Sudden cardiac death screening in adolescent athletes: an evaluation of compliance with national guidelines

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ABSTRACT

Objective In the USA, the preparticipation physical evaluation (PPE) is the standard of care for screening eight million high-school athletes for their risk of sudden cardiac death (SCD). Our aim was to evaluate both physician and school compliance with national guidelines for SCD screening.

Methods We conducted a confidential survey of the Washington Chapter of the American Academy of Pediatrics (AAP), the Washington Academy of Family Physicians (WAFP) and Washington State high-school athletic directors. Responses were evaluated for compliance with the American Heart Association (AHA) guidelines for SCD screening.

Results We received a response rate of 72% (559/776) from the AAP, 56% (554/990) from the WAFP and 78% (317/409) from the athletic directors. Only 6% of all providers and 0% of schools were in compliance with AHA guidelines. In addition, 47% of the physicians and 6% of athletic directors reported awareness of the guidelines. There was no difference in compliance between physician specialties (p=0.20). Physician location, years of experience and exposure to SCD were not significantly associated with compliance. Provider knowledge of the guidelines, number of PPE/month and frequency of referrals to cardiology were all positively associated with improved overall compliance (p<0.05).

Conclusions Despite the unaltered presence of the AHA SCD screening guidelines for the past 15 years, compliance with the recommendations is poor. Lack of compliance does not reflect clinical experience, but rather lack of knowledge of the guidelines themselves. New directions for provider education and policy requirements are needed to improve this implementation gap.

INTRODUCTION

In the USA, the Preparticipation Physical Evaluation (PPE) is the standard of care for screening nearly eight million high-school athletes for their risk of sudden cardiac death (SCD).[1] This represents an estimated 50% of all enrolled students. The annual cost of this screening programme is approximately $250 million.[2–4] Although the PPE has been adopted by nearly every state as a recommended prerequisite to athletic participation, and despite its endorsement by all principal medical organisations, the clinical practice remains variable and its utility remains a topic of debate.[3]

The purpose of the PPE as identified by the American Medical Association is to accurately identify medical conditions that may affect safe participation in athletic endeavours.[1] The American Heart Association (AHA) states that the principle objective of PPE screening is to reduce the cardiovascular risks associated with physical activity and enhance the safety of athletic participation.[3] Despite the controversy surrounding how best to perform these cardiovascular screenings, the AHA and the European Society of Cardiology jointly agree that screening all athletes is both ethically and medically justified.[3 5 6]

In 1996 and reaffirmed in 2007, the AHA published consensus recommendations for the cardiovascular screening of athletes.[3] These guidelines have established a standard of care in the USA and advocate for the cardiovascular screening of athletes based on a comprehensive history and physical examination (see online supplementary appendix A).[3]

There remains significant debate regarding the effectiveness of the PPE, and whether the history and physical alone is a sufficiently sensitive and cost-effective strategy for SCD screening.[7 8] Despite high levels of specificity (75–95%), the PPE is often criticised for its relative lack of sensitivity (5–44%).[9–11] However, the value of the PPE as a screening tool is incompletely understood as there is substantial variability nationally regarding its actual practice. Specifically, it is unknown to what degree providers are in compliance with national consensus guidelines, in particular those put forward by the AHA. In Washington State, providers are not mandated to utilise a particular form or method when screening athletes for sudden cardiac death risk factors. This lack of a standardised process is not unique to Washington State. Currently, 54% of US states lack a mandated PPE form.

The purpose of this study was to evaluate statewide awareness and compliance of the 2007 AHA consensus guidelines on cardiovascular screening in athletes. Specific focus was given to the three fundamental groups involved in SCD assessment of the high-school athlete in the USA: the paediatrician, the family medicine physician and the high-school athletic director.

METHODS

Inclusion/exclusion criteria

We contacted all members of the Washington Chapter of the American Academy of Pediatrics (776 subjects) and 990 members of the Washington Academy of Family Physicians (WAFP). The entire membership of the WAFP totals 1980 persons; we contacted 50% after a process of randomisation. Each membership's governing body enabled direct communication with their members.

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Contact with the high-school athletic directors in Washington State was facilitated by the Washington Interscholastic Activities Association (WIAA). The WIAA governs 409 of the state's high schools (98% of total), and 100% of all schools which field at least one athletic team. Every school maintains an individual athletic director.

Participation in the study was voluntary without incentives, and responses were kept confidential with removal of all identifiers. All non-responders were contacted twice by mail over a 2-month period (September–November 2010). In addition, American Academy of Pediatrics (AAP) and athletic director non-responders were contacted once every 7 days by email with a link to the web-based version of the survey (University of Washington Catalyst WebQ service). The WAFP limited web-based contact with its members to once every 14 days.

Survey contents

The surveys to the AAP and WAFP were identical. Survey questions evaluated the following: presence of a clinic-specific PPE form, patient population demographics, provider clinical experience, PPE satisfaction, knowledge of AHA cardiovascular screening guidelines, utilisation of each of the 12 individual elements of the AHA guidelines, comfort performing the PPE, frequency of PPE practice, frequency of cardiology referral and willingness to support a statewide universal PPE form.

The survey to the athletic directors was unique relative to the physician survey. Survey questions evaluated the following: WIAA classification (surrogate for school size), WIAA district (surrogate for school location), presence of a school mandated or recommended PPE form, recognition of PPE performed by non-physicians, satisfaction with the PPE, awareness of the AHA guidelines and willingness to support a statewide universal PPE form.

In addition, all physician and athletic directors were requested to share a copy of any PPE forms utilised in their clinical practice or by their school (either mandated or recommended).

Statistical analysis

Provider compliance with each of the 12 AHA components was analysed by the Wilcoxon-Mann-Whitney test (answers options were as follows: always perform, perform most of the time, perform about half of the time, rarely perform and never perform). A subsequent analysis of overall compliance with the AHA guidelines was generated by the creation of a composite score of survey responses of 'always perform' (<4, 5–8, 9–11 and all 12) based on prior study.[12] Analysis of the overall composite score was by an ordinal regression model. Compliance by composite score was analysed according to physician type (AAP/WAFP), practice location (rural, suburban and urban), provider experience (years), provider satisfaction with the PPE, provider knowledge of AHA guidelines, provider referral frequency (avg. #/month) and lifetime experience with SCD.

Athletic director responses were analysed utilising c^2 analysis and Fisher's exact test depending on the number of variables. Variables were analysed relative to school size (WIAA classification: 1–2B, 1–4A) and school location (WIAA district: 1–9). School size was divided into an ordinal variable (large/small) according to student enrolment data (large school: 3–4A with an average enrolment >1085 students; small school: 1–2B, 1–2A with an average enrolment <1085 students). School location was likewise divided into a categorical variable (urban/non-urban) according to school district data (urban districts: WIAA classification 2 and 8; non-urban districts: WIAA classification 1, 3–7 and 9). The variables analysed included: existence of a school mandated or recommended PPE form, satisfaction with the PPE, awareness of the AHA guidelines and willingness to support a statewide PPE form.

RESULTS

Physician and athletic director participants

We received a response rate of 72% (559/776) from the AAP, 56% (554/990) from the WAFP and 78% (317/409) from the athletic directors. Responses were fairly evenly distributed between the mail (55%) and web-based (45%) formats. Survey responses were excluded if the responding physician reported that conducting PPEs was not a routine aspect of their practice (AAP: 119/559, WAFP: 71/554).

The majority of physician respondents were from suburban locations with a larger proportion of family physicians practicing in a rural location relative to paediatricians (table 1). The distribution of clinical experience was skewed slightly towards those with greater than 20 years of experience (37% of respondents). The majority of physicians described themselves as only somewhat satisfied with the PPE as a screening tool (65%). The average number of PPEs performed per month varied between the provider types with 55% of paediatricians performing at least six PPEs per month, and 25% of family physicians performing at least six PPEs per month. Likewise, 55% of paediatricians refer an average of at least two athletes per year for cardiology evaluation versus only 23% of family physicians, mirroring the volume of PPEs performed. Overall, comfort knowing when to refer to cardiology is similar between physician types with 73% stating they are comfortable 'most of the time'. In addition, the number of physicians who report direct experience with an athlete from their practice suffering an SCD event as a result of an unknown condition is similar (5%).

Knowledge of AHA Guidelines

Less than half of physicians reported an awareness of the AHA Guidelines (47%). No statistical difference exists between physician specialty (49% of the AAP and 45% of the WAFP, p=0.33). Only 6% of the athletic directors reported an awareness of the AHA Guidelines (figure 1).

Physician compliance with AHA Guidelines

Only 5.7% of physicians were always in compliance with the AHA Guidelines according to the overall composite score (table 2). While many providers always perform a majority of the elements of the AHA Guidelines, a significant proportion (13%) routinely perform 8 or less of the recommended 12 components.

Compliance with each individual component of the AHA Guidelines was also assessed (figure 2). In total, 72% of physicians always ask about chest pain with exertion, 78% always ask about syncope with exertion and 74% always ask about a family history of premature death. Conversely, 10% of physicians ask about exertional chest pain less than half of the time. Similarly, 6.3% of physicians ask about syncope with exertion and 6.5% ask about a family history of premature death less than half of the time. Only 33% always ask about family members with a known cardiac diagnosis placing them at risk of SCD. In particular, 28% of providers state that they either rarely or never ask about a known family history of specific disorders causing SCD.

With regard to the physical exam, the vast majority of physicians always listen for the presence of a heart murmur (95%) and always measure brachial artery blood pressure (87%; figure 2). However, 43% of physicians rarely or never perform

Table 1 AAP and WAFP demographic and PPE experience

General demographics	AAP N (%)	WAFP N (%)	Total N (%) £
Total providers contacted	776 (N/A)	990 (N/A)	1766 (N/A)
Total responses	559 (72)	554 (56)	1113 (63)
Providers utilising the PPE in clinic practice	440/559 (79)	483/554 (87)	923/1113 (83)
Practice location			
Rural	63 (14.5)	111 (23.2)	174 (19.1)
Suburban	228 (52.7)	243 (50.8)	471 (51.7)
Urban	142 (32.8)	124 (26.0)	266 (29.2)
Years in practice			
0–3	103 (23.5)	32 (6.7)	135 (14.8)
4–10	94 (21.5)	116 (24.4)	210 (23.0)
11–20	109 (24.9)	125 (26.3)	234 (25.6)
>20	132 (30.1)	203 (42.6)	335 (36.6)
Level of satisfaction with PPE			
Very satisfied	64 (14.7)	135 (28.5)	199 (21.9)
Somewhat satisfied	302 (69.6)	283 (59.8)	585 (64.5)
Not satisfied	68 (15.7)	55 (11.7)	123 (13.6)
Number of PPE/month			
1 or less	71 (16.2)	55 (11.8)	126 (13.9)
2–5	126 (28.8)	294 (62.8)	420 (46.4)
6–10	126 (28.8)	89 (19.0)	215 (23.7)
>10	115 (26.2)	30 (6.4)	145 (16.0)
Number of athletes referred/year			
1 or less	196 (45.2)	365 (77.3)	561 (61.9)
2–5	204 (47.0)	102 (21.6)	306 (33.8)
6–10	26 (6.0)	2 (0.5)	28 (3.1)
>10	8 (1.8)	3 (0.6)	11 (1.2)
Comfortable when to refer			
Always	53 (12.2)	92 (19.7)	145 (16.0)
Most of the time	332 (76.1)	329 (70.3)	661 (73.1)
About half of the time	43 (9.9)	45 (9.6)	88 (9.7)
Rarely	8 (1.8)	2 (0.4)	10 (1.2)
SCD experience in clinic panel			
Yes	26 (6.0)	18 (3.8)	44 (4.9)
No	410 (94.0)	454 (96.2)	864 (95.1)
Knowledge of the AHA guidelines			
Yes	212 (49.2)	210 (45.1)	422 (47.0)
No	219 (50.8)	256 (54.9)	475 (53.0)
Support of a statewide PPE form			
Yes	416 (96.5)	440 (94.4)	856 (95.4)
No	15 (3.5)	26 (5.6)	41 (4.6)

AAP, Academy of Pediatrics; AHA, American Heart Association; PPE, physical evaluation; SCD, sudden cardiac death; WAFP, Washington Academy of Family Physicians.

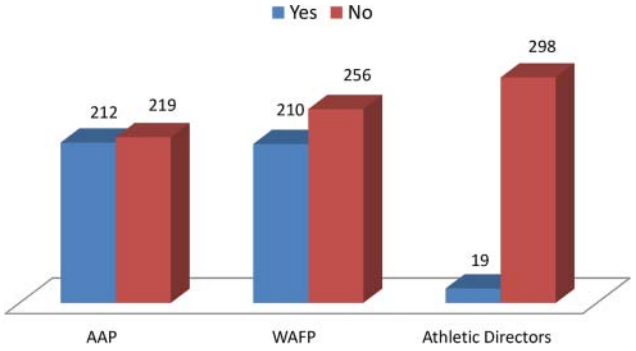

Figure 1 Physician (AAP & WAFP) and Athletic Director Knowledge of the AHA Guidelines

- 49% of AAP and 45% of WAFP reported a knowledge of the AHA guidelines (p=0.33)
- 6% of athletic directors reported knowledge of the AHA guidelines.

This figure demonstrates the number of AAP members, WAFP members and athletic directors who reported knowledge of the contents of the AHA SCD guidelines when surveyed. The total responses 'yes' and 'no' are listed above each column. The percentages are listed with a p value comparison of the AAP and WAFP members demonstrating no significant difference in their responses. AAP, Academy of Pediatrics; AHA, American Heart Association; WAFP, Washington Academy of Family Physicians. This figure is only reproduced in colour in the online version.

an evaluation of lower extremity pulses, and 19% of physicians screen for the physical stigmata of Marfan syndrome less than half of the time.

When comparing the physician types, there is no difference between the responses of the AAP and the WAFP relative to their composite score of overall compliance (p=0.20). When analysed by each individual component, AAP physicians were more likely to always evaluate femoral pulses (p<0.001), Marfan stigmata (p=0.049) and inquire about a family history of cardiac disease known to cause SCD (p<0.001). The WAFP physicians were more likely to always ask about a history of dyspnoea with exertion (p=0.005), a history of a murmur (p=0.024) and measure blood pressure (p=0.003).

Clinical practice location (p=0.14), years of experience (p=0.76) and experience with SCD in a prior patient (p=0.71) were not significantly associated with the overall compliance. However, provider satisfaction with the PPE as a clinical tool (p<0.001), comfort knowing when to refer an athlete to cardiology (p<0.001), number of cardiology referrals per year (p=0.003) and number of PPEs performed per month (p=0.029) were all associated with improved compliance. In addition, reported knowledge of the AHA guidelines was associated with improved compliance (p<0.001).

Athletic director participants

The responding athletic directors represented every WIAA district (1–9) and school classification (1–2B, 1–4A). Of those athletic directors who replied, 55% (175 schools) noted that their school requires a specific PPE form distributed by the school (table 3). The remaining 45% of schools without a required form are evenly divided between those that recommend a form (77 schools) and those that do not (73 schools). Three schools do not utilise any form at all. Only 44% of the schools recognise PPEs performed by non-physician providers, 74% of which are performed by physician assistants and nurse practitioners. Ten per cent of schools allow completion of a PPE form by a

Table 2 Physician (AAP and WAFP) overall AHA Composite Compliance Score

	Overall Compliance Score			
	0–4 (%)	5–8 (%)	9–11 (%)	12 (%)
AAP (466)	4 (0.8)	52 (11.2)	387 (83.0)	23 (5.0)
WAFP (445)	2 (0.5)	59 (13.3)	355 (80.0)	29 (6.5)
Overall (911 total)*	6 (0.7)	111 (12.2)	742 (81.4)	52 (5.7)

*Number of overall responses does not equal total respondents because of missing data.
AAP, Academy of Pediatrics; AHA, American Heart Association; WAFP, Washington Academy of Family Physicians.

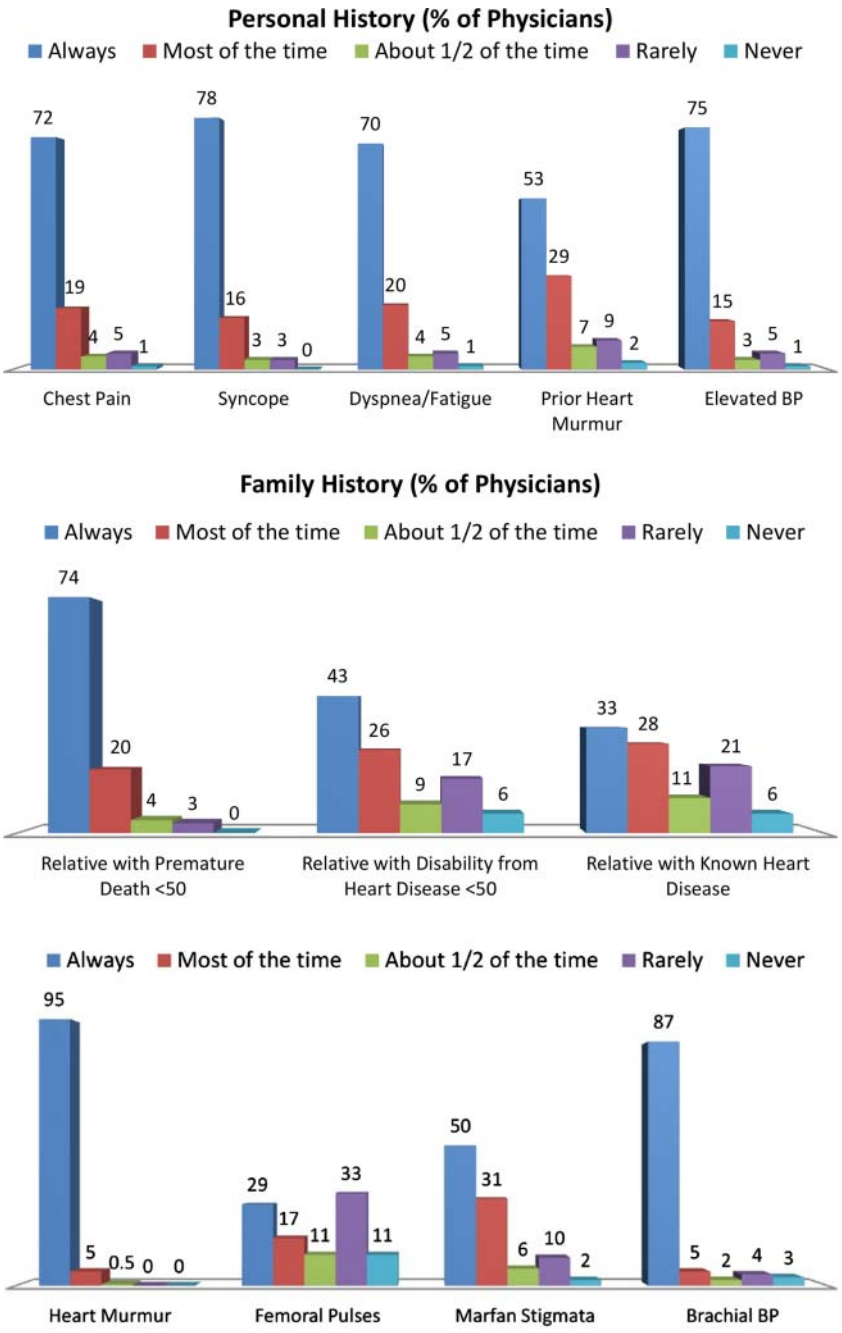

Figure 2 Pooled Physician (AAP and WAFP) Compliance with the 12 Elements of AHA Guidelines ▶ AAP members were more likely to always evaluate femoral pulses, Marfan stigmata, and whether a family member had known heart disease ($p < 0.05$). ▶ WAFP members were more likely to always evaluate dyspnea with exertion, history of murmur, and blood pressure ($p < 0.05$).These three figures demonstrate to what percentage all physician respondents (pooled AAP and WAFP members) utilise the 12 separate elements of the AHA SCD guidelines. Each physician reported whether they clinically practiced the element in question 'always', 'most of the time', 'about half of the time', 'rarely' and 'never'. The percentage for each category is listed above the columns. In addition, it is also noted which elements demonstrated a statistically significant difference ($p < 0.05$) between the two physician groups. AAP, Academy of Pediatrics; AHA, American Heart Association; SCD, sudden cardiac death; WAFP, Washington Academy of Family Physicians. This figure is only reproduced in colour in the online version.

naturopathic physician, chiropractor or physical therapist. Urban schools were more likely to require a single PPE form ($p=0.023$) and were more likely to allow non-physicians to perform the PPE ($p<0.001$).

Only 6% of athletic directors reported an awareness of the AHA Guidelines for SCD screening. In addition, 114 of the athletic directors, representing schools that require or recommend a school-specific form, submitted these forms along with their survey responses. None of these forms (0/114) were found to be in complete compliance with the AHA Guidelines. The majority (60%) included 8 of the 12 total recommended elements.

Single statewide PPE form

Ninety-five per cent of the physician responders supported the adoption of a single, statewide PPE form. This near unanimous support was equal between the physician specialties. Sixty-six per cent of the athletic directors were in favour of a statewide PPE form. Those athletic directors in favour of a statewide form were more likely to represent a school that already mandates a single form ($p=0.002$), and more likely to be a small school ($p<0.001$).

DISCUSSION

The PPE is the cornerstone of SCD screening in the USA and is universally supported by all principal medical organisations. The size of the population at risk is substantial, with eight million high-school athletes in the USA. Thus, the development of effective, feasible strategies for prevention is critical.

Sudden cardiac death is the leading cause of death in young athletes during sport, although the exact frequency of these

Table 3 Athletic director demographic data (N=317)*

a	N (%)
WIAA classification	
1B	45 (14.2)
2B	47 (14.9)
1A	55 (17.4)
2A	49 (15.5)
3A	54 (17.1)
4A	66 (20.9)
Percent student athletes (%)	
0–20	11 (3.6)
21–40	86 (27.7)
41–60	103 (33.2)
61–80	91 (29.3)
81–100	18 (5.8)
PPE form required	
Yes	175 (55.4)
No	141 (44.6)
PPE form recommended	
Yes	77 (24.4)
No	73 (23.1)
PPE form if none recommended	
Provider supplied	67 (21.2)
No form—signature only	3 (1.0)
No clearance required	0 (0.0)
Recognise PPE by non-MD providers	
Yes	140 (44.3)
No	169 (53.5)
Other recognised providers	
PA	118 (37.3)
ARNP	115 (36.4)
ND	31 (9.8)
Chiropractor	2 (0.6)
Physical therapist	1 (0.3)
Other	0 (0.0)
Aware of the AHA National Guidelines	
Yes	12 (3.8)
No	287 (90.5)
Willing to adopt statewide PPE	
Yes	209 (65.9)
No	92 (29.0)

*Number of overall responses does not equal total respondents because of missing data.
AHA, American Heart Association; ARNP, advanced registered nurse practitioner; MD, doctor of medicine; ND, doctor of naturopathic medicine; PA, physician assistant; PPE, physical evaluation; WIAA, Washington Interscholastic Activities Association.

catastrophic events is unknown due to the lack of systematic reporting systems. In the USA, Maron *et al* have estimated that the annual incidence is 0.5–0.93/100 000 competitive athletes (age 12–35).[13–15] Recent estimates of college athletes suggest that the rate is greater at approximately 1/43 000 NCAA participants per year.[16] In Italy, Corrado *et al* reported an SCD incidence of 1:28 000 for young competitive athletes (age 12–35 years) prior to the implementation of a national screening programme.[17–19] This rate of SCD is further supported by a recent evaluation of the US Department of Defense Cardiovascular Death Registry.[20]

The AHA has advocated for cardiovascular screening in athletes since 1996.[3] After the AHA reaffirmed its recommendations in 2007, Glover *et al* determined that there had been a significant interval improvement in the state approved history and physical examination questionnaires as compared with 1996.[12] In particular, in 2007, 48 states had approved, but not necessarily mandated, PPE forms as compared with only 43 in 1997. In addition, the strength of the approved forms, as determined by their reliance on the AHA recommendations, was statistically much greater. In 1997, only 40% included more than nine items, whereas by 2007, 81% had more than nine items. However, this study was not able to address the degree of physician or school utilisation of these state-approved forms.

Thus, this study presents new information on the knowledge and compliance of physicians and athletic directors regarding the AHA guidelines. Alarmingly, less than 6% of primary care providers are in full compliance with national guidelines, and less than one-half of these providers are even aware of the guidelines. While this survey only included physicians practicing in Washington State, the formal medical training for this group of providers occurred throughout the USA, and the results may reflect a broad educational deficiency prevalent in primary care training. In addition, the conditions in Washington State are not unique, as greater than half of the states in the country (54%) are also without a mandated standardised approach to the PPE.

None of the schools in Washington State are compliant with national guidelines, which is especially important considering that over half of the athletic directors who responded reported that their school requires a specific PPE form. While Washington State does have a recommended PPE form in the high-school athletic association handbook, use of the form is not mandated and the current iteration only includes 8 of the 12 elements of the AHA Guidelines.[21] It is possible that states with laws or policies that mandate use of a specific PPE form would demonstrate better compliance.

Our data suggest that the lack of compliance with the national guidelines is not related to geography, practice location or experience, but rather, it is heavily influenced by knowledge of the guidelines themselves. Physicians who reported an awareness of the guidelines were not only more likely to be compliant with the guidelines; they were more likely to feel comfortable about when to refer a patient for continued evaluation by a cardiologist. Physicians with greater compliance were also more likely to refer an increased number of athletes per year; an important result given the purpose of the PPE is to serve as a sensitive screening tool to bring those at risk to appropriate care. It is also remarkable that increased compliance was positively associated with increased provider satisfaction with PPE screening, suggesting that increased compliance is of benefit to the provider. These findings are particularly illustrative given the common criticism of poor sensitivity that surrounds using history and physical alone as a screening tool.[7] The more variable the clinical approach, the less likely the proportion of athletes with cardiovascular warning symptoms or a concerning family history would be detected.

Notably, the physician support for a single, standardised form was near unanimous. Similar support was also appreciated from the athletic directors. And importantly, the potential benefit of a standardised form reaches beyond SCD screening alone and benefits how athletes are evaluated for concussion risk, female triad potential and other musculoskeletal injuries. The 4th Edition PPE Monograph created by the AAP, AAFP, American Medical Society for Sports Medicine and the American College of Sports Medicine would serve most optimally as the standard

form as it is consistent with all relevant and necessary guidelines.[22]

A primary limitation of survey based investigations can be the response rate. However, the response rate in this study was robust and minimises the potential for selection bias among the respondents versus the non-respondents. There is also the possibility of a social desirability bias in the responses to the individual AHA elements on the survey. Providers may realise that they should be performing these highlighted elements and their survey responses may bias the data in that direction with the potential to falsely elevate compliance. Yet our data already demonstrates poor compliance, and therefore such a bias only serves to strengthen our conclusions.

CONCLUSION

Unfortunately for the high-school athlete, the consensus recommendations by the AHA, which have been present and unaltered for 15 years, are poorly understood and poorly followed by primary care physicians and school districts. According to our data, the burden of responsibility for this suboptimal compliance lies in the lack of awareness of the recommendations. New directions for provider education and policy requirements are needed to improve this implementation gap if the conventional model for PPE screening continues to be endorsed. Given the favourable response of physicians and athletic directors regarding the creation of a single, universal PPE form, it appears that standardising the PPE process should be strongly considered.

What this study adds

Our data provide direct evidence that:

- Physicians and schools are not following clinical guidelines when screening athletes for sudden cardiac death risk factors.
- Utilisation of the guidelines by providers improves satisfaction with screening and helps to improve comfort knowing when referral for subspecialty care is necessary.
- Standardisation of the process is nearly universally supported by physicians.

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Contributors NLM conceptualised and designed the study, gathered the data, analysed the data, drafted the initial manuscript and approved the final manuscript as submitted. JAD assisted with design of the study, reviewed and revised the manuscript and approved the final manuscript as submitted. JCS assisted with design of the study, assisted with data gathering, assisted with data analysis, reviewed and revised the manuscript and approved the final manuscript as submitted.

Competing interests None.

Ethics approval Seattle Children's Institutional Review Board.

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