BRITISH JOURNAL OF HOSPITAL MEDICINE

QUALITY IMPROVEMENT

Improving guideline-mandated care of patients with implantable cardiac defibrillators

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Abstract

Background/Aims Implantable cardiac defibrillators reduce the risk of sudden cardiac death in selected patients. The value of an implantable cardiac defibrillator declines as the patient's disease progresses. Guidelines suggest that the appropriateness of maintaining implantable cardiac defibrillator therapy be regularly reviewed as part of monitoring of the patient's disease trajectory. It is recommended that implantable cardiac defibrillators are deactivated as patients approach the end of life. Patients with a better understanding of their current state of health and the role that the implantable cardiac defibrillator plays within it are more likely to make informed decisions about the timing of deactivation.

Methods: A quality improvement project was undertaken on appropriate deactivation of implantable cardiac defibrillators within a large tertiary cardiac centre. This was driven by audit data showing inadequate patient communication and documentation around deactivation. Drivers for change included the introduction of electronic data records, clinical review of comorbid patients approaching elective battery change and an ongoing forum for patient and carer education. Measured outcomes included the number of deactivations performed, evidence of patient discussion and consent, and timing of deactivation of the implantable cardiac defibrillator.

Results There were increased numbers of timely device deactivations undertaken following the interventions with improved documented evidence of patient discussion and consent. The educational forum was received favourably.

Conclusions Focused multidisciplinary interventions can impact favourably on appropriate implantable cardiac defibrillator deactivation and improve patient engagement.

Key words: End of life care; Implantable cardioverter defibrillators; Multidisciplinary team; Quality improvement project

Submitted: 20 May 2020; accepted after double-blind peer review: 2 June 2020

Background

Implantable cardiac defibrillator therapy is a lifesaving intervention for selected patients. In the last 10 years, there has been a 20% increase in the number of patients undergoing implantation of these devices in the UK (Raatikainen et al, 2017). The latest data from the national audit of cardiac rhythm management reported a 179/million population implant rate for new implantable cardiac defibrillators in England in 2016–17 (British Heart Rhythm Society, 2019). Implantable cardiac defibrillators are classed as primary prevention if they have been implanted prophylactically. Secondary prevention implantable cardiac defibrillators are those implanted after threatened or aborted sudden cardiac death.

These devices protect against ventricular arrhythmias by delivering painless anti-tachycardia pacing or an automated electrical shock to the heart. While the implantable cardiac defibrillator is very effective for terminating ventricular arrhythmia, around 10% of patients may experience inappropriate shocks. In the landmark MADIT II trial nearly a third of all shocks delivered were deemed inappropriate (Moss et al, 2002).

Despite improvements in programming and device algorithms, a relatively constant annual appropriate shock rate of 5.8% has been reported, compared to an annual inappropriate shock rate of 6.4% which had progressively reduced over time (Auricchio et al, 2017). Unfortunately, the number of patients receiving shocks at the end of life remains static,

How to cite this article:
Garner D, Blackburn M, Wright DJ, Rao A. Improving guideline-mandated care of patients with implantable cardiac defibrillators. Br J Hosp Med. 2020. https://doi.org/10.12968/hmed.2020.0259

with studies reporting shocks in 8–30% of patients who die with an active implantable cardiac defibrillator (Sherazi et al, 2013; Stoevelaar et al, 2018).

To experience inappropriate and often repeated shocks at the end of life can be extremely harrowing, and guidelines advocating timely discussion around implantable cardiac defibrillator deactivation and the role of advanced care planning have been produced by the British Cardiovascular Society (Pitcher et al, 2016), the European Heart Rhythm Association (Padeletti et al, 2010) and the Heart Rhythm Society (Lampert et al, 2010). However, when studied, the number of patient-reported discussions about deactivation of the implantable cardiac defibrillator was low (Stoevelaar et al, 2020).

Study centre

Liverpool Heart and Chest Hospital is a large tertiary cardiothoracic centre in the north west of England serving around 2 million patients. As a standalone cardiac centre responsible for implanting and following up implantable cardiac defibrillators, the data are comprehensive and can provide a historic perspective, as well as the opportunity to reflect on current practice and evaluate the impact of interventions to improve guideline-recommended management of patients with implantable cardiac defibrillators.

In the latest UK cardiac rhythm management audit (British Heart Rhythm Society, 2019), Liverpool Heart and Chest Hospital performed a total of 637 high energy implants (implantable cardiac defibrillators and cardiac resynchronization devices with defibrillators) which included 394 (62%) new implants, 83 (13%) upgrades and 160 (25%) battery replacements.

Historic perspective

In 2016, a retrospective audit of all deceased patients who had an implantable cardiac defibrillator in situ between September 2013 and September 2015 under Liverpool Heart and Chest Hospital was undertaken. Clinical practice was audited against the guideline recommendations (Table 1) and data gathered on device status before death. Documentation of deactivation, record of do not attempt resuscitation, patient consent, and family and patient involvement were recorded. A total of 71 patients were identified, of which only 22 (31%) had documentation of their implantable cardiac defibrillator being deactivated before death.

Twelve per cent of patients received shocks at the time of death. Documentation around end of life discussions was noted for 30% and the presence of a do not attempt resuscitation was recorded for 25% of patients. The audit concluded that documentation of implantable cardiac defibrillator deactivation was inadequate and recommended the incorporation of a formal deactivation document in the electronic patient record.

Quality improvement project

Following on from the retrospective audit, a holistic review of the service was undertaken and a quality improvement project was designed to improve guideline-mandated management of patients who have an implantable cardiac defibrillator (Figure 1). It was recognised that deactivation of an implantable cardiac defibrillator is a complex issue; in addition

Table 1. Summary of guidelines on deactivation of implantable cardiac defibrillators from the British Cardiovascular Society and Resuscitation Council that guided the methodology of the quality improvement project

People with implantable cardiac defibrillators who are approaching the end of their life should be given opportunities to discuss the option of deactivating their device
Discussions and decisions about device deactivation, including those at the time of consent to implantation, should be documented fully
Effective and consistent communication with the patient, family and with members of the healthcare team is crucial to enable good decision making
If it has not occurred already, a do not attempt resuscitation decision should be discussed at the same time as discussion of deactivation of the implantable cardiac defibrillator

From Pitcher et al (2016)

to incorporation of a formal document, improving patient education, engagement and multidisciplinary team interaction were necessary to bring about sustained improvement in care. It was also noted that a quarter of the implantable cardiac defibrillators were replacement devices (often in elderly patients), and replacement was sometimes undertaken without prior clinical review to evaluate appropriateness of continued therapy. The driver diagram in Figure 1 sets out the goals and main elements of the project.

Measurement

The measured outcomes included:

- Improved documentation of appropriate deactivation of the implantable cardiac defibrillator at the end of life
- Evidence of discussion and consent
- Multidisciplinary team involvement and counseling.

Appropriate deactivation of implantable cardiac defibrillators was defined as elective pre-mortem deactivation with documentation of process, consent and discussion. The project aimed to measure the number of deactivations being performed and the timing, whether there was documented discussion with the patient and family, and whether there was an active do not attempt resuscitation decision. The number of shocks around the time of death was recorded as a secondary quality measure.

The primary drivers included measures to improve documentation, patient understanding, expectation and engagement, and to identify the cohort upfront that would benefit from review before elective battery replacement.

Secondary drivers to enable this were initiated sequentially between 2016 and 2018 as below:

1. A formal deactivation document was incorporated in the electronic patient record to facilitate comprehensive documentation of discussions undertaken by healthcare professionals and details around deactivation of the implantable cardiac defibrillator
2. An ongoing multidisciplinary educational event for patients with implantable cardiac defibrillators and their carers
3. A formal review of patients with implantable cardiac defibrillators approaching the elective replacement indicator (the alert received by the clinician when the battery is running low and the patient is listed for a battery change), to assess the appropriateness of ongoing therapy. Patients were selected for review if they were felt to be frail, defined as having a clinical frailty score of 6 and above with significant comorbidity, or with whom contact has been established via the community heart failure team or GP to highlight significant life-limiting comorbidity.

This project reports on the impact of each of these interventions.

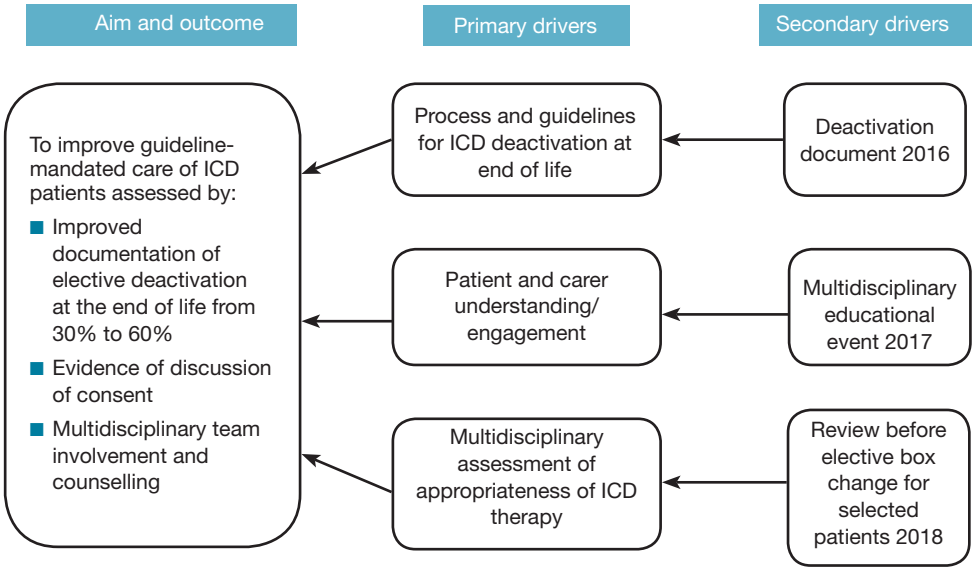

Figure 1. Aims of the quality improvement project and drivers for change. ICD = implantable cardiac defibrillator.

Stages of data collection

The plan do study act (PDSA) cycle was enacted at two stages with real-time incorporation of feedback wherever possible and evaluation of its impact on the next cycle. The baseline data from the previous audit were used as the reference point. Data were gathered retrospectively by searching the electronic patient record for patients undergoing deactivation from 2016 to 2019 and the dataset split into two time periods to reflect ongoing interventions as part of the quality improvement project.

The first PDSA cycle covered 2016–17 to follow on from the implementation of the electronic patient record deactivation form. The second PDSA cycle measurements were collected between 2017 and 2019, to allow assessment of the second stage of interventions. At each stage data on deactivation and documentation were gathered as outlined above. Data specific to each secondary driver intervention were also reported on.

Electronic patient record deactivation document

The electronic patient record deactivation document was created in 2016. All deactivation forms on the electronic patient record until December 2019 were retrospectively reviewed. Baseline data on demographics, type of device, implantation date and indication were collected to provide a clinical perspective. The reasons for deactivation, timing, location and communication around deactivation were recorded. Do not attempt resuscitation status and number of shocks at the time of death were also recorded.

Multidisciplinary implantable cardiac defibrillator education events

The education event was started in 2017 for all patients (and their carers) who underwent implantation of an implantable cardiac defibrillator. The event was run bimonthly and included three talks: 'understanding your ICD [implantable cardiac defibrillator]', 'getting back to normal' and 'adjusting to life with an ICD' (which discussed deactivation of the implantable cardiac defibrillator). Data on the number of patients attending were prospectively collected and contemporaneous feedback obtained and incorporated into subsequent events.

Clinical review of patients with significant comorbidity approaching elective replacement indicator

This service was set up in 2018 to avoid inappropriate replacement of implantable cardiac defibrillator generators. Patients with implantable cardiac defibrillators approaching the elective replacement indicator, who were felt to be comorbid or with whom contact had been established via the community heart failure team or GP to highlight a significant life-limiting comorbidity, were reviewed by the specialist team. A prospective record of all reviews was maintained and data on demography, type of device and indication for implant and outcomes were collected. The Rockwood clinical frailty score and Charleson comorbidity index were calculated to risk stratify patients.

The following factors were assessed before discussion with the patient:

- The indication for the implantable cardiac defibrillator (primary vs secondary)
- Therapy delivered by the device (antitachycardia pacing and shocks)
- Pacing dependence
- Requirement of cardiac resynchronisation therapy.

A formal review of the patient was then undertaken where appropriate to discuss whether the device was to be replaced, downgraded or deactivated.

Statistics

Descriptive statistics were used to summarise key demographic data. The analysis of the quantitative outcome data used frequencies, cross-tabulations and chi-squares. SPSS 26.0 (IBM Corporation, Armonk, NY) was used for statistical calculations.

Results

Implantable cardiac defibrillator deactivation document

Between 2016 and 2019, 327 patients had implantable cardiac defibrillator deactivation documents completed on their electronic patient record.

Of these, 293 (90%) had died. The cohort was predominantly male (84%) and the implantable cardiac defibrillator had been implanted for on average 5.1 years, with 64% of implantable cardiac defibrillators inserted for primary prevention. Overall, 71% had documented elective deactivation of the implantable cardiac defibrillator. Location of deactivation was primarily the inpatient hospital setting (45%), with 15% turned off in the implantable cardiac defibrillator clinic and 11% in the patient's home.

The majority of deactivations were indicated for end of life or palliative care (61%). Patient preference guided a small but significant number of decisions (7%), and 3% were deactivated for other reasons, such as significant comorbidity or hardware failure (Table 2).

Multidisciplinary team education event

The study day ran 14 sessions from March 2017 until December 2019 and 290 patients and caregivers attended (160 patients and 130 caregivers). The median number of attendees per session was 18 (range 5–25). Surveys were returned by 253 patients and the feedback was very positive, with 84% reporting the content as being very appropriate and over 70% finding each talk very useful (Figure 2).

Table 2. Results of the audit of implantable cardiac defibrillator deactivations from 2016 to 2019 (*n*=327)

Average age in years (range)		76.5 (27–96)
Male		274 (84%)
Deceased		293 (90%)
Average age of device (years)		5.1
Primary prevention		208 (64%)
Secondary prevention		119 (36%)
Severe left ventricular impairment		276 (84%)
Cardiac resynchronisation therapy		168 (51%)
Patient or carer communication		201 (87.3%)
Repeat hospital admission		5
Indications for deactivation	Patient felt to be at end of life	200 (61%)
	Post death	97 (29%)
	Patient preference	23 (7%)
	Other or unknown	8 (3%)
Location of deactivation	Inpatient hospital setting	149 (45%)
	Outpatient clinic	50 (15%)
	Patients home	36 (11%)
	Hospice	5 (2%)
	Mortuary or funeral home	87 (27%)
Timing of device deactivation	After death	97 (29%)
	Day of death	24 (7%)
	1–5 days before death	56 (17%)
	6–10 days before death	13 (4%)
	11–30 days before death	39 (12%)
	31 days or more before death	98 (30%)

Clinical review of patients with significant comorbidity approaching elective replacement indicator

Since the service was set up in November 2018, 60 patients were referred to the nurse-led service. The mean age of the patients was 75 years (range 28–88 years), and the majority were male (89.8%). Twenty-five patients had cardiac resynchronization devices with defibrillator devices and 35 had implantable cardiac defibrillators, with 53% being primary prevention devices. As a result of the review, 21.7% (13/60) had their management adjusted with eight patients having devices downgraded, four being deactivated and one currently awaiting a multidisciplinary team decision.

The Charleson comorbidity index was calculated and a score of ≥7 was associated with a statistically significantly higher likelihood of undergoing device deactivation or downgrade ($P<0.05$, sensitivity 100% and specificity 85%). A Rockwood clinical frailty score of ≥6 (moderately frail) was also associated with a statistically significantly higher chance of having deactivation or downgrade but was less sensitive ($P<0.05$, sensitivity 69% specificity 86%). Combining these values increased the specificity to 98% with a positive predictive value of 93% (Table 3).

Outcomes at each stage

The first PDSA cycle (2016–17) showed a significant increase in the number of deactivations (68 per year vs 32 per year at baseline). The number of appropriate elective deactivations

Figure 2. a. Patient and carer attendance and (b) feedback at the multidisciplinary study day. ICD = implantable cardiac defibrillator.

Table 3. Results of the clinical review of patients with implantable cardiac defibrillators approaching elective replacement indicator with significant comorbidity (November 2018–March 2020)

Number of patients	60
Average age in years (range)	74.9 (28–88)
Male	53 (89.8%)
Female	6 (10.2%)
Cardiac resynchronisation therapy	35 (58.3%)
Primary	32 (53.3%)
Secondary	28 (46.7%)
Left ventricular function	
Normal	7
Mild to moderate	10
Severe	43
Management decision adjusted	13/60 (21.7%)
Downgraded	8
Device deactivated	4
Consultant review requested	1
Average Rockwood frailty score (range)	4.3 (1–9)
1–3 (Fit to managing well)	24
4–6 (vulnerable to moderately frail)	25
7–9 (Severely frail–terminally ill)	9
Charleson comorbidity index average (range)	8.2 (0–11)
≥7	20

increased from 31% to 70%. The number of documented discussions with patients and/or carers had also increased (30–94%), as had the proportion of patients with documented do not attempt resuscitation decisions (25–58%). The number of shocks at the end of life was 12% in the baseline group but there was only one reported inappropriate shock in 2016–17 (1.5%).

The second PDSA stage (2017–19) showed a continued increase in the number of deactivations performed (258 deactivations, mean of 89 per year) and again the number of appropriate deactivations increased to 72%. The number of documented patient discussions was still high at 85%, and the proportion of those with a documented active do not attempt resuscitation decision had increased to 65%. The rate of inappropriate shocks at the end of life was 4.5% (Figure 3, Table 4).

Discussion

The number of patients approaching the end of their life with an active implantable cardiac defibrillator or cardiac resynchronization device with defibrillator is on the rise (Beattie, 2013). Joint guidance from Resuscitation Council UK, Heart Rhythm UK/Arrhythmia Alliance and British Cardiovascular Society advises that patients approaching end of life should be offered a choice of defibrillator deactivation to avoid shocks in the latter stages of their illness (Pitcher et al, 2016). This is not reflected in published literature.

The reasons for non-adherence and shortfalls in practice in the real world are complex and multifactorial. Heart failure is a chronic condition and patients often have significant comorbidity. The physicians who implant and follow up implantable cardiac defibrillators

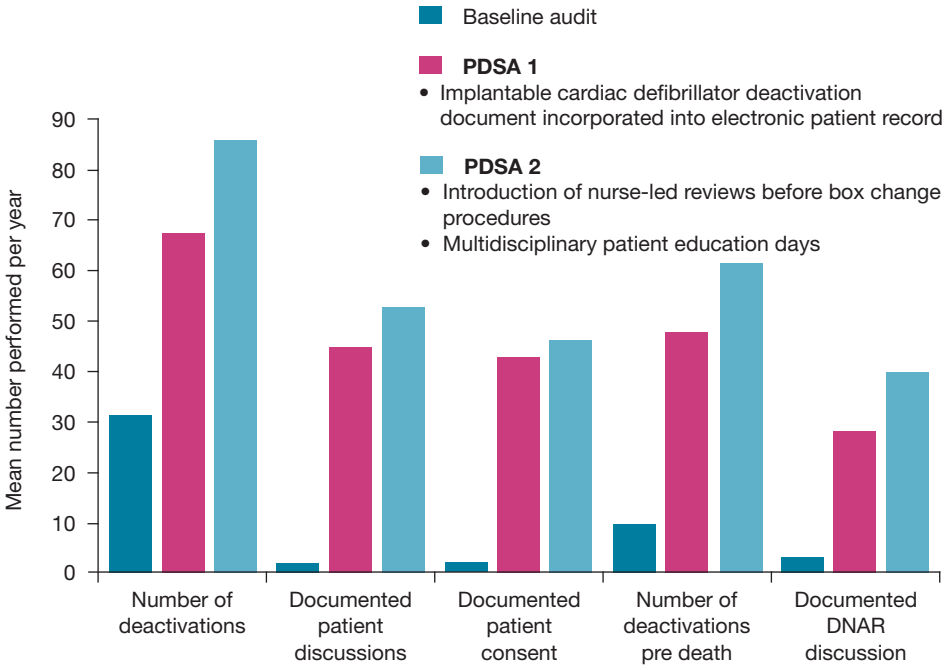

Figure 3. Deactivation of implantable cardiac defibrillators at each stage of the quality improvement project. DNAR = do not attempt resuscitation; PDSA = plan do study act.

Table 4. Outcomes of implantable cardiac defibrillator deactivation at each cycle of the quality improvement project

	Baseline (2014–15)	PDSA cycle 1 (2016–17)	PDSA cycle 2 (2017–19)
Mean number of deactivations performed per year	32	68	86
Number performed before death	10 (32.3%)	48 (70.6%)	185 (71.7%)
Documented patient or carer discussions	3 (30%)	45 (93.7%)	158 (85.4%)
Documented patient consent	3 (30%)	43 (89.6%)	141 (76.2%)
Do not attempt resuscitation in place	8 (26.7%)	28 (58.3%)	121 (65.4%)
Patients experiencing shocks at the time of death	4 (12.5%)	1 (1.5%)	11 (4.3%)

PDSA=plan do study act

may not be responsible for the general management of the patient and hence may be unaware of non-cardiac comorbidity. Furthermore, those patients deemed 'stable' from the heart failure perspective may be discharged into the care of the community heart failure nurses and/or primary care with device follow up alone as per the European recommendations (Todd et al, 2014). Remote follow up of the device streamlines care but reduces opportunity for holistic assessment of the patients that perhaps a face-to-face appointment would allow.

A UK-based survey suggested that 80% of patients with implantable cardiac defibrillators die in hospitals or healthcare facilities, and two-thirds are treated in non-cardiac wards under the care of general or elderly care physicians who may lack knowledge of the clinical management of implantable cardiac defibrillators (Javaid et al, 2018). The same survey identified gaps in knowledge about identification of implantable cardiac defibrillators, confusion about function and lack of awareness about the local deactivation pathway. The discussion around deactivating an implantable cardiac defibrillator is also often challenging, as patients have lived with these devices for a number of years and often overestimate the protective effect afforded to them by the defibrillator (Stewart et al, 2010).

A cross-sectional survey looking at knowledge of implantable cardiac defibrillators and end of life deactivation reported that insufficient knowledge about implantable cardiac

defibrillators was associated with unwillingness to discuss deactivation, even during the last days towards the end of life. They concluded that an interdisciplinary approach was required to ensure that discussions about deactivation issues were initiated at appropriate time points, with family members ideally being included (McEvedy et al, 2018).

These discussions need to happen at various stages – before implant, post implant, after an episode of increased therapy from the implantable cardiac defibrillator, before elective replacement of the device as a result of battery depletion, during repeated hospitalisation with heart failure and progression of disease, at the time of a do not resuscitate order or indeed at the end of life. Putting device deactivation into practice involves timely and effective communication among patients, families and healthcare providers (Lampert et al, 2010).

This quality improvement project reports on a series of interventions deployed to improve holistic care of implantable cardiac defibrillator patients within a large tertiary centre. The improvements in the second PDSA cycle are modest but sustained and the authors believe that education and reviews are more likely to result in medium- to long-term improvements in clinical practice. The patient feedback from the educational days is very promising and is likely to have a positive impact on their acceptance of therapy and adjustment to it. The possibility of using established clinical risk scores to guide deactivation decisions is a promising area and the authors intend to validate the results in a larger cohort.

Limitations

The main limitation of these data is that they were collected retrospectively and only represent a single centre. However, the authors believe that the principles of this quality improvement project are valid to both primary and secondary care. Thorough documentation, ongoing education and engagement are essential to improve care for patients with implantable cardiac defibrillators across the board.

Conclusions

This quality improvement project involved a series of interventions to improve guideline-mandated care of patients with implantable cardiac defibrillators. These were designed to increase patient and carer engagement and multidisciplinary team involvement, and to improve documentation of elective deactivation in patients approaching end of life.

The programme was tested for effectiveness through improvement cycles. This translated into significant outcome improvements, namely increased documentation of elective deactivations with evidence of improved communication and consent. This improved patient engagement and facilitated appropriate and timely multidisciplinary interventions.

Acknowledgements

The authors would like to acknowledge the contribution of Sue Hughes (cardiac physiologist), Lindsay Lunt (heart failure nurse specialist), Rachel Goode (heart failure nurse specialist) and Lynsey Jackson (cardiac rehab therapist) to this quality improvement project.

Conflicts of interest

DG and MB declare no conflicts of interest; AR and DJW have received honoraria from Medtronic and Boston Scientific.

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References

Auricchio A, Hudnall JH, Schloss EJ et al. Inappropriate shocks in single-chamber and subcutaneous implantable cardioverter-defibrillators: a systematic review and meta-analysis. Europace. 2017;19(12):1973–1980. https://doi.org/10.1093/europace/euw415

Key points

- Documentation of elective deactivation of implantable cardiac defibrillators can be improved with incorporation of a formal deactivation document into electronic patient records.
- Provision of an ongoing multidisciplinary educational event for patients with implantable cardiac defibrillators improves patient and carer engagement with the device and allows patients a safe forum for discussion.
- A formal review of patients with implantable cardiac defibrillators approaching elective replacement indicator (battery replacement) allows a comprehensive assessment of the overall benefits and implications of ongoing implantable cardiac defibrillator therapy based on a patient's needs and preferences and the appropriateness of maintaining therapy.

Beattie JM. ICD deactivation at the end of life: principles and practice. 2013. https://www.bhf.org.uk/informationsupport/publications/living-with-a-heart-condition/icd-deactivation-at-the-end-life (accessed 15 April 2020)

British Heart Rhythm Society. National report of cardiac rhythm management devices and ablation – 2016–17 summary report. 2019. https://bhrs.com/wp-content/uploads/2019/07/CRM-Report-2016-2017.pdf (accessed 30 June 2020)

Javaid MR, Squirrell S, Farooqi F. Improving rates of implantable cardioverter defibrillator deactivation in end-of-life care. BMJ Open Qual. 2018;7(2):e000254. https://doi.org/10.1136/bmjoq-2017-000254

Lampert R, Hayes DL, Annas GJ et al. HRS expert consensus statement on the management of cardiovascular implantable electronic devices (CIEDS) in patients nearing end of life or requesting withdrawal of therapy. Heart Rhythm. 2010;7(7):1008–1026. https://doi.org/10.1016/j.hrthm.2010.04.033

McEvedy SM, Cameron J, Lugg E et al. Implantable cardioverter defibrillator knowledge and end-of-life device deactivation: a cross-sectional survey. Palliat Med. 2018;32(1):156–163. https://doi.org/10.1177/0269216317718438

Moss AJ, Zareba W, Hall WJ et al. Prophylactic implantation of a defibrillator in patients with myocardial infarction and reduced ejection fraction. N Engl J Med. 2002;346(12):877–883. https://doi.org/10.1056/NEJMoa013474

Padeletti L, Arnar DO, Boncinelli L et al. Ehra expert consensus statement on the management of cardiovascular implantable electronic devices in patients nearing end of life or requesting withdrawal of therapy. Europace. 2010;12(10):1480–1489. https://doi.org/10.1093/europace/euq275

Pitcher D, Soar J, Hogg K et al. Cardiovascular implanted electronic devices in people towards the end of life, during cardiopulmonary resuscitation and after death: guidance from the Resuscitation Council (UK), British Cardiovascular Society and National Council for Palliative Care. Heart. 2016;102(Suppl 7):A1–A17. https://doi.org/10.1136/heartjnl-2016-309721

Raatikainen MJP, Arnar DO, Merkely B et al. A decade of information on the use of cardiac implantable electronic devices and interventional electrophysiological procedures in the European Society of Cardiology countries: 2017 report from the European Heart Rhythm Association. Europace. 2017;19(suppl_2):ii1–ii90. https://doi.org/10.1093/europace/eux258

Sherazi S, McNitt S, Aktas MK et al. End-of-life care in patients with implantable cardioverter defibrillators: A MADIT-II substudy. Pacing Clin Electrophysiol. 2013;36(10):1273–1279. https://doi.org/10.1111/pace.12188

Stewart GC, Weintraub JR, Pratibhu PP et al. Patient expectations from implantable defibrillators to prevent death in heart failure. J Card Fail. 2010;16(2):106–113. https://doi.org/10.1016/j.cardfail.2009.09.003

Stoevelaar R, Brinkman-Stoppelenburg A, Bhagwandien RE et al. The incidence and impact of implantable cardioverter defibrillator shocks in the last phase of life: an integrated review. Eur J Cardiovasc Nurs. 2018;17(6):477–485. https://doi.org/10.1177/1474515118777421

Stoevelaar R, Brinkman-Stoppelenburg A, van Driel AG et al. Implantable cardioverter defibrillator deactivation and advance care planning: A focus group study. Heart. 2020;106(3):190–195. https://doi.org/10.1136/heartjnl-2019-315721

Todd D, Bongiorni MG, Hernandez-Madrid A et al. Standards for device implantation and follow-up: Personnel, equipment, and facilities: results of the European heart rhythm association survey. Europace. 2014;16(8):1236–1239. https://doi.org/10.1093/europace/euu209