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Original research

Assessing the utility of yearly pre-season laboratory screening for athletes on a major professional sports team

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ABSTRACT

Objectives: Professional athletes undergo annual pre-season laboratory screening, although clinical evidence supporting the practice is limited and no uniform set of guidelines on pre-season laboratory screening exists. The aim of this study was to assess the clinical value of annual pre-season laboratory screening tests for a major professional sports team over multiple years.
Design: Retrospective chart review.
Methods: A retrospective analysis was performed of all laboratory results as well as screening ECGs for a single major professional sports team over a 9-year timeframe (2009–2017).
Results: The data show that 10.01% of initial screening test results were abnormal and 40.32% of abnormal tests resulted in additional testing. Overall, only 0.35% of initial tests resulted in a clinically significant outcome. Non-US born players showed a significantly higher average rate of abnormal tests/year compared to US-born players (p-value 0.006), but there was no difference in clinically significant outcomes. There was no relationship between athlete age and laboratory screening outcomes.
Conclusions: In our study population, yearly pre-season laboratory screening of professional athletes did not yield substantial clinically significant outcomes and would not be warranted under normal clinical standards. Future best practice guidelines should combine research concerning effects of family medical history, race, gender, country of origin, and type of sport on athlete health when creating recommendations for which pre-season laboratory screenings may be pertinent even with evidence of little utility.

Practical implications

- Yearly pre-season laboratory screening of professional athletes in this study population did not yield substantial clinically significant outcomes.
- MMR and Varicella titers represented the majority of clinically significant outcomes.
- Non-US born players showed a significantly higher average rate of abnormal tests/year compared to US-born players, but no difference in clinically significant outcomes.
- Athlete age did not contribute to laboratory screening outcomes.

1. Introduction

Most major professional sports teams undergo yearly pre-season laboratory screening tests as part of their preparticipation physicals, which also include collecting personal and family history, completing a physical exam, and potentially undergoing cardiovascular screening. Research suggests that in asymptomatic, young adult athletes, yearly screening laboratory work should not be performed and such tests are an unnecessary cost driver.[1–3] At the collegiate level, laboratory tests are not recommended in yearly pre-participation physical examinations for athletes, based on lack of evidence that they are cost effective diagnostic tools.[2,3] Furthermore, screening electrocardiography and blood and urine testing in asymptomatic patients is discouraged by U.S. medical and athletic organizations.[4]

In the healthcare transition from a fee-for-service model to a value-based care reimbursement model, the implementation of quality metrics and best practice guidelines have been significant in transforming the quality of care. Best practices, also known as clini-

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cal practice guidelines, are defined by the Institute of Medicine to be systematically developed statements which assist practitioner and patient decisions about appropriate health care for specific clinical circumstances. At the moment, there is no best practice guideline for elite level preparticipation physicals. In the United States, there is heterogeneity between professional sports leagues and between individual teams when it comes to laboratory screening tests used during pre-season physicals. Of the major professional sports in North America, only the National Football League has guidelines as part of the collective bargaining agreement. These guidelines require every athlete to undergo yearly laboratory blood and urine tests.[5] Three other professional leagues (National Basketball Association, National Hockey League and Major League Baseball) do not have any recommendations on which pre-season laboratory screening tests should be performed.[6–8]

To our knowledge, there is no data published on the subject of which tests each professional team performs; anecdotal evidence suggests that most teams perform extensive laboratory testing. This is time consuming for team medical staff and has a low yield in detecting clinically significant medical conditions. Extensive testing is likely driven by well-intentioned team executives and players associations who may believe that more testing will lead to a higher likelihood of keeping players healthy. Although there is significant discussion and debate regarding cardiovascular screening with electrocardiograms,[9,10] there is very little published on the value of screening laboratory tests. The financial cost of doing extensive pre-season laboratory screening tests is substantial, but it is unlikely to deter major professional teams. The development of a best practice guideline would streamline the preparticipation evaluation and provide more consistent care for the elite athletes.

Professional Sports teams are comprised of players of different ethnicities and ages. This analysis was designed to determine if there were differences in the number of abnormal screening tests and clinically significant outcomes inherent to the athletes' ages or country of origin, especially in light of the potential differences in health care received in different countries. The purpose of this study was to assess the value of pre-season screening laboratory tests performed by a professional sports team by analyzing all available data for one major professional sports team over an extended period of time.

2. Methods

A retrospective analysis of all laboratory work, as well as screening ECGs, was performed for a 9-year timeframe (2009–2017) as part of pre-season physicals for a major professional sports team. Laboratory results for all players who underwent screening tests as part of a preparticipation physical were accessed through the professional sports team's medical database (Athlete RMS). Some players played multiple years, and therefore had multiple screening records. Initial screening tests differed by year, as the team physicians added or removed different tests from the panel. For the year 2009, the testing panel consisted of complete blood count (CBC), complete metabolic panel (CMP), lipid panel, thyroid-stimulating hormone (TSH), urinalysis (UA), rapid plasma reagin (RPR), iron, purified protein derivative (PPD, tuberculosis skin test), and electrocardiogram (ECG). In 2010–2014, RPR was removed from the screening panel. In 2015–2017, MMR and Varicella titers were added and TSH and iron were removed from the screening panel. Each year, PPD was only ordered for players originating from Latin America or players who spent time in Latin America. Abnormal results were defined as values outside of laboratory normal ranges, with the exception of CBC differential values.

All analyses were performed with SPSS, Version 24. Descriptive statistics were performed for initial tests ordered, abnormal tests, additional tests ordered (ATO), and clinically significant outcomes (CSOs). Abnormal tests, ATO and CSOs were averaged over years tested for US-born players and non-US born players. The average yearly occurrence of abnormal tests, ATO, and CSO for all US-born players and non-US born players were compared using an independent samples t-test, paired with Levene's Test for Equality of Variances. T-test analysis was also performed to compare screening results between individual countries of origin. A linear regression analysis was performed to determine whether athlete age was related to the number of abnormal tests, additional tests ordered or clinically significant outcomes. A p-value of <0.05 was considered statistically significant.

3. Results

Lab results over a nine-year period were analyzed for 142 individual players, totaling 336 screening records. A total of 3148 initial tests were ordered, resulting in 315 abnormal tests (10.01%) (Table 1). Of those abnormal tests, 40.32% resulted in additional testing (127 tests). All players were male between the ages 19–38, with a median age of 27.

The most common abnormal lab tests were lipid profile, liver function, ECG, and CBC (Table 1). Abnormal test results resulted in additional tests ordered per the physician's discretion, with the exception of abnormal MMR and Varicella titers, which did not result in additional tests ordered. Out of 3148 initial tests ordered, 11 resulted in a clinically significant outcome (0.35%). The abnormal tests most likely to yield a clinically significant outcome were MMR (4) and Varicella (2) titers (Table 1). One CSO originated from an abnormal ECG finding that led to an echocardiogram and the discovery of, a mild aortic root dilation. The remaining four clinically significant outcomes were elevated triglycerides and LDL cholesterol. They were deemed by the team physician to not warrant statin therapy and instead resulted in dietary counseling and, for two of the cases, fish oil supplementation.

The majority of players (94 of 142) originated from the United States, followed by the Dominican Republic (18), Venezuela (12), and Cuba (5). The remaining countries had two or fewer players, and consisted of Brazil, Columbia, Canada, Australia, Japan, Mexico, Nicaragua, and Panama. Non-US born players collectively had significantly higher average abnormal test results per year compared to that of combined US born players (1.19 vs 0.83; T-test p-value 0.006). Next, we compared the average number of abnormal tests per year between individual countries of origin. Dominican-born players had a significantly higher number of abnormal tests per year compared to US-born players (1.29; T-test p-value 0.016), but there were no statistically significant differences found between the US and Cuba (1.23; T-test 0.206) or Venezuela (1.12; T-test 0.176) (Fig. 1). No other countries had a large enough sample size to be tested.

Non-US born players did not have a significantly different average number of additional tests ordered per year compared to that of combined US born players (0.45 vs 0.32; T-test p-value 0.141). Next, we compared the average number of additional tests ordered per year between individual countries of origin. Dominican-born players had a significantly higher number of abnormal tests per year compared to US-born players (0.58; T-test p-value 0.051), but there were no statistically significant differences found between the US and Cuba (0.5; T-test 0.4) or Venezuela (0.45; T-test 0.33) (Fig. 1).

There was no significant difference in clinically significant outcomes (CSOs) between US-born players and players from other countries (0.043 vs 0.038; T-test 0.872). Likewise, no significant difference was found when comparing CSOs between the US and

Table 1
Pre-season laboratory screening tests and results.

Initial test	Normal results, n (%)	Abnormal results, n (%)	Total initial tests	Additional tests ordered	Clinically significant outcomes
RPR	19 (100)	0	19	0	0
Sickle cell	2 (100)	0	2	0	0
Blood pressure	336 (100)	0	336	0	0
Electrolytes	335 (99.7)	1 (0.3)	336	0	0
TSH	215 (98.2)	4 (1.8)	219	2	0
Urinalysis	246 (96.5)	9 (3.5)	255	8	0
MMR titer	52 (92.9)	4 (7.1)	56	0[a]	4
Varicella	26 (92.9)	2 (7.1)	28	0[a]	2
Tuberculosis (PPD)	72 (90.0)	8 (10.0)	80	6	0
CBC	299 (89.3)	36 (10.7)	335	7	0
Renal	299 (88.9)	37 (11.1)	336	8	0
Iron studies	190 (88.8)	24 (11.2)	214	16	0
ECG	292 (87.7)	41 (12.3)	333	46	1
Liver function tests	266 (79.2)	70 (20.8)	336	29	0
Lipid profile	184 (69.9)	79 (30.1)	263	5	4
Total	2833 (90.0)	315 (10.0)	3148	127	11

TSH, thyroid-stimulating hormone; PPD, purified protein derivative; CBC, complete blood count; A1C, glycated hemoglobin; RPR, rapid plasma reagin; MMR, measles, mumps, and rubella; ECG, electrocardiogram.
[a] Abnormal MMR and Varicella titers did not require additional tests ordered.

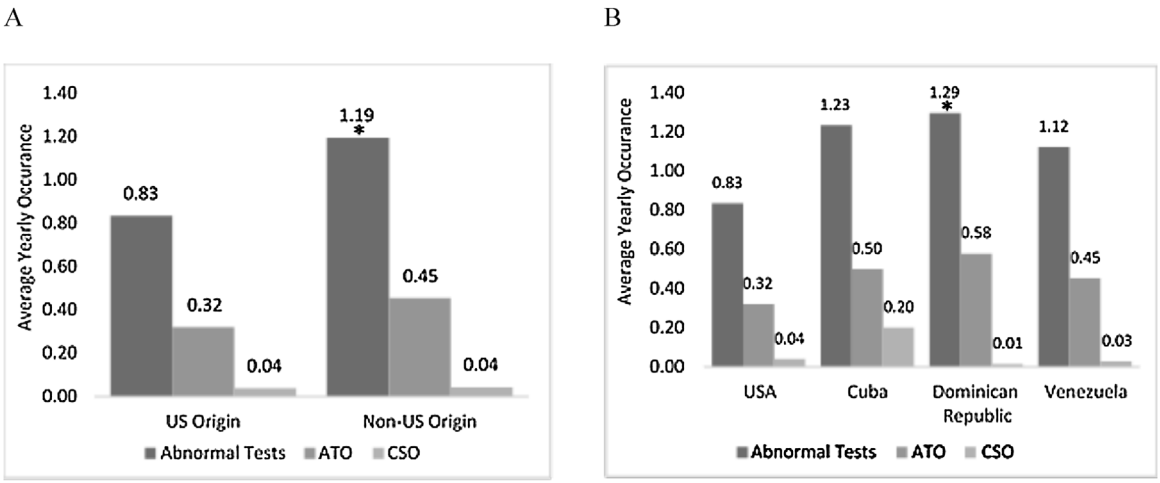

Fig. 1. Average abnormal tests, additional tests ordered and clinically significant outcomes per year for all US-born and non-US born players (A) and by individual countries of origin (B). ATO, additional tests ordered; CSO, clinically significant outcomes. * denotes statistical significance.

individual countries of origin, Dominican Republic (0.014; T-test 0.545), Cuba (0.20, T-test 0.466) or Venezuela (0.038; T-test 0.830).

The mean age of the players was 27.04 years with a range of 19–42 years (Std. Dev. 3.713). No association was found between age and abnormal test results or CSOs, based on a linear regression analysis (data not shown).

4. Discussion

Although most professional sports teams undergo extensive pre-season laboratory screening tests, our study suggests this practice does not yield substantial clinically significant outcomes and may not be warranted. In this study, non-US born players showed a higher rate of abnormal tests, but no difference in clinically significant outcomes. The difference in the rate of abnormal tests could be due to the small sample size, different diets, or different normal ranges in different ethnic groups. Athlete demographics may determine appropriate laboratory test requirements.

Abnormal MMR and Varicella titers accounted for 55% of CSOs in this study. These data suggest that screening titers to determine immunization status may be justified. Furthermore, measles outbreaks[11] and low immunity levels to vaccine-preventable diseases in major league sports athletes have been an issue in recent years.[12]

Regulatory guidelines for pre-season laboratory testing could help define which tests are recommended for subsets of athletes, based on scientific data. For example, studies suggest female athletes and male endurance athletes should be screened for ferritin and hemoglobin levels,[13–15] and obese athletes in power sports, such as football linemen, may require cholesterol screening.[16]

Yearly cardiovascular screening of elite athletes by ECG remains a subject of debate.[2,17] Screening has the potential to prevent sudden cardiac death in elite athletes, which is a rare but important medical concern associated with competitive sports. However, cardiologists and researchers debate the efficacy of yearly cardiovascular screening and report an abundance of false positive ECG results due to the cardiac structural changes associated with intensive athletic training.[18–20] While the risk of sudden cardiac death appears to be independent of level of athlete,[19] a study in college level athletes showed that certain groups were at higher risk, including males, black athletes, and basketball palyers.[21] Future guidelines should acknowledge this increased risk and provide recommendations accordingly. In addition, Sickle cell disease is a cause of non-cardiovascular sudden death in athletes.[22] The National Col-

legiate Athletic Association (NCAA) has mandated sickle cell trait screening in all student athletes since 2013.[23]

The financial cost of laboratory screening is significant, but it is unlikely to be a deterrent for major professional sports teams who have large budgets and a willingness to invest large sums of money in athlete health in order to minimize time lost due to injury or illness. To these organizations, the cost of performing laboratory testing is not greater than the benefit of maintaining athlete health, and therefore a competitive edge with other teams. It can be argued that screening tests have a low risk of side effects, but they result in repeat testing and extensive workups. This can cause anxiety to the affected athlete. Furthermore, two studies of laboratory testing of elite athletes reported a high rate of false positives.[1,24] Managing the lab results and the subsequent work ups are also time-consuming for team physicians.

Lack of consistency across sports teams in regard to laboratory testing creates a potential legal liability for the physician and the team. In the United States, there is no law regarding the "mass preparticipation screening of competitive athletes".[19] The few lawsuits that allege negligent preparticipation screening of athletes were settled out of court, providing no precedent for future cases.[25] Due to the lack of best practice guidelines and legal requirements, testing relies on the discretion of the physician. The best way to minimize the potential for a negligence suit is to perform all the possible necessary tests. The creation of a best practice guideline would provide team physicians with a set standard of care, which would define future litigation.

Limitations of this study include a small sample size, which consists of one major sports team and only male subjects. In addition, our analysis on country of origin and screening outcomes was limited to twelve countries, predominately Latin American. Although the findings of this paper suggest that there is limited utility in preparticipation laboratory screenings, these findings are not generalizable to all professional athletes due to the limitations mentioned above. Future studies could expand this analysis to all genders and teams across different sports, as well as provide a more thorough investigation into countries of origin and screening outcomes. Furthermore, an investigation into the utility of yearly pre-participation laboratory screening at the collegiate level, where budgetary constraints are more prevalent, would be informative. More research on this topic could contribute to the goal of creating a uniform set of guidelines on pre-season laboratory screening for professional athletes in each sport, based on factors such as intensity, duration of play, and individual athlete risk factors.

5. Conclusion

In our study population, yearly pre-season laboratory screening of professional athletes did not yield substantial clinically significant outcomes and would not be warranted under normal clinical standards. This study contributes to the evidence that extensive, yearly pre-season laboratory screening of professional athletes has limited clinical utility. Future best practice guidelines should combine research concerning effects of family medical history, race, gender, country of origin, and type of sport on athlete health when creating recommendations for which pre-season laboratory screenings may be pertinent even with evidence of little utility.

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