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In This Issue

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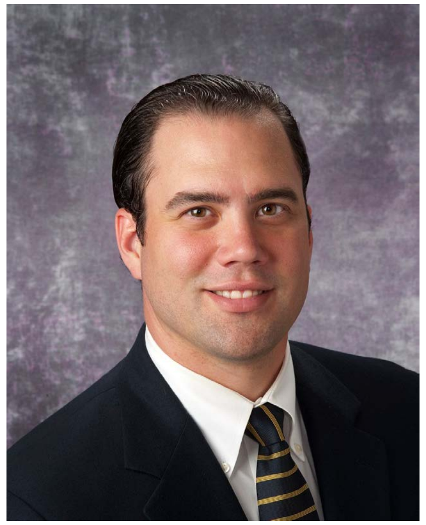
Guest Editor



Aaron Mares, MD

Dr. Mares is a Pittsburgh native, specializes in the non-operative care of sports-related and musculoskeletal injuries, general medical conditions in the athlete, and sports injury prevention at the UPMC Rooney Sports Complex. Dr. Mares serves as the Co-Head Team Physician for the University of Pittsburgh football team and a medical consultant for several local high school teams. He is the Associate Medical Director of the Pittsburgh Marathon and has served as a lead physician for many other running and extreme sporting events. Additionally, Dr. Mares is an Assistant Professor of Orthopaedic Surgery at the University of Pittsburgh. Dr. Mares is a graduate of the Temple University School of Medicine. He completed a residency in internal medicine, as well as a sports medicine fellowship, at the University of Pittsburgh Medical Center.

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Guest Editor

Hank Pelto, MD

Dr. Pelto was born and raised in the Seattle area. He received his undergraduate degree from Gonzaga University in Spokane, WA where he studied Biology. He attended medical school at Saint Louis University in St. Louis, MO where he graduated in 2009 receiving the Family Health Foundation of Missouri Scholarship Award. After medical school he returned to Seattle where he completed his Family Medicine Residency at the University of Washington and received the Society of Teachers of Family Medicine Resident Teaching award. He also completed a Primary Care Sports Medicine Fellowship at the University of Washington where he is currently an Assistant Professor in the Department of Family Medicine and a Team Physician. He is Board Certified in Family Medicine and Sports Medicine. His professional interests include family medicine, musculoskeletal care and ultrasound guided procedures. He has a clinical and research interest in the field of Sports Cardiology, specifically the prevention of sudden death in athletes. He has an additional interest in cardiac stress testing and cardiopulmonary exercise testing. Dr. Pelto is a member of the American Medical Society for Sports Medicine (AMSSM), American Academy of Family Physicians (AAFP) and the American College of Sports Medicine (ACSM). In addition to his time with the UW Huskies his sports event coverage has included working as the Team Physician for Ingraham High, working for the UW Husky Club Hockey team, and the Seattle Marathon. He is also an active physician volunteer for the Nick of Time Foundation, a Seattle group dedicated to educating schools, athletes, families, and communities about Sudden Cardiac Arrest (SCA) and death in young people.

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Sport Rev J. 2017; 2(4) "Sports Cardiology Edition"

Reliability of QT Measurement to Risk Stratify the Young Athlete

Craig Ziegler[a,b,d], Aaron V. Mares[a,c]

Level of Evidence: II

Introduction: In this observational study, level II evidence, Pickham et al. sought to evaluate a new way to estimate QT interval as part of pre-participation cardiovascular screening among young athletes. The ability to accurately identify long QT syndrome (LQTS) may help medical providers determine and reduce the risk of sudden cardiac death in athletes. Using correction equations among well-conditioned athletes may lead to an inaccurate risk assessment because lower heart rates result in underestimation of the QT interval. The authors sought to compare different QT value screening methods to determine the best approach for risk stratifying young athletes at risk of LQTS.

Methods: Resting ECG data (n = 2077; mean age 19 ± 3.5 years) was obtained from high school, collegiate, and professional athletes during pre-participation health screenings. Tracings were analyzed automatically by an ECG machine and were then verified by a sports cardiologist. Four different correction formulae (Bazett; Framingham; Friderica; Hodges) were used to calculate QTc interval and the results for each were plotted by HR. Additionally, the 95th and 99th percentiles for uncorrected QT intervals were grouped by gender and HR.

Results: Of the 25 athletes in the 99th percentile for uncorrected QT intervals adjusted by HR, up to 75% were not identified for further LQTS evaluation when using the Seattle Criteria. Between the four correction formulae compared, the Friderica approach demonstrated the lowest residual dependence upon HR, while the Bazett and Hodges calculations had high residual dependences upon HR. The author's conclusion is that the Seattle ECG Interpretation Criteria for Athletes recommendations are not adequate to identify young athletes at risk of LQTS.

Strengths: The study includes a large cohort of young athletes to compare uncorrected QT values with HR, as well as different correction formulae. Using 99th percentiles, the clinician can easily identify athletes with prolonged QT values per HR and direct care towards further evaluation. The authors compare use of their proposed screening method with the Seattle Criteria.

Weaknesses: In order to determine the sensitivity and specificity of the author's recommended screening method, there needs to be athletes confirmed with LQTS. None of the athletes in this study were found to have LQTS. Without this data, the clinician is unable to accurately determine the clinical significance of the results demonstrated when using the authors proposed criteria and the Seattle Criteria.

Conclusion: This study demonstrates using that uncorrected QT intervals may identify more athletes with QT prolongation than does following the Seattle Criteria, which uses the Bazett correction formula. Using uncorrected QT intervals adjusted by HR is simpler and can aid the clinician in determining which athletes would benefit from further evaluation for LQTS. The methods used to compare the different approaches to determining the corrected and uncorrected QT values were appropriate and valid. The author's concluding opinion is supported by their results, but more robust data including comparison with athletes known to have LQTS is required in order to compare the sensitivities and specificities of each screening approach.

Practice Pearl: Continued use of the Seattle Criteria is prudent as it remains the clinical standard for sports physicians in cardiac risk stratification. However, acknowledging its' limitations in underestimating QT prolongation in athletes with low HR ranges is important. In these circumstances, sports physicians shoulder consider following the recommendations by Pickham at el. in addition to the Seattle Criteria to identify athletes that would not otherwise be referred for further cardiac evaluation.

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The Refined Criteria as a Specific and Sensitive Screening Criteria for Cardiac Abnormalities in Black, Arabic, and Caucasian Athletes

Luci Olewinski[a,b,e], David Bernhardt[a,c], Hank Pelto[a,d]

Level of Evidence: Cross-sectional observational study

Introduction: As sudden cardiac death is a leading cause of non-accidental death in athletes, screening with the PPE, ECG, and/or echocardiogram has been explored as a method to identify individuals with conditions associated with sudden cardiac arrest. These methods have variable sensitivity, specificity, and costs. The initial criteria for ECG interpretation in athletes presented by the European Society of Cardiology (ESC) in 2010 resulted in a reduced number of abnormal ECGs compared with traditional ECG interpretation, however, false positive rates were still high, particularly among the Black athletes, leading to further testing (echocardiograms, stress testing, 24 hour Holter monitor) to rule out structural or electrical abnormalities. The Seattle Criteria, published in 2012, further reduced the number of false positives, and the Refined Criteria (2014), which took elements from the ESC recommendations and the Seattle Criteria, has an even lower false positive rate (1). The Refined Criteria considers isolated findings of left or right atrial enlargement, left or right axis deviation, or right ventricular hypertrophy as normal, training-related ECG changes. Two or more of these findings do warrant further screening. These refinements were made with the goal of creating a screening process that is most cost effective with high sensitivity and specificity.

The initial study on the Refined Criteria looked at a population of Black and Caucasian athletes. Riding, et al (2) compared the ESC recommendations, the Seattle Criteria, and the Refined Criteria in a population of Black, Arabic, and Caucasian athletes to further validate the Refined Criteria as a screening tool.

Methods: 2491 male athletes (ages 16-29; 30% Black, 55% Arabic, 15% Caucasian) underwent pre-participation physicals with a history, physical exam and ECG for all athletes, and an echocardiogram for the 1718 athletes whose club required it. All ECGs were reviewed for potential abnormalities using the ESC recommendations, the Seattle Criteria, and the Refined Criteria. In the subset of athletes who had requisite echocardiograms, the ECG results were compared with echocardiogram findings to determine the sensitivity and specificity of the three criteria.

Results: Of the total 2491 athletes screened, the Refined Criteria had the lowest percentage of abnormal ECG results (5.3%), followed by the Seattle Criteria (11.6%) and ESC recommendations (22.3%). These trends held true when the athletes were separated into Black (10%/16.6%/29.9%), Arabic (3.6%/9.7%/19.1%), and Caucasian (2.1%/8.5%/18.6%) cohorts. In all three criteria, Black athletes had the highest rate of abnormal ECG's, followed by Arabic athletes and Caucasian athletes.

In the 1718 athletes who had routine echocardiograms, all three criteria had 100% sensitivity for the seven cases of HCM and three cases of WPW found, but the Refined Criteria had a specificity of 94% as compared to the Seattle Criteria (87.5%) and the ESC recommendations (76.6%).

Strengths: The population of athletes studied with the Refined Criteria was expanded to include Arabic athletes in addition to Black and Caucasian athletes. With a large sample size, it further validates the Refined Criteria as a tool for interpreting EKGs.

Weaknesses: This study compared rates of positive findings with the three screening criteria in all 2491 athletes, but only assessed sensitivity and specificity in the 1718 athletes who were required to have echocardiograms as standard screening. The further workup of the athletes whose clubs did not require echocardiograms was not discussed.

The participants were elite international athletes, and different results may be found in screening younger athletes at earlier points in their careers. The study also did not follow the patient population over time to determine a false negative rate for the different ECG criteria.

This population was entirely male, and the results may not correlate to screening of women.

Conclusion: The Refined Criteria were developed to improve the specificity of ECG screening for cardiac abnormalities in athletes. This study affirms that the Refined Criteria achieves that goal without reducing sensitivity in Black, Arabic, and Caucasian elite male athletes.

Practice Pearl: In this study, the Refined Criteria were able to capture all cases of cardiac abnormalities associated with SCD while drastically lowering the false positive rate as compared to the ESC and Seattle criteria. For practitioners who include or are considering ECGs as part of their pre-participation screening, using the Refined Criteria could make ECGs a more cost effective measure with more specificity than the ESC or Seattle Criteria.

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Performance of ECG Versus History and Physical Exam as a Screening Tool for Serious Morbidity or Sudden Cardiac Death (SCD) in NCAA Athletes

Stephen Shaheen[a,b,d], Aaron V. Mares[a,c]

Level of Evidence: Level II (Prospective Cohort)

Introduction: This prospective multi-center trial was designed to compare ECG to traditional history and physical as a means to identify athletes with serious heart conditions. Pre-participation cardiac screening exams vary by physician and practice because of controversy surrounding the best method to effectively complete this goal.

Methods: Over two years (August 2012 – June 2014), 5,258 student-athletes at the NCAA level participated in the study permitted they were 18 or older, had no prior ECG screening, and were without previously diagnosed cardiovascular pathology. 35 schools participated: 13 in study year 1 (Division I) and 25 in year 2 (13 Division I, 12 Division II/III); study expansion was planned to include increased variety with regard to resources and facilities. Standard physical exam was defined as a brachial artery blood pressure, cardiac auscultation, and evaluation for physical findings associated with Marfan Syndrome.

[a]Stephen Shaheen, MD and Aaron V. Mares, MD reviewing Drezner et al. Electrocardiographic Screening in National Collegiate Athletic Association Athletes. Am J Cardiol 2016; Published online before print June 14, 2016.

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The American Heart Association (AHA) 12 point questionnaire was used for historical assessment. ECG machines were standardized; all tracings were electronically submitted to the University of Washington for interpretation by Cardiologists with training in athlete specific pathology. After identification of abnormality, secondary treatment plans were led by the athlete's home institution; the University of Washington made themselves available for consultation if requested.

Results: The 5,258 participants were evenly distributed across each year of the study (Year 1: 2,465, Year 2: 2,793) and well-represented well the overall NCAA population of athletes: 55% men with an average age of 20.1 years. Race, self-reported, was 73% Caucasian, 16% African-American, 4.7% Hispanic, and 2.9% Asian-American.

1,750 athletes reported at least one positive answer for the AHA 12-point assessment with a slightly higher rate (36.9% to 30.3%) in females as compared to males. The most common response across both groups regarded "excessive shortness of breath or fatigue with exercise." 108 physical exams were reported as positive; 88 of these fell into the category of previously unknown cardiac murmur. 283 blood pressures were either > 140 systolic and/or >90 diastolic. 192 athletes had ECG abnormalities, most commonly Q waves (36.4%), T-wave inversions (19.2%), and left axis deviation (12.6%). Male basketball players had a significantly higher rate of ECG findings as compared to their male athletic peers and female basketball players. After secondary studies, 13 (0.25%) were found to have serious cardiac disease, including 1 with hypertrophic cardiomyopathy. All 13 athletes had an abnormal ECG; 2 had an abnormal history and just 1, an abnormal physical exam.

After analysis, ECG showed significantly improved rates of sensitivity, specificity, and positive predictive value (100%/96.6%/6.8%) than history (15.4%/66.9%/0.1%) and physical exam (7.7%/98.2%/0.9%). The false-positive rate for the questionnaire was 33.3%; both ECG and physical exam were below 5%.

Of note, 8 of the 13 athletes identified with serious cardiac disease were upperclassmen, previously screened in pre-participation physicals.

Strengths: Because of a strong methodology, a large number of participants was achieved that closely represented the NCAA student-athlete cohort as a whole. All ECGs were recorded on the same machine and over-read by the same group of cardiologists.

Weaknesses: Although well built, the study had several weaknesses. First, physical exam skills vary by physical to physician. Secondary evaluation and testing was left up to the host institution, meaning that individual cases may have been treated differently and even resulted in missed diagnoses. Each university or college may have different access to resources or finances by which to pursue diagnosis. Although athlete-experienced cardiologists were used, there is no formal training for these interpretations.

Conclusion: This was a well-constructed study that highlighted several important findings with relation to athlete cardiac screening exams. First, physical exam varies by staff and remains extremely unreliable. Next, the AHA questionnaire (since updated to 14 questions) is extremely vague and low-yield. Finally, while not appropriate for every athlete, ECG is an extremely valuable tool that shows extremely strong biostatistics when used in conjunction with the aforementioned modalities.

Practice Pearl: Every athlete must be considered on a case-by-case basis, but this study seems to indicate significant potential for identification of serious cardiac disease by ECG.

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(1) Drezner et al. Electrocardiographic Screening in National Collegiate Athletic Association Athletes. Am J Cardiol 2016 Sep 1;118(5):754-9. Epub 2016 Jun 14.

Costs of ECG Screening in Athletes

Victoria Kang[a,b,d], Hank Pelto[a,c]

Level of Evidence: Level II (Prospective Cohort Study)

Introduction: This prospective cohort study, level 2, compared the costs of cardiovascular screening (using history, physical exam and ECG) and subsequent evaluation of abnormal screens. Furthermore, the costs of initial screening and secondary investigation were stratified by interpretation of ECG using the 2010 European Society of Cardiology (ESC) recommendations, Seattle, and refined criteria.

Methods: 4,925 unscreened athletes age 14 to 35 (average age 19.9 ±5 years) were evaluated with health questionnaire, physical examination, and ECG as interpreted using 2010 ESC criteria, between 2011 and 2014 in the United Kingdom. Indications for secondary investigation were determined by the attending cardiologists present at the screening. The cost of secondary investigations were calculated on the basis of the 2014/2015 U.K. National Health Service tariff payment system. Cost between ECG criteria were compared using paired rank sum testing with significance of $p < 0.05$.

Results: The health questionnaire was abnormal in 61 athletes (1.2%), of which, 43 reported symptoms consistent with cardiac disease, the remainder with a family history with significant cardiac disease. A total of 1,072 (21.8%) athletes exhibited ≥ 1 ECG abnormalities according to the 2010 ESC criteria; 295 (6.4%) athletes had an abnormal ECG based on the Seattle criteria, compared with 210 (4.3%) with the refined criteria.

581 (11.8%) of the 4,925 athletes underwent secondary investigation after the primary screening. The lower number of secondary evaluations was due to the cardiologist's clinical practice of not investigating asymptomatic athletes with isolated long QT (<470ms in males and <480ms in females) or short QT (320ms-380ms) interval. In contrast, application of Seattle criteria would result in 374 (7.6%) and 289 (5.9%) athletes requiring further investigation. This represents a 35% and 50% reduction, respectively. Fifteen (0.3%) athletes were diagnosed with cardiac disease implicated in sudden cardiac death. These 15 athletes had a normal history and physical exam and were identified via abnormal ECG (based on all 3 criteria used in this study).

The initial screening tests (history, physical exam, and ECG) cost $261,025 for the 4,925 athletes screened, or $53 per athlete. The overall cost for the entire cohort of unscreened athletes was $539,888, $110 per athlete, and $35,993 for each serious cardiovascular diagnosis, when including secondary investigation following 2010 ESC criteria. Using Seattle and refined criteria reduce the overall cost to $92 and $87 per athlete screened, $30,251 and $28,510 per serious diagnosis, respectively.

Strengths: This study featured a large sample size of 4,925 previously unscreened athletes and effectively analyzed the costs of cardiovascular screening, including ECG, per athlete and per serious diagnosis identified, using the 2010 ESC recommendations, Seattle Criteria, and refined Criteria.

Weaknesses: This study utilized cost analysis based on United Kingdom National Health Services Tariffs, and therefore, the costs could vary from other heath care systems in other countries. Secondary investigations were at the discretion of attending cardiologists and therefore subject to personal clinical practice.

Conclusion: Contemporary ECG interpretation, such as Seattle and refined criteria, decrease costs for de novo screening of athletes (16% and 21%, respectively), without compromising sensitivity to detect serious cardiac disease.

Practice Pearl: Using contemporary criteria for ECG interpretation during cardiovascular screening in athletes reduced overall cost of screening. These savings may further justify additional costs of noninvasive risk stratification tests for athletes who require further work up. Based on the results of this study, clinicians should consider using refined Criteria instead of 2010 ESC Recommendations for ECG screening in athletes, in order to reduce rate of false-positive ECG findings that trigger unnecessary additional tests and their associated costs.

References:

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[a]Victoria Kang, DO and Hank Pelto, MD reviewing Dhutia et al. Cost implications of using different ECG criteria for screening young athletes in the United Kingdom. J Am Coll Cardiol 2016;68:702-11.
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ECG Comparability in High School Athletes to Adolescents with Known HCM

Vicki R. Nelson[a,b,d], Aaron V. Mares[a,c]

Level of Evidence: Level II (Cohort Study)

Introduction: In the US, electrocardiogram (ECG) screening to identify high-risk cardiac pathology has been debated, often due to overlapping changes seen with physiologic adaptations for well-conditioned athletes. This cohort study (level 2 evidence) used athlete-specific ECG interpretation criteria to compare ECG changes in elite high school athletes from adolescents with known hypertrophic cardiomyopathy (HCM) to determine findings most associated with cardiac pathology.

Methods: 147 elite student athletes (average age 16.0±1.3 years) with echocardiographically normal hearts and 148 adolescents diagnosed with HCM (16.1±1.8 years) were included in this study. Student athletes underwent cardiac screening including focused physical examination and15-lead ECG. All student athletes were reported to have a normaltransthoracic echocardiogram. Findings were then stratified according to the Seattle Criteria and 2010 European Society of Cardiology (ESC) guidelines for ECG interpretation in athletes.

Results: On ECG screening, 52% of student athletes met hypertrophy criteria. Male athletes more commonly met hypertrophy criteria (78%) compared to females (15%, p<0.0001). 85% of patients with HCM met standard ECG criteria for hypertrophy, with males again meeting criteria more commonly than females (90% vs 73% respectively, p=0.01). The most useful ECG findings for delineating HCM from healthy student athletes were T-wave inversion (62% vs 1%, p<0.0001) ST-segment depression (30% vs 0%, p<0.0001), and Q-wave pathology (21% vs 0%, p<0.0001). Individuals with HCM also had significantly higher rates of left axis deviation, right axis deviation, prolonged QT and pre-excitation compared to student athletes. ECG findings for patients with HCM were more likely to be identified as abnormal using both ESC guidelines (89% vs 24% of student athletes) and Seattle Criteria (84% vs 1%). However, false negative rates were greater than 10% using either guideline with 3% of adolescents with HCM having normal ECGs. Sensitivity was comparable between Seattle criteria and ESC guidelines and (84% vs 88%, respectively) with Seattle criteria providing a higher specificity (99% vs 76%).

Strengths: This study provided the opportunity for blinded interpretation of ECG abnormalities in a cohort of HCM patients in comparison to a geographically and ethnically similar healthy athlete cohort. While the number of athletes is relatively low in comparison to other studies, prior US studies have not focused on cohorts with known pathology or echocardiographically confirmed results making estimation of false negative rates difficult.

Weaknesses: In contrast with previously published estimates which identify false negative rates of 0% with either ESC or Seattle Criteria, a high false negative rate (10-15%) was seen among adolescents diagnosed with HCM employing either guideline. The utilization of non-athlete adolescents with HCM is in contrast to prior studies and may underlie to the false negative rate. If athletic training accentuates the electrophysiologic abnormalities of HCM, the false negative rate may be much lower among athletes making this less of a concern for screening. The false negative rate is consistent with that reported in other non-athlete HCM cohorts. The included student athlete and HCM cohorts are also predominantly Caucasian (90 and 93%, respectively), potentially limiting the generalizability of these finding to more ethnically diverse populations.

Conclusion: False positive rates for ECG screening in high school athletes are lower using the Seattle Criteria compared to the 2010 ESC guidelines. This dramatically reduces the number of athletes needing further investigation from 1 in 4 to 1 in 74. Nevertheless, both the Seattle Criteria and ESC criteria had a false-negative rate greater than 10% for adolescents with HCM. Compared to healthy athletes, HCM patients are more likely to exhibit ST depression, T wave inversion, and Q waves and athletes with these findings necessitating further evaluation.

Practice Pearl: ECG screening programs should employ the use of published criteria for ECG interpretation in athletes to guide identification of pathologic abnormalities. Voltage criteria alone is not a good marker of distinguishing normal physiologic adaptation from changes associated with cardiac pathology. The presence of ST-segment depression, T wave inversion, or pathologic Q waves in any patient requires further evaluation for underlying cardiomyopathy.

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Cardiac Controversy in the PPE

Amy Singer[a,b,d], Hank Pelto[a,c]

Level of Evidence: Level II (Prospective Cohort)

Introduction: This small scale prospective study assessed the feasibility of incorporating limited screening portable echocardiography into the routine PPE. Cost effectiveness and time efficiency were evaluated in conjunction with production of reliable and accurate diagnostic information with the hope for the improved detection of cardiac abnormalities that might lead to sudden cardiac death.

Methods: Informed consent for this prospective study was acquired from thirty five Division I male athletes on the day of their PPEs. Each athlete completed screening with a routine AHA recommended twelve question history and focused cardiac exam, an ECG interpreted using the Seattle criteria (2013), and a limited portable echocardiogram performed by a frontline physician (PEFP) obtained in the parasternal long axis view with standard measurements assessed. Time for each screening station was assessed and compared using the Bonferroni correction with priori alpha level set at 0.05. The athletes with positive findings on any part of the screening PPE were then followed to assess whether the screening modalities were timely, cost effective, and capable of detecting cardiac abnormalities associated with increased risk of sudden cardiac arrest.

Results: Overall, PEFP was proven to be significantly more time efficient than screening H&P or ECG alone ($P < 0.01$) whereas virtually no difference from a time standpoint was found between H&P and ECG ($P = 0.999$). Of the 35 athletes tested using the three modalities, 25 had negative PPEs. Based on the AHA criteria, six athletes had positive findings on H&P and required no further work up after review by the screening physician. Three athletes with positive ECG findings were referred to cardiology (of these three athletes only one had a positive H&P as well). The athlete with positive H&P and positive ECG had a normal PEFP and was cleared for sports participation after Cardiology consultation. Additionally, of the other two athletes with positive ECG findings (both with LAD on ECG and normal PEFP), one was evaluated by cardiology and cleared without formal ECHO and the second was unable to get a formal ECHO due to insurance and on second review of ECG by cardiologist was found to have a left anterior fascicular block and cleared for participation. One athlete with borderline wall thickness on PEFP and ECG findings suggestive of RVH was evaluated and found to have a small patent foramen ovale on formal ECHO but cleared for sport participation. Another athlete with negative H&P and ECG but borderline PEFP findings was referred to cardiology and on formal ECHO was shown to have borderline left ventricle dilatation and cleared for participation with annual follow up.

Strengths: Both primary outcomes in terms of time efficiency and secondary outcomes in terms of evaluation of athletes with positive results on any of the three screening modalities were assessed. Limited staffing was utilized to optimize consistency of the PPE elements performed. The parasternal long axis view and standard cardiac anatomy measurements were used to optimize the power of the limited PEFP. Additionally, standardization for how time was kept across measuring each of the three components of the screening exam was made and corrected for. The authors did acknowledge that the use of the Seattle Criteria has assisted with decreasing the number of false positive and false negative ECG reports and also noted that no single method of screening (H&P vs ECG vs ECHO) has been shown to be perfect for screening as the leading cause of SCD at autopsy is still autopsy negative sudden unexplained death.

Weaknesses: A limited number of athletes were studied and the demographic groups at highest risk for SCD (particularly male African American basketball players) were not involved in the study. Including the higher risk groups is pivotal to assessing the validity of this study in detecting those at risk for SCD. Also noting factors such as age, race, and sport specific information would be helpful to better identify those at greater risk of suffering cardiac arrest. Another concern is the proficiency of the provider completing the PEFP; limited training (e.g. one weekend course) may not be sufficient to accurately evaluate for cardiac pathology. Even with a highly proficient ultrasound user some structural heart disease may not be easily detected via Echo, specifically apical variant HCM, and for such cases cardiac MRI is considered the gold standard the article focuses primarily on time and the fact that completing a PEFP is much more efficient than going through an H&P. While time is increasingly recognized as an important factor in the cost of delivering healthcare, it is not the only component (training costs, downstream evaluation of abnormal screens, purchasing ultrasound equipment). These factors were not evaluated in the current study. The focus on single elements rather than the screening process as a whole may be misguided as in many situations it takes more than just one stand-alone piece of data to determine if further work up is needed.

Additionally, PEFP does not adequately assess for primary electrical diseases that may be associated with sudden cardiac arrest/death such as long QT, Wolf Parkinson White, or Brugada syndromes. Along with HCM, these are typically among the most common identified diseases in prospective studies looking at sudden cardiac arrest in athletes.

Conclusion: Although PEFP is a potential screening tool for conditions associated with sudden cardiac death, particularly from a time utilization perspective, it does not appear to sufficient as a stand-alone test. This study was limited in scope based on the number

[a]Amy Singer, DO, and Hank Pelto, MD, reviewing Gleason et al. Early Screening for Cardiovascular Abnormalities with Preparticipation Echocardiography: Feasibility Study. Clin J Sports Med 2016. Submitted for publication January 26, 2016; accepted June 28, 2016
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of subjects and the patient population evaluated. It did not study the populations at highest risk of sudden cardiac arrest. Cost effectiveness and time efficiency are important, as not only the physician's time and availability can be limited but also the athlete's times (i.e. holding an athlete out of practice/play into work up can be completed). Based on this and other studies, it does not that appear that one individual method, including PEFP is adequate to screen for conditions associated with SCD particularly given the leading cause of SCD at autopsy is still autopsy negative sudden unexplained death (SUD).

Practice Pearl: The goal of this study was to evaluate the ability of limited cardiac echocardiography to improve our current PPE system for diagnosis of potentially lethal cardiovascular diseases and prevention of SCD. This study evaluated this primarily from a time efficiency and cost effectiveness standpoint. Including a PEFP in the PPE may be effective from a time and resource distribution standpoint, but further studies in the higher risk population of athletes are required. Formal ECHO and potentially cardiac MRI are still considered the "gold standard" for detecting structural cardiac abnormalities predisposing young competitive athletes to SCD.

References:

(1) Gleason et al. Early Screening for Cardiovascular Abnormalities with Preparticipation Echocardiography: Feasibility Study. Clin J Sports Med 2016. Submitted for publication January 26, 2016; accepted June 28, 2016.