

Knowledge Gaps in Implantable Cardioverter Defibrillator Therapy: a Survey of Trainees in Internal Medicine and Cardiology

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Abstract

Background: Knowledge of clinical practice guidelines for Implantable Cardioverter Defibrillator (ICD) therapy is a pre-requisite for effective application of this life-saving technology. The level of trainee familiarity with these guidelines is unknown. The objective of this study was to assess trainee familiarity with clinical practice guidelines for ICD therapy.

Methods: This study surveyed 32 clinicians of varying training levels in internal medicine and cardiology at a large VA medical center. This is a survey study conducted from a population of all trainees in internal medicine at the medical center; the sample included trainees from PGY-1 through PGY-7 as well as attending physicians in internal medicine. Analysis of the collected survey data was performed using either Chi-square tests for comparison of categorical variables or unpaired t-tests for comparison of means.

Results: Of all respondents, 69% reported that they were familiar with published guidelines, and consistent with previously published data. Cardiologists were significantly more likely to report familiarity than internists (85% vs 42%, $P=0.01$). Most respondents (75%) reported satisfactory or better knowledge of published guidelines, though only 34% self-reported their knowledge as good or very good. The majority of respondents (86%) underestimated the usual cost of ICD implantation, while most respondents (78%) agreed that implantation of an ICD was cost-effective for secondary prevention, cardiologists were far more likely to agree than internists (95% vs. 50%, $P<0.03$).

Conclusion: There are considerable knowledge gaps evident among trainees with regard to clinical practice guidelines for ICD therapy. This likely represents a modifiable barrier to ICD implantation. Structured education for medical trainees on the appropriate use and referral practices consistent with practice guidelines may reduce knowledge gaps and increase appropriate ICD implantation.

Keywords: IMPLANTABLE CARDIOVERTER DEFIBRILLATORS, SURVEY, TRAINING, CLINICAL PRACTICE GUIDELINES

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Introduction

Sudden cardiac death is a leading cause of mortality in the United States (1). Optimal medical therapy for the associated cardiac

pathology, typically congestive heart failure, and multiple well-designed trials have unequivocally shown that ICD implantation improves mortality in specific primary (2-5) and secondary (6-8) prevention cohorts. As a result of this definitively demonstrated benefit, ICD implantation has been considered the standard of care for secondary prevention and as primary prevention in appropriate

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high-risk groups for over a decade (9, 10). Despite this, referral for ICD implantation has consistently lagged behind in the incidence of factors establishing candidacy for the device (11). Implantation is typically contingent on referral, and referral to an electrophysiologist is a decision made by other practitioners. While a multitude of medical and socioeconomic factors contribute to referral failure (12), insufficient knowledge of practice guidelines may also be a contributing and potentially limiting factor.

Adequate knowledge of currently accepted indications for ICD therapy is important in identifying patients who will likely benefit from implantation. Prior studies have tried to evaluate the knowledge of practicing physicians with respect to guidelines application (13), but trainees' knowledge of ICD guidelines is not well established. A survey was conducted of internists and cardiologists at a large Veterans' Affairs (VA) medical center about their knowledge and practices with respect to ICD implantation, in order to assess knowledge of appropriate implantation indications and costs as potential barriers to ICD therapy. Understanding that the perception of limited resources at a particular facility can be a deterrent to appropriate referral for ICD implantation, our initial intent was to survey participants again after establishment of ICD implantation services at the medical center; however, logistics in approving and distributing the initial survey prohibited effective assessment of changes in responses.

Methods

This study was designed as a cross-sectional survey to assess knowledge of practice guidelines at the time of the study. We distributed surveys to internists and cardiologists at different levels of training at a large inner city VA medical center and participation in the study was voluntary. The survey questions employed were derived with permission from a telephone survey performed in New

Zealand by McHale et al. (14). The questions submitted to participants inquired about referral habits for ICDs including estimated referrals, indications for ICD implantation referral, perceived survival benefits of ICD implantation, perceived cost effectiveness, and familiarity with national guidelines for ICD implantation; the distributed document can be found in the supplemental material. To our knowledge, this is the first use of this tool in the trainee population. Study participants included interns, residents, and attending physicians of internal medicine in the primary care clinic as well as cardiology fellows in the general cardiology clinic at a large VA medical center. Electrophysiologists and electrophysiology fellows were excluded from the study. A total of 64 prospective participants were identified and were contacted regarding participation in this study over a period of three months from August to October of 2016.

Responses to questions with definite answers were represented as percentages. Analysis of the differences in responses between cardiologists and internists as well as among reported levels of training were performed using either Chi-square tests for comparison of categorical variables or unpaired t-tests for comparison of means. A p-value of less than 0.05 was considered statistically significant. All statistical tests were performed using RStudio (RStudio, Boston).

Results

A total of 32 cardiologists and internists at a single medical center participated in the study, resulting in an initial response rate of 19% and a final response rate of 50% after multiple requests and reminders. The survey sample consisted of trainees in a busy working environment who may not have had strong motivation to respond, so a 50% response rate was considered practicable. Participants were predominantly composed of trainees (84%). There were 20 participants (62%) who identified themselves as cardiologists and 12

who identified as internists. A large majority (97%) reported involvement in the care of patients with ICDs. While a majority (81%) reported that patients were referred for ICDs, this is substantially lower than those reported in other surveys which may reflect the relative inexperience or practice environment of this cohort. There was a significant difference in referral experience between cardiologists and internists (90% vs. 67%, $P < 0.001$) as well as the estimated number of referrals between the two groups (43.8 vs. 7.1, $P < 0.01$).

Knowledge of Indications

There was substantial variation between cardiologists and internists regarding the identification of appropriate ICD indications,

as established in existing clinical practice guidelines (9), summarized in Table 1. The majority of participants in both groups identified secondary prevention after sustained ventricular arrhythmia (Table 2, 94%) and heart failure with left ventricular dysfunction (91%) reliably without significant intergroup variability. Fewer participants identified other

Table 1. Summary of indications for ICD therapy based upon current practice guidelines

Indications for ICD Therapy

Secondary Prevention
Myocardial infarction and LV dysfunction
Heart Failure and LV dysfunction
Long QT Syndrome
Brugada Syndrome
Hypertrophic Cardiomyopathy

Table 2. Summary of survey results

	Respondents	Physicians	Cardiologists	P
Participants	32	12 (62.5%)	20 (37.5%)	
Involvement	31 (97%)	11 (92%)	20 (100%)	0.19
Caring for ICD patients	30 (94%)	10 (84%)	20 (100%)	0.06
Have referred patients for ICDs	26 (81%)	8 (67%)	18 (90%)	<0.01
Estimated number of patients with ICDs	32.9	43.8	7.1	0.05
Estimated number of ICD referrals	9.3	3.4	12	0.08
Familiarity with guidelines	22 (69%)	5 (42%)	17 (85%)	0.01
<i>Recognition of ICD Indications</i>				
Secondary Prevention	30 (94%)	10 (84%)	20 (100%)	0.06
Myocardial infarction and LV dysfunction	21 (66%)	5 (42%)	16 (80%)	0.03
Heart Failure and LV dysfunction	29 (91%)	10 (84%)	19 (95%)	0.27
Long QT Syndrome	22 (69%)	7 (58%)	15 (75%)	0.32
Brugada Syndrome	27 (84%)	11 (92%)	16 (80%)	0.38
Hypertrophic Cardiomyopathy	19 (59%)	2 (17%)	17 (85%)	<0.01
Dilated Cardiomyopathy	10 (62%)	5 (42%)	15 (75%)	0.06
Other	4 (12%)	1 (8%)	3 (15%)	0.58
<i>Benefits and Costs</i>				
Estimated absolute survival benefit for secondary prevention ICD	23.5%	20.5%	25.2%	0.58
Estimated absolute survival benefit for primary prevention ICD	23.9%	28.3%	20.9%	0.47
Believe AVID trial results to be realistic	14 (44%)	1 (8%)	13 (65%)	<0.01
Believe MADIT & SCDHeFT trial results to be realistic	16 (50%)	2 (17%)	14 (70%)	<0.01
Estimated cost of ICD system	\$13955	\$13469	\$14150	0.91
Believe ICD to be cost-effective for secondary prevention	25 (78%)	6 (50%)	19 (95%)	0.02
Believe ICD to be cost-effective for primary prevention	21 (66%)	7 (58%)	14 (70%)	0.11

appropriate guideline indications, including left ventricular dysfunction after myocardial infarction (66%), long QT syndrome (69%), and hypertrophic cardiomyopathy (59%). Dilated cardiomyopathy without further qualification was identified inappropriately as an indication by 62% of respondents. There was a significant difference in the identification of hypertrophic cardiomyopathy as an appropriate ICD indication between cardiologists and internists (85% vs. 17%, $P < 0.001$), but no other significant differences were found between the two groups. Participants were asked if they were familiar with published guidelines on ICD therapy, and 69% reported that they were consistent with previously published data. Cardiologists were significantly more likely to report familiarity than internists (85% vs. 42%, $P = 0.01$). Each participant was then asked to rate his or her knowledge of ICD indications. Among all respondents, 41% reported satisfactory knowledge, 31% reported their knowledge as good, 12% reported their knowledge as poor or very poor, and only 3% reported their knowledge as very good (Figure 1). Cardiologists rated their knowledge of ICD indications higher than internists ($P = 0.02$). Participants were asked to rate the referral process of patients for whom they believed an ICD was indicated. Of all respondents, 47%

rated the process as satisfactory, 28% rated it as good, 9% rated it as very good, and 6% rated it as poor. Three participants (9%) did not respond. There was no significant difference in responses between cardiologists and internists.

Strength of Indications

The respondents were first asked to estimate the absolute risk reduction achieved by implantation of an ICD for secondary prevention. There was significant variability in responses with a mean estimate of 24% absolute risk reduction (median 12%, range 5-75%). When asked to estimate the absolute risk reduction achieved by implantation of an ICD for primary prevention in patients with a low EF, similar variability was found, with a mean estimated absolute risk reduction of 24% (median 12%, range 2-90%). There was no significant difference in estimated absolute risk reduction between cardiologists and internists for either of the patients' population.

Subsequently, participants were informed of an estimated 8% absolute survival benefit at 2 years for patients in whom an ICD was implanted for secondary prevention. This was the benefit observed in the AVID trial, considered to be a major qualifying randomized study supporting the "secondary prevention" implantation of ICDs, and were asked if they

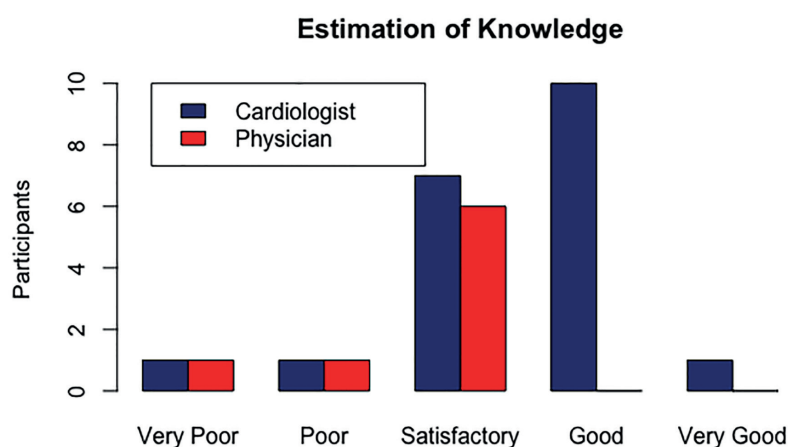


Figure 1. Count of respondents by role for knowledge classification. "Cardiologist" includes cardiology fellows. "Physician" encompasses all other non-cardiologists and non-cardiology trainees.

believed that this was a realistic result. Among all respondents, 44% agreed that the result was realistic, while 38% answered that they did not know, 9% responded that it was not realistic, and the remaining 9% did not respond (Figure 2). Cardiologists were far more likely to agree that the result was realistic (65% vs. 8%, $P<0.001$). Most internists (67%) responded that they did not know, while three did not respond. Similarly, participants were informed of an estimated 5% absolute survival benefit for 2 years for patients with a low EF in whom an ICD was implanted for primary prevention, based on the results of the MADIT II and SCD-HeFT trials, and were asked if they believed that this was a realistic result. Fifty percent of respondents agreed that this result was realistic, 31% reported that they did not know, and the remaining respondents reported that the result was not realistic (9%) or did not respond (9%). Cardiologists were again far more likely to agree that the result was realistic (70% vs. 17%, $P<0.01$), with most internists responding that they did not know.

Estimated Cost

There was substantial variation in the estimated cost of an ICD system across

participants with no significant difference between cardiologists and internists. The mean estimated cost was \$13,955 (median \$10,000, range \$750–\$50,000). In 2016, the ambulatory payment for implantation of a single-lead primary prevention ICD as \$26,658 (15) and this is presumably a minimal estimate of the attributable cost. The majority of respondents (86%) underestimated this cost. When asked if implantation of an ICD for secondary prevention was cost-effective, 78% of respondents said yes, while 3% said no, 9% reported that they did not know, and 9% did not respond. Cardiologists were more likely to respond that the therapy was cost-effective for secondary prevention (95% vs. 50%, $P<0.03$). Participants were similarly asked about cost-effectiveness of ICD implantation for primary prevention, and 66% of respondents said yes, 22% reported that they did not know, 9% did not respond, and 3% said no. With regard to cost-effectiveness for primary prevention, there was no significant difference in responses between the two groups.

Discussion

In this study, an attempt was made to identify

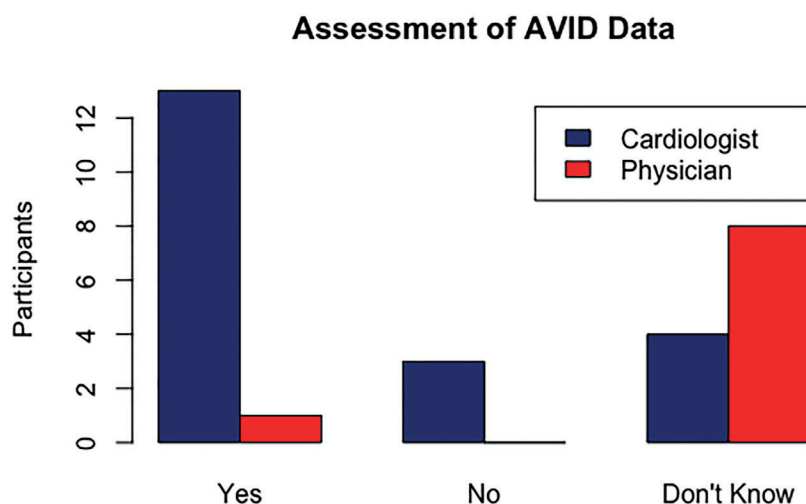


Figure 2. Count of respondents by role for assessment of AVID trial data. "Cardiologist" includes cardiology fellows. "Physician" encompasses all other non-cardiologists and non-cardiology trainees.

knowledge deficits in the value of ICD therapy as potential barriers for ICD referral in an academically affiliated VA medical center. We selected this population for several reasons. Trainee's knowledge of ICD referral indication has not been systematically studied and reported. The chosen survey population was accessible to study and contained a variety of practitioners at different stages of training, and was "ICD" but not cardiology-naive. While sophisticated tertiary cardiology was present at the institution, directly available electrophysiology was not, although it was clearly represented at the affiliated university hospital. This approach was appropriate for this environment, but carries several intrinsic and important limitations. We surveyed clinicians likely to be involved in the care of patients who would benefit from ICD therapy, predominantly trainees, in a single VA medical center. Thus, conclusions made about educational deficits may not necessarily be consistent among trainees at other institutions, although the trainees are drawn from diverse external environments. We achieved a lower response rate than initially projected, but increasing this would likely have required more substantial incentives which may have introduced bias. The relatively small number of participants limits the precision of our conclusions and did not enable us to detect differences in knowledge across training levels, which may have been possible with a larger sample size. A multi-site survey of trainees sufficiently separated geographically, could improve the precision and generalizability of our conclusions. The survey sample consisted of trainees in a busy working environment who may not have had strong motivation to respond, so a 50% response rate was considered informative and usable.

Using a previously validated questionnaire (14), we confirmed a discrepancy between perceived knowledge of guidelines for appropriate use of ICD therapy and objective demonstration of this knowledge. In our study, while a similar percentage of surveyed trainees reported

familiarity with international guidelines on ICD therapy to internists and cardiologists in a prior study, there were substantial discrepancies in the estimated survival benefit achieved by ICD implantation as well as the estimated cost of implantation. In general, participants overestimated the survival benefit based upon randomized controlled trials and underestimated the cost of implantation. Furthermore, despite assuming this more favorable theoretical scenario, one of five participants believed that the therapy would not be cost-effective for secondary prevention, while one in three felt similarly for primary prevention. This contrasts with prior studies based on the validation of randomized clinical trials, which have demonstrated the cost-effectiveness of ICD therapy for both of these populations (16). The majority of participants recognized secondary prevention after ventricular arrhythmia and systolic heart failure with a low ejection fraction as appropriate indications. However, there was inconsistent recognition of other indications, with no remaining indication being recognized by more than 70% of respondents. Furthermore, dilated cardiomyopathy was inappropriately identified as an indication by more than half of the respondents. With the exception of the identification of hypertrophic cardiomyopathy as an indication, these knowledge deficiencies were found both among cardiologists and internists. This represents a prime area for educational supplementation to optimally target the use of this therapy in patients in whom it will have the most benefit. These perceptions reflect the perceived value of ICD therapy and may be a factor in under-referral and underutilization of this specific therapeutic modality. Knowledge of demonstrated populations likely to receive benefit is also important in correctly targeting what is a very costly therapy. Addressing both knowledge gaps may also help in addressing the well-recognized disparities in ICD utilization, since specific under-resourced patient populations may disproportionately receive care in teaching environments.

As noted previously, the cost of ICD therapy was substantially underestimated by participants in this study. Despite underestimating the cost of implantation, less than two-third of the respondents believed that the therapy was cost-effective. This is in contrast to analyses performed over ten years ago which demonstrated the cost-effectiveness of ICD implantation for primary prevention (17). With the surveyed population primarily composed of trainees in internal medicine and cardiology, it is plausible that a lack of sufficient experience with medical billing may be responsible for this underestimation.

The majority of respondents in this study rated the referral process for ICD therapy as “satisfactory,” below good or very good. This was consistent among cardiologists and internists. A suboptimal referral process has previously been identified as a barrier to ICD therapy (14) and may be an additional target for improvement. The initial intention behind this study included a plan to survey participants again after the establishment of electrophysiology services at the medical center with a new referral process, but this exceeded the time frame for the current study. Nonetheless, this study establishes a clear and actionable area of educational need, with important (real “life-or-death”) consequences. We have not yet evaluated the effect of specific formal or informal educational programs, and anticipate doing so. It is anticipated that focused education and embedded teaching material in clinical reminders (18) would result in improved knowledge of guidelines and an increase in appropriate referral and ICD utilization. Our findings are consistent with prior surveys of practicing clinicians and thus, we are confident that they represent a true knowledge deficit despite the small sample size.

Conclusion

In a single-center survey of internists and cardiologists at a large VA medical center, significant knowledge deficits in the

appropriate indications, benefits and costs of ICD therapy were found. These deficits are likely to represent a correctable barrier to appropriate referral for ICD implantation and are targets for educational supplementation.

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Conflict of Interest

The author declares no conflict of interest.

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