has a conscientious or religious objection to providing any health care service.

Practice points

- Every person deemed eligible for medical assistance in dying who has a pacemaker or ICD should be provided with a review process, and their management plan should be coordinated in advance with the primary care provider and the designated CIED treating team.
- All CIED clinics should develop local standard operating procedures to support patients who are capable of requesting device deactivation. Effective communication and collaboration is necessary for effective planning among involved stakeholders (e.g., patients, palliative care teams, CIED clinicians, MAID providers, and/or MAID care coordination service).
- The timing of deactivation of an implantable cardioverter defibrillator should be discussed with the patient and caregivers to determine whether the device will be deactivated in a clinic before MAID or at the time of MAID with a CIED magnet. Deactivation in a clinic may expose the patient to risk of fatal arrhythmia before their desired time and location of death.

Medical assistance in dying is an emerging and evolving area in health care that affects virtually every Canadian health care sector, including primary care.

- Pacemaker function may be reprogrammed to deliver essential treatment for bradycardia, but this is typically unnecessary and places the patient at risk of non-life-threatening bradycardic symptoms.
- The process and options regarding CIED deactivation or reprogramming, and potential manifestations at the time of medical assistance in dying, should be discussed with the recipient with the advice and support from the MAID provider and CIED clinic team member.

Summary

Medical assistance in dying is an emerging and evolving area in health care that affects virtually every Canadian health care sector, including primary care. An interdisciplinary, collaborative, patient-focused care plan is vital for successful medical assistance in dying, especially for patients with pacemakers or implantable cardioverter defibrillators. Locally adaptable device management protocols should be implemented for seamless and timely care of patients who request medical assistance in dying. ■

Competing interests

None declared.

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