



Antibiotic Prophylaxis Practices in Pediatric Cardiac Implantable Electronic Device Procedures: A Survey of the Pediatric And Congenital Electrophysiology Society (PACES)

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Abstract

Cardiac implantable electronic device (CIED) infections are associated with significant morbidity in the pediatric device population, with a tenfold higher risk of infection in children compared to adults. The 2010 American Heart Association (AHA) guidelines recommend a single dose of systemic antibiotic (ABX) prophylaxis prior to CIED implantation and no post-operative (OP) ABX. However, there is limited data regarding adherence to this recommendation among the pediatric community. To assess current clinical practices for CIED ABX prophylaxis in pediatrics; whether the AHA guidelines are being followed; and if not, the reasons for non-adherence. An anonymous web-based survey was sent to physician members of the Pediatric And Congenital Electrophysiology Society regarding ABX prophylaxis for new CIED implants and reoperations. 75 (25%) members responded. Only 7% of respondents follow the 2010 AHA guidelines. While all respondents give pre-OP IV ABX, 64% routinely treat patients with 24-h post-OP IV ABX with additional oral or IV therapy. 69% of respondents are cognizant of the guidelines but 88% of those cognizant do not follow the guidelines for a variety of reasons including lack of data and different substrate (pediatric patients). 79% stated that pediatric-specific data would be required for them to change their practice and follow the published guidelines. The majority of pediatric EP physicians who responded to this survey do not follow the current AHA guidelines on ABX prophylaxis and administer post-OP ABX. Most pediatric EP physicians believe that the increased risk of infection in children merits additional ABX.

Keywords Pediatric · Implantable device · Antibiotics · Prophylaxis

Introduction

The use of cardiac implantable electronic devices (CIED) in pediatric patients has expanded in recent years, with implantable cardioverter defibrillator (ICD) utilization in children more than doubling in the 10 years between 1997 and 2006 [1, 2]. While these devices have proven to be life-saving therapies, complications continue to be a significant problem with rates as high as 10% [3–7]. CIED-related infection remains an important cause of morbidity following CIED implantation. Infection rates have continued to rise disproportionately when compared to rates of new device

implant, with studies showing a tenfold higher risk of infection in children compared to adults [8–11].

The American Heart Association (AHA), with the endorsement of the Heart Rhythm Society and the Infectious Diseases Society of America, issued a scientific statement in 2010 addressing CIED infections and management [12]. The writing committee, citing a large randomized control trial, recommended systemic administration of antibiotic prophylaxis once immediately before device implant [13]. The committee did not recommend the use of antibiotic prophylaxis post-operatively, citing the lack of data for efficacy and concerns for drug adverse events, drug resistance, and cost. While the AHA statement cites multiple studies suggesting higher CIED-related infection rates in the pediatric population, it does not have specific recommendations for antibiotic prophylaxis in pediatric CIED implant procedures.

At present, there is no study examining adherence rates to the AHA guidelines for antibiotic prophylaxis in pediatric clinical practice. We performed an international survey

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of practicing pediatric electrophysiologists to assess current clinical practices for CIED antibiotics prophylaxis in pediatrics.

Methods

An anonymous web-based survey was sent in 2016 via Qualtrics to physician members of the Pediatric And Congenital Electrophysiology Society (PACES). The survey consisted of 25 Yes/No, multiple choice, and open-ended questions regarding antibiotic prophylaxis for different scenarios concerning new CIED implants and reoperations. Physicians were asked to explain practice preferences such as the antibiotics agents of choice and duration of antibiotic prophylaxis for each of the following scenarios: ICD implant, pacemaker implant, ICD reoperation, and pacemaker reoperation. We also asked whether they had knowledge of the current CIED antibiotic prophylaxis guidelines, and why they chose to follow or not follow these guidelines. Summary statistics of this descriptive study was presented as counts and percentages (*n*, %) for categorical data.

Results

Respondent Characteristics

A total of 75 PACES physician members of the 305 queried (25%) responded to the survey. 28% of those who responded reported practicing for < 5 years; 23% reported 5–10 years; and 49% reported > 10 years. Median center implant volume was 20 (5–75) CIED implants per year (Table 1).

Survey Responses

Antibiotic use surrounding CIED use is shown in Fig. 1. The vast majority (99%) of respondents administer prophylactic antibiotics during CIED procedures. Only 7–8% of respondents report to follow the 2010 AHA guidelines (single dose of pre-operative antibiotics) for new device implants and 15–16% for device reoperations. While all respondents give pre-operative IV antibiotics, 93% of respondents report administering additional antibiotics in new device implants and 84% in device reoperations. 64% routinely treat patients with 24 h of post-operative IV antibiotics followed by an additional course of oral or IV antibiotics. Different regimens for epicardial and transvenous systems were reported by 34% of participants. These differences were attributed to operator preference. 89–93% of respondents report administering Cefazolin as the preferred intravenous agent in CIED implant and reoperation procedures and 91% report

Table 1 Physician and center response

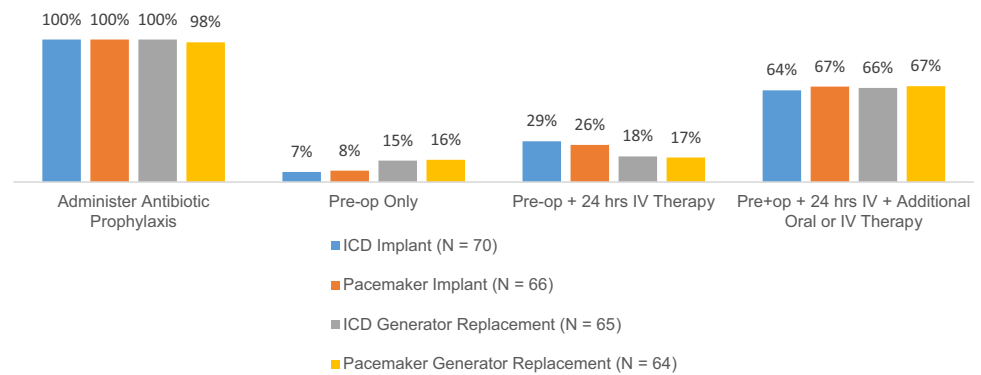
Respondents	
Years in practice	<i>N</i> = 61
< 5 years	17 (28%)
5–10 years	14 (23%)
> 10 years	30 (49%)
Center implant volume (Median: 20, IQR: 16)	<i>N</i> = 56
0–10	9 (16%)
11–20	23 (41%)
21–30	15 (26%)
> 30	9 (16%)
Guideline awareness	<i>N</i> = 61
Cognizant of AHA guidelines	43 (69%)
> 20 device implants/year	47%
> 10 years in practice	45%
Non-compliant of those cognizant of guidelines	88%
Reasons for non-compliance	<i>N</i> = 50
Personal experience	18 (36%)
Children are different than adults	17 (34%)
Lack of data	5 (10%)
Institutional guidelines	1 (2%)
Other	9 (18%)
Same regimen for epicardial versus transvenous systems?	<i>N</i> = 63
No	22 (35%)
ICD IV antibiotic of choice	<i>N</i> = 66
Cefazolin	59 (89%)
Vancomycin	19 (29%)
Clindamycin	8 (12%)
Cefuroxime	5 (8%)
Cefalexin	3 (5%)
Cefotaxime	1 (2%)
ICD PO antibiotic of choice	<i>N</i> = 35
Cefalexin	32 (91%)
Clindamycin	10 (28%)
Cefdinir	2 (6%)
Bactrim	2 (6%)
Doxycycline	1 (3%)
Ciprofloxacin	1 (3%)

using Cefalexin as the preferred oral agent in ICD implant procedures.

A majority (69%) of respondents were cognizant of the AHA guidelines. However, 88% of respondents do not practice guideline recommendations. Reasons given for this included personal experience and the fact that children pose a different risk for infection when compared to adult patients. 81% stated that pediatric-specific data would be required for them to change their practice and follow the published guidelines.

Of the five respondents reported to follow the AHA guidelines (single dose of pre-operative antibiotics), all have

Fig. 1 Antibiotic prophylaxis results by type of CIED implant. ICD implantable cardioverter defibrillator



been in practice for > 10 years and four of the five respondents practice at high implant volume centers (defined as > 20 implants/year). No association was found between guideline awareness and center implant volume or physician years in practice ($p = 0.6$).

Discussion

This survey demonstrates that the majority of pediatric electrophysiologists do not follow current AHA guidelines regarding antibiotic prophylaxis, citing differences in pediatric versus adult infection rates as one of the main reasons for this discrepancy. The concern about higher device infection rates in children is well supported in the literature. Indeed, the AHA guidelines cite studies supporting the premise that pediatric and congenital heart disease patients have higher infection rates compared to adult patients. Klug et al. reviewed a large pacemaker database and found a much higher infection rate in young patients < 40 years of age (5.5% vs. 1.2% $p < 0.001$) [14]. They hypothesized that several factors may influence these findings, including higher rates of reintervention and higher likelihood of trauma in young active individuals. ICDs in children also have a high infection rate. In a four center retrospective registry, Berul et al. found an acute infection rate of 1.5% and a chronic infection rate of 2.9% [15]. In a comparison of adults and pediatric patients in the same institution, Link found an ICD infection rate of 18% in pediatric patients compared to 1.2% in adults [11]. Despite these concerning findings, no specific pediatric guidelines were proposed in the AHA guidelines, presumably due to the lack of prospective data.

This dissent from the guidelines is not limited to pediatric practice. Recently, Basil et al. surveyed clinicians on antibiotic prophylaxis practices for CIED procedures in the adult population [16]. According to the study, 50% of respondents administer post-operative intravenous antibiotics in new CIED implant procedures and 25% in device reoperations. Over 20% administer post-operative oral antibiotics in new CIED implant procedures and 35% in device

reoperations. While these results are significantly lower than the 93% reported in new CIED implant procedures and 84% in reoperations presented here, they still represent a high number of centers with practice that departs from current AHA guidelines. Survey participants from this study have similar characteristics in the number of years in practice.

Surprisingly, one-third of surveyed pediatric electrophysiologists were not aware of the AHA guidelines. We did not find a significant association between guideline awareness and years in practice or center implant volume. Much has been done to increase awareness of guidelines by the AHA, American College of Cardiology, and Heart Rhythm Society. While it is beyond the scope of this work to address possible reasons for the high rate of unfamiliarity with the guidelines, it does highlight a problem with dissemination of guideline recommendations.

Limitations

As this study was based on a voluntary survey sent to members of PACES, it may not reflect practice preferences of all pediatric electrophysiologists. In addition, not all physicians responded to all of the questions presented.

Conclusions

In conclusion, the majority of pediatric electrophysiologists surveyed do not follow the published AHA guidelines on antibiotic prophylaxis usage for CIED. Further work is needed to reconcile the discrepancy between current practice patterns among pediatric electrophysiologists and current AHA guidelines. While the majority of pediatric electrophysiologists cite a lack of data for their preferences, a prospective randomized study of antibiotic prophylaxis in children would be challenging due to the size, scope, and limited patient population to provide definitive pediatric-specific data that would change individual practices.

Compliance with Ethical Standards

Conflict of interest Kara S. Motonaga has received educational fellowship support from Medtronic (20K) & Abbott (20K). Anne M. Dubin has received educational fellowship support from Medtronic (20K) & Abbott (20K). The other authors declare that they have no conflict of interest.

Research Involving Human and Animal Participants This article does not contain any studies with human participants or animals performed by any of the authors.

Appendix

Survey Questions

1. Do you routinely use antibiotic prophylaxis when placing new ICDs?
2. Do you give antibiotics:
 - (a) preoperative IV dose prior to implantation only
 - (b) preop + 24 h of IV therapy
 - (c) preop + 24 h of IV therapy followed by 3 days of oral
 - (d) preop + 24 h of IV followed by 5 days of oral
 - (e) prep + 24 h of IV followed by 7 days of oral
 - (f) Other
3. What other antibiotic regimen do you use?
4. Which IV antibiotics do you use?
5. Which oral antibiotics do you use?
6. Do you routinely use antibiotic prophylaxis when placing new pacemakers?
7. Do you give antibiotics:
 - (a) preoperative IV dose prior to implantation only
 - (b) preop + 24 h of IV therapy
 - (c) preop + 24 h of IV therapy followed by 3 days of oral
 - (d) preop + 24 h of IV followed by 5 days of oral
 - (e) prep + 24 h of IV followed by 7 days of oral
 - (f) Other
8. What other antibiotic regiment do you follow?
9. Which IV antibiotics do you use?
10. Do you use antibiotic prophylaxis for ICD generator replacement?
11. Do you give antibiotics:
 - (a) preoperative IV dose prior to implantation only
 - (b) preop + 24 h of IV therapy
 - (c) preop + 24 h of IV therapy followed by 3 days of oral
 - (d) preop + 24 h of IV followed by 5 days of oral
 - (e) prep + 24 h of IV followed by 7 days of oral
 - (f) Other
12. What other antibiotic regimen do you use?
13. Which IV antibiotics do you use?
14. Do you use antibiotic prophylaxis for pacemaker generator replacement?
15. Do you give antibiotics:
 - (a) preoperative IV dose prior to implantation only
 - (b) preop + 24 h of IV therapy
 - (c) preop + 24 h of IV therapy followed by 3 days of oral
 - (d) preop + 24 h of IV followed by 5 days of oral
 - (e) prep + 24 h of IV followed by 7 days of oral
 - (f) Other
16. What other antibiotic regimen do you use?
17. What IV antibiotics do you use?
18. Are you aware of the present AHA guidelines regarding antibiotic prophylaxis?
19. If you are not following these guidelines, why not?
 - (a) Lack of data
 - (b) Personal experience
 - (c) Children are different than adults
 - (d) Other
20. If you do not follow the guidelines, what would you need to see to convince you to follow them?
21. How long have you been in practice?
22. Number of devices you place per year?
23. Do you have same regimen for epicardial and TV systems?
24. If not, what do you do different?
25. If not, why not?

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