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# Don't Strike Out Too Early in the Game: The Nurse Practitioner's Role in Preventing Youth Pitching Related Injuries

## Introduction

More than 775,000 children, ages 14 and younger, are treated in hospital emergency rooms for sports-related injuries each year. Nearly 110,000 children ages 5-14 are treated for baseball related injuries (Johns Hopkins Medicine, 2013). According to the Little League International, baseball injuries affect up to 18% (1 out of 5) of players annually. Pitchers appear to be at higher risk for musculoskeletal injury than any other position on the field; these types of injuries can have lasting effects on the player's ability to play and the long-term normal function of their arm. This organization has worked diligently to promote safety among its players, yet maintaining the integrity of the sport. Using evidence-based research, Little League has placed restrictions on pitchers, mandating a precise number of pitches allowed per day followed by periods of rest. The organization makes continual efforts to review current research and make adjustments to the rules and regulations in their best attempt to protect the safety of its youth pitchers.

Studies have shown that improper technique, inadequate rest periods, and overuse increase the young pitchers vulnerability for shoulder and elbow injury (Parks & Ray, 2009). The most difficult injury suffered by pitchers is damage to the ulnar collateral ligament; this ligament is the main stabilizer of the elbow and is needed to adequately perform the fluid motion of pitching. The combination of elbow torque and elbow extension velocity can lead to impingement, once there is damage it is often difficult to restore and repair (Flesig & Andrews, 2012). Proximal humerus epiphysiolysis, or little league shoulder, is also a commonly seen overuse injury among youth pitchers, this occurs when there is damage to the growth plate. This condition is thought to be caused by constant traction and rotational torque to the epiphysis,

leading to micro-fractures. Localized pain during throwing is typically the presenting chief complaint (Osbahr, Kim, Dugas, 2010).

Despite the efforts made by Little League International, the medical community has a perception that shoulder and elbow injuries continue to escalate among youth baseball players. In the early 1990's Dr. James Andrews noticed a significant increase in the number of ulnar collateral ligament reconstruction surgeries he performed on youth baseball pitchers. From 1994-1998 he performed 116 surgeries, 9 of which were children. In the years 2004-2008 the number of surgeries had increased to 512 and 179 of those were performed on youth baseball pitchers. With the increase in pitching related injuries, there appears to be a deficit in identifying risk factors and providing preventative intervention to avoid these types of injuries (Flesig & Andrews, 2012).

The purpose of this literature review is to provide family nurse practitioners with information regarding the prevalence of pitching related injuries among the youth population and the associated risk factors to assist in the prevention of youth pitching related injuries.

## Theoretical Framework

Neuman's systems model is the framework used to direct this literature review. Nurse Practitioners should identify the three levels of prevention to aid in the care of children involved in baseball. Primary prevention would require the nurse practitioner to determine a child's potential for risk factors and provide education on the prevention of such risks. Secondary prevention would require effective screening of current risk factors and early treatment of current disease processes to avoid further progression into higher risk levels. Tertiary prevention would include treatment of morbidities resulting from injuries sustained while playing baseball and preventing complications of further progression of the injury (Alligood & Tomey, 2010).

While using Neuman's model the physiological structure and maturity of the pitchers should be understood so the nurse practitioner can recognize individualized risk factors for various age groups. The biomechanics and kinetics of the pitch must also be incorporated into the prevention and treatment plan. The education level of the parents and coaches will also need to be taken into consideration, for this will be weigh heavily on the outcome of the prevention and treatment strategies.

## Literature Review

During the conduction of this literature review, articles were chosen based on relevance to sports related injuries. The information was then narrowed down to baseball injuries occurring during childhood, or persons less than eighteen years old. The search included phrases, such as; pediatric sports injuries, youth baseball injuries, epidemiology of baseball injuries, prevention of pitching injuries, and pitching biomechanics. Articles that preceded the year 2000 were excluded from the review in efforts to preserve the accuracy of the information presented. Data was retrieved from CINHAL, PubMed, and Sage Premier Research databases.

### Epidemiology of Injury

Collins and Comstock (2008) set out to describe the epidemiology of baseball related injuries occurring among high baseball players by welcoming all United States high schools with an active board-certified national athletic trainer on staff to participate. One hundred high schools were randomly selected for the National High School Sports-Related Injury Surveillance Study. The study took place during the 2005-2006 school year and was repeated for the 2006-2007 school year. Athletic trainers from each participating school reported all baseball-related injuries weekly through the Reporting Information Online (RIO), which was modeled after the National Collegiate Athletic Association Injury Surveillance System. The study defined

reportable injuries as injuries that occurred as a result of an organized high school practice or competition, required medical attention, and resulted in player restrictions for greater than one day after injury. It was reported an estimate 131, 555 baseball related injuries occurred during the 2005-2006 and 2006-2007 school, this can be calculated to 1.26 injuries per 1000 athletic exposures. Pitchers were affected 20% of the time. Of these injuries, the shoulder was the most commonly injured site, and was reported in 17.6% of the cases. The most common diagnoses were ligament sprains (21%) and muscle strains (20.1).

Lawson (2009) conducted a retrospective analysis from the National Electronic Injury Surveillance System, data was analyzed from 1994-2006 for children younger than 18 years of age treated in a United States emergency department for baseball related injuries. During that 13 year period, roughly 1,566,000 were treated; the face (33.5%) and upper extremity (32.4%) were identified as the most commonly injured body part. This study concluded that being hit by a batted ball posed greater risk (46%) and recommended that all leagues enforce the use of safety baseballs, mouth guards and face shields for pitchers and catchers, and that all batters wear properly fitted helmets.

Stracciolini, et al (2013) performed a cross-sectional study comparing injuries sustained in younger children (5-12 years old) to older children (13-17 years old). Data was collected between 2000 and 2009 on 5-17 year old patients treated for sports related injuries at the Division of Sports Medicine at Boston Children's Hospital. There were 121,047 patients treated during that time period but only the cases with full data; such as diagnosis, sex, injury area, injury type, treatment, and activity were included in the sample. The final sample was made up of 2133 cases; 27.7% were in the younger children category and 72.3% were in the older children category. The younger children were more commonly treated for upper extremity

injuries and were more traumatic injury (49.2%), whereas, the older children were treated for overuse type soft tissue injuries to the chest, pelvis and spine (54.4%). Surgical intervention was required in 40% of the injuries in the full sample.

**Biomechanics**

Sabick, et al. (2005) conducted a descriptive, observational study by filming elite Little League pitchers. The 12 year old pitchers were filmed from the front and dominant side while pitching fastballs during a simulation. Using standard biomechanical techniques, a calculation of the net force and torque during the pitching motion on the humerus was obtained. It was found that the stress caused by high torque during the late phase arm-cocking is significant enough to cause deformity in the proximal humeral epiphyseal cartilage, over time causing humeral retrotorsion or proximal humeral epiphysiolysis.

A biomechanical analysis of sixteen right hand dominant pitchers was performed by Keeley, et al. (2008); the average age of participants was 12 years old. In this observational study, 21 bony landmarks were digitized using 3-dimensional video frame to measure kinematic calculations of the anterior/posterior, medial/lateral, and proximal/distal axes of the arm during pitching. The study indicated that youth pitchers initiate trunk rotation too early and can lead to hyperangulation of the shoulder. The high net torque during the late phase of arm-cocking may increase humeral retrotorsion. The underdevelopment of the muscles leads to poor control of the ball during the pitch.

Dun, et al. (2008) compared different types of pitches thrown to identify which pitch was more harmful. Twenty-nine youth baseball pitchers (age 12.5 +/- 1.7 years) pitched a series of 5 fastballs, 5 curveballs, and 5 change-ups; a 3-dimensional motion analysis system was used to compare the force required for the 3 selected types of pitches. It was found that the change-up

created the least amount of torque, while the fastball produced greater torque in the elbow and shoulder. This study did not prove the curveball to be a more harmful pitch type as hypothesized.

Motion analysis testing was performed by Hurd, Kaufman, & Wendel (2012) on 27 uninjured high school baseball pitchers with at least 3 years' experience, to evaluate relationships between clinical measures of shoulder rotational motion and strength. Anatomic landmarks and joint axes were marked to measure motion. Pitch velocity was measured using a radar gun and kinetic variables were measure using the 3-dimensional camera. A relationship was found between external-rotation of the shoulder and internal rotator strength and upper extremity pitching biomechanics; providing insight to risk factors for pitching related injuries.

Urbin, et al. (2012) performed a descriptive study using 16 active collegiate baseball pitchers. Kinetic data was obtained, via 3-dimensional motion camera, as the pitcher pitched 9-15 fastballs. Each pitch was evaluated in four phases to isolate an association between kinetics and the speed of the ball. I t was found that while increased phase times decrease the risk of overuse injuries, it also decreases the kinetics and speed of the ball.

**Risk Factors**

Lyman, Fleisig, & Andrews (2002) conducted a prospective cohort study in attempts to find an association between the pitch counts, pitch types, and pitching mechanics and elbow pain among young pitchers. Four hundred and seventy-six players age 9-14 years old were chosen from 15 parks throughout Alabama during the 1999 spring season**.** Pre-and postseason questionnaires, injury and performance interviews after each game, pitch count logs, and video analysis of pitching mechanics were obtained. Fifty percent of the subjects experienced elbow or shoulder pain during the season. The curveball was associated with a 52% increase risk of shoulder pain and the slider was associated with an 86% increased risk for elbow pain. A

significant association between the number of pitches thrown in a game and during the season and the rate of elbow and shoulder pain was also found. The writers recommend that curveball and slider pitchers be thrown with caution because of the increased risk of elbow and shoulder pain; pitching count limitations were also recommended.

Andrews, et al (2006) performed a case control study between September 2003 and September 2004, 140 participants were recruited from 8 high schools and 11 colleges in Alabama. The participants were separated into two groups, an injured group and an uninjured group; 95 of the participants had experienced either a shoulder or elbow injury in the past and were placed in the injured group. The remaining 45 reported never having shoulder or elbow pain that caused them to not play, if they had experienced shoulder or elbow pain it did not exceed 2 weeks, and denied recurrent shoulder or elbow pain. It was found that the participants in the injured group pitched significantly more months per year, games per year, innings and pitches per games, and warm-up pitches before a game than the uninjured group. These pitchers were often times starting pitchers and pitched with higher velocity, and more often with arm pain and fatigue. This study concluded that the overriding risk for injury is overuse and recommend future studies to be directed at addressing new safety recommendations for pitching counts.

In an attempt to quantify the incidence of throwing in injuries in young baseball pitchers; Fleisig, et al (2011) performed a 10 year follow-up cohort study. In this study the 481 participants were chosen from a previous study, all were active youth baseball pitchers aged 9-14 at the time of the original study. The participants were contacted each fall by telephone, they were asked about any injuries, how many pitches were thrown, and if any showcase pitches were thrown. During the study; 3 participants required elbow surgery, 7 required shoulder surgery, and 14 did not receive surgical intervention but were injured badly enough and retired. The rate of

injury was 5% and only 2.2% of those injured were still pitching by the end of the study. It is concluded from this study that limiting the number of innings pitched per year may reduce the risk of injury; however, those limitations are not clearly defined.

**Prevention**

Petty, et al (2004) discovered in this retrospective cohort study there was an increase in ulnar collateral ligament injury among high school students. Ulnar collateral ligament (UCL) injury is often associated with overuse, high velocity throwing, early throwing of breaking pitches, and improper warm-ups. Twenty-seven former high school baseball players who underwent UCL reconstruction were given follow up examinations and asked to fill out a questionnaire 35 months after surgery. The data was reviewed to evaluate the six potential risk factors; year round throwing, seasonal overuse, event overuse, throwing velocity more than 80mph, throwing breaking pitches before age 14, and inadequate warm-ups. Overall, 74% returned to baseball at the same or higher levels. Patients averaged 3 potential risk factors, and 85% demonstrated at least one overuse category. The average self-reported fastball velocity was 83 mph, and 67% threw breaking pitches before age 14. The overuse of the throwing arm and premature breaking pitches may be related to their injuries. The authors recommend that coaches and parents should be educated on the risks of overuse, the throwing athlete should take a 2-3 month rest from all throwing each year, and the curveball should be avoided before the age of 14.

Trakis, et al (2008) conducted a controlled laboratory study after discovering a high prevalence of throwing-related shoulder and elbow pain in adolescent baseball pitchers. Twenty-three adolescent pitchers were evaluated; twelve of the pitchers were currently symptom-free, but had experienced pain with throwing in the previous season. The remaining 11 pitchers had no

reported history of pain. Bilateral internal and external rotation range of motion and muscle strength was measured. Dominant versus nondominant range of motion and strength were compared between pitchers with and without throwing related pain. As a whole, the pitchers experienced a loss of internal rotation but experienced a gain in external rotation on the dominant versus nondominant arm; no effect was noted on total range of motion. No difference was appreciated in the bilateral comparison of total range of motion between pitchers with and without throwing related pain. This data revealed an adaptive process in strength and range of motion in the dominant arm and suggests that throwing related pain is a result of the inability of the compromised musculature to tolerate the stress produced while pitching.

## Discussion

### Summary

According to studies reviewed, it was found that 1.26 out of every 1000 pitching exposure results in injury. Upper extremity injury occurs 33.5% of the time among 20% of youth pitchers; 21% of these injuries are ligament sprains and 20.1% are muscle strains. Older children ages 13-17 years old are 3 times more likely to suffer from pitching related injury compared to younger children ages 5-12 years old.

The research has shown a 52% increase of shoulder pain associated with the curveball and an 86% increase of elbow pain associated with the slider pitch; these types of showcase pitches should be avoided before the age of 14. The high torque in the elbow and shoulder during the late arm-cocking phase appears to cause hyper-angulation and retro-torsion; contributing to damage to the ulnar collateral ligament, deformity of the epiphyseal cartilage, and proximal humerus epiphysiolysis. Evidence suggests that strength training may decrease risks for injury.

**Recommendations**

Little League International suggests that pitchers refrain from overhead throwing for at least 3 months per year. One calendar day of rest is required after 21-35 pitches, 2 calendar days of rest after 36-50 pitches, 3 calendar days of rest after 51-65 pitchers, and 4 calendar days of rest after 66 or more pitches; rest is also recommended when the pitcher experiences pain or fatigue. Further evaluation is warranted anytime there are complaints of shoulder or elbow pain during or after pitching.

Maximum Pitch Counts

| Age | Pitches/Game |
|---|---|
| **7-8** | 50 |
| **9-10** | 75 |
| **11-12** | 85 |
| **13-16** | 95 |
| **17-18** | 105 |

**Role of the Nurse Practitioner**

**Pre-participation physical examinations.** For nurse practitioners the pre-participation physical exam is the ideal time to screen for potential risk factors for injury. Pre-participation physical exams are not required for all baseball leagues, and in some cases are not required until high school. It would be a wise decision on the nurse practitioners part to screen all patients and perform pre-participation physical exams on known athletes, regardless of the requirements of the team. By doing so the nurse practitioner can evaluate and identify any potential problems provide injury prevention strategies. The ultimate goal of pre-participation physical exam is not to eliminate athletes from particular sports, but to ensure the health and safety of the athlete (Armsey & Hosey, 2004).

**Resistance and Strength Training.** Injury prevention can be achieved through proper warm-up, balance, and strengthening exercises. Proper throwing technique and routine resistance

strength training can contribute to the prevention of shoulder and elbow injuries. The nurse practitioner can refer patients to a Certified Strength and Conditioning Specialist for resistance training; it is important to make referrals to certified specialist to ensure proper mechanics are used to avoid injuries (Szymanski, 2011).

**Education.** It is the absolute role of nurse practitioners to educate patents and provide preventative medicine. The nurse practitioner should provide education and guidance not only to the patient and their parents; but also to coaches, trainers, and athletic directors. One survey of youth baseball coaches revealed a knowledge deficiency and non-compliance of regulatory pitch count guidelines (Fazarale, et al., 2012). This finding places baseball players at an increased risk for pitching related injuries. Players, parents, and coaches should be informed of all risk factors and should report any pain or fatigue experienced after pitching.

### Limitations

The varying degrees of pitching related injuries and the lack of reports of injury make it difficult to accurately quantify the epidemiology of pitching related injuries; clear parameters should be set defining reportable injuries and reporting of such injuries should be mandatory throughout all leagues. The lack of larger study research obscures the significance of this problem, as well, and should be conducted in the future to enhance the understanding of accurately identifying, treating, and ultimately preventing these types of pitching injuries.

## Conclusion

While the possibility for injury during a baseball game is limitless; with proper mechanics and heightened awareness of the risk factors, the risks for injury can be significantly decreased. The nurse practitioner must form a partnership with the patients, caregivers, and coaches to provide optimal care for each player. The player, caregiver, and coach must all take

an active role in reporting any pain, fatigue, or changes in throwing motions; as these are often signals that more serious injury is ahead. It is the hope of the writer that by raising awareness of the problem, the information can provide a basic knowledge to prevent further injuries or worsening progression of current injuries as they are identified. The writer appreciates that all physical activity has an inherent risk of injury; however, it is believed that through communication, education, and regulation; risk factors can be identified early enough to prevent injury and ultimately keep the child from striking themselves out of the game indefinitely.

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