Note: This is a transcript of a talk I gave to the coaches in the Mount Pleasant baseball league. These are the coaches of the competitive youth baseball teams in the Mount Pleasant Recreation Department in Mount Pleasant South Carolina. I spoke to them on March 5, 2008.

Thank you for having me. As Ryan said, my name is David Geier, and I am an orthopaedic surgeon and Director of MUSC Sports Medicine. I am thrilled to be speaking to you today, both as a physician and as a baseball fan. Those of you who know me know that I am a huge St. Louis Cardinals fan from my time working with the doctors of the Cardinals during my sports medicine fellowship. Preventing overuse injuries in youth sports, especially baseball injuries, is also a passion of mine. I've always admired the Mount Pleasant Baseball organization for all of its work trying to keep its players healthy.

I'm going to start with a quote I read recently in The State, the newspaper in Columbia. The writer talked to Dr. Timothy Kremchek, the orthopedic surgeon for the Cincinnati Reds. Kremchek was asked about the Little League World Series and youth baseball injuries, and this is what he had to say.

Ron Morris: Little League Baseball and Dixie Youth Baseball suggest that curveballs not be thrown, but neither has a rule against it for 11- and 12-year olds. Is that enough? And what do you think when you watch the Little League World Series on TV?

Dr. Kremchek: It is disgusting. I don't watch it anymore. I saw a kid a couple of years ago, that's all he threw was curveballs. I would love to see what happens to him in three years. You might as well watch some parent hitting his kid. Knowing what we know and what we are preaching, and then to watch a kid throw a curveball at that age. …It made me sick. I'm against it. It should be illegal at age 12. They should have pitch counts and no curveballs. It's a serious abuse of pitchers. ...The future of these kids in baseball is very dismal. That makes me absolutely sick. I can become violently ill watching that. It kills me. We are watching 12-year-olds with sponsorships, ESPN coverage, immense peer pressure, the over-desire to win at age 12. Who really gives a (darn) at age 12? That kid on the mound thinks he can pitch in the major leagues one day, and God bless him, but his chances are almost zero, because no one is telling him the truth. That is absolute child abuse on public display. At age 11, these kids are the best pitchers because they can throw curveballs. At age 14, they are watching the other kids play. By and large, we know better than that, and the people around him know better than to do that.

Wow. Definitely powerful language. I'm not sure I agree with the child abuse suggestion, but I do think the general point he's making is on target.

I'm going to talk about overuse injuries in baseball, but much of what I'm going to discuss applies to all throwing and overhead athletes. All of the sports listed here

place the same types of stress on their shoulders and elbows, including tennis players, football quarterbacks, volleyball, ice hockey, and water polo players, and javelin throwers. In fact, the ulnar collateral injury (or what we know as the Tommy John injury) was actually first described in javelin throwers many years ago.

Let's start with some statistics. It's estimated that approximately 8.6 million athletes between the ages of 6 and 17 play baseball. The elbow is the part of the body most frequently injured in youth baseball, and one study found that 58% of adolescent pitchers experience elbow pain at some point during a given season.

Why is that? If you look at the velocity, power, and repetitious nature of the throwing motion, you can see how the shoulders and elbows of youth pitchers endure significant microtrauma, especially in the late cocking and early acceleration phases of throwing. If you look at the valgus stress, which is the detrimental stress on the inside of the elbow, you can understand how elbow injuries occur. It's been shown that during the acceleration phase of a pitch there are 64 N-m of stress, and with the tennis serve there is over 60 N-m of stress. The problem is that the ulnar collateral ligament has been shown to have an ultimate tensile stress of 33 N-m. Obviously forearm muscle strength helps to protect the ligament, or the ligament would fail with every pitch, but you can see how this force can injure the elbow over time.

The shoulder experiences the same excessive stress. Researchers have shown that just prior to the release phase of a throw, the shoulder reaches a peak internal rotation velocity of approximately 7500° per second. At 7500° per second the shoulder could go through 20 complete revolutions in one second. To demonstrate this velocity even further, the tires of a car traveling at 90 mph have angular velocities approaching 7500° per second.

Are these excessive stresses a problem? The problem is repetitive excessive stress. Imagine a pitcher that puts stress on his shoulder and elbow over 150 pitches per week, 50 weeks per year, and over 10 or more years. It's no wonder that youth pitchers suffer overuse injuries.

So what are the injuries that can occur to the shoulders and elbows of youth pitchers? I'm sure everyone has heard of Little Leaguer's shoulder. That is a stress reaction of the growth plate of the humerus, or arm bone. If you look at these x-rays comparing this pitcher's throwing shoulder compared to his opposite shoulder, you can see that the growth plate is much wider on his throwing shoulder than his non-throwing shoulder. This injury resulted from too much pitching. As pitchers get older they can suffer other shoulder injuries, such as internal impingement, SLAP tears, and even rotator cuff tears.

Looking at the elbow, there are a number of injuries that can occur. The pitcher can have inflammation of the growth plate on the inside of the elbow (medial

epicondylar apophysitis) or a fracture there (medial epicondyle avulsion fracture). He can have a compression injury to the outside of his elbow (Panner's disease or osteochondritis dissecans of the capitellum or radial head). He can cause inflammation or fracture to the growth plate at the tip of the elbow (olecranon apophysitis or avulsion fracture). He can also injure muscles on the inside of the elbow (flexor-pronator strain), stress the nerve on the inside of the elbow (ulnar nerve compression), or injure the ulnar collateral ligament.

Kids are more at risk for injuries to these structures than older pitchers for several reasons. First, as I always tell patients, structures fail at the point of least resistance. In this case, it's often at the weaker growth plates of bones. They often have lax ligaments of the shoulder and elbow. Most importantly, they lack the muscle strength to provide dynamic stability to resist the high forces on the shoulder and elbow while pitching.

So is this really a problem? Sports Illustrated used to have a short article at the beginning of each magazine called "Sign of the Apocalypse." I recently saw an interview on ESPN's Outside the Lines show talking about the Tommy John injury that seemed to be another sign. It was fascinating because the show interviewed a young pitcher. What he said illustrates a common misperception with this injury. He said that he could throw as hard as he wants and as often and as long as he wants. If he gets injured, he can have surgery and be stronger than before.

The American Sports Medicine Institute, home of Dr. James Andrews, published a study showing that while Tommy John surgery was traditionally a surgery performed on adult pitchers, it was becoming more common in youth pitchers. They showed that from 1995 to 2000 they had performed Tommy John surgery on 5 high school athletes per year, but by 2004, they had performed 61 Tommy John surgeries per year in this age group. The pitcher on Outside the Lines just stated the belief that many youth pitchers, parents, and coaches hold. It might explain the huge spike in surgeries that should only be performed on college and professional pitchers now occurring in youth sports.

Is surgery the answer? It is absolutely NOT an antidote to overuse injuries in youth sports. I think almost all sports medicine orthopaedic surgeons who treat young athletes would argue that the younger a pitcher is at the time of injury or surgery, the less likely that pitcher is to progress to the next level of competition.

Are these kids pitching too much? Let's look at data taken from the Little League World Series. In 1996, only 50% of starting pitchers threw 75 or more pitches per game. By 2006, 80% of starting pitchers threw 75 or more pitches per game.

Are they throwing too many breaking pitches? In 1991, 23% of the pictures were throwing breaking pitches. In 2006, 31% of the pitchers were throwing breaking

pitches. In fact, less than 0.5% of all pitches thrown were changeups, which is the only off-speed pitch felt to be safe in this age group.

But who am I to say that this is wrong? Let's see what some professional pitchers believe. Dr. Joe Chandler, the former team physician for the Atlanta Braves, surveyed a number of professional pitchers. He found that most of them did not play year-round baseball as a child, and most played sports other than baseball as well. He asked 101 Atlanta Braves pitchers how old they were when they started throwing certain pitches. On average, they started throwing fastballs at age 10, curveballs at age 14, changeups at age 17, and sliders at age 18. What is interesting is what pitches they would allow their own sons to throw at different ages. On average, they would allow their sons to throw changeups starting at age 12, curveballs at age 17, and sliders at age 18.

Why are breaking pitches bad for youth pitchers? Well, the age that a child is ready to throw off-speed pitches is best determined by his muscle strength. Without the muscle strength of the deltoid, pectoralis, trapezius, rhomboids and rotator cuff, there will be much higher stress on the shoulder and elbow.

Another problem with breaking pitches is that the technique and mechanics taught to these kids is often inconsistent at best. The pitcher tries to throw using faulty mechanics with full effort and velocity when the muscles are not fully developed to withstand the forces across the shoulder and elbow. And as those of you who have worked with pitchers who learn new off-speed pitches have seen, pitchers often fall in love with breaking pitches and throw them over and over.

The USA Baseball Medical and Safety Advisory Committee has recommended appropriate ages for children to learn different pitches. You can see the list of ages on this slide. I want to emphasize three pitches. They recommend that the fastball be used at age 8, with the changeup started at age 10, and the curveball started at age 14. I think it's important that curveballs not be thrown while the athlete's growth plates in his bones have not fully closed. A good rule of thumb is to only allow the child to throw curve balls when he is old enough to shave. What is more important to emphasize than learning many new pitches is to focus on the fastball, and secondarily the changeup. Coaches and parents need to emphasize good command, location, and movement rather than learning breaking pitches too young.

There are new pitch count rules in Little League baseball, and you can see the pitch restrictions in the various age groups. Recommendations for the number of days of rest between starts at various ages have been adopted, and I think these are important too.

So what can parents do to prevent injuries? Based on all of this information, they can ensure that the child rests between outings, adheres to pitch count rules,

waits until the appropriate age to learn various pitches, and adequately warms up prior to pitching.

What can coaches do to prevent injuries? It's important to teach proper pitch mechanics and technique. He should promote year-round conditioning but discourage year-round throwing. And he should monitor pitch quantity and type.

I'll conclude by giving the new recommendations of the USA Baseball Medical and Safety Advisory Committee:

-Coaches and parents should listen and react when a child complains of arm pain.
-Pitch counts should be monitored and regulated in youth baseball.
-Pitch count limits pertain only to pitches thrown in games.
-Throwing breaking pitches, especially with poor mechanics, increases the risk of injury.
-Pitchers should develop proper mechanics early.
-Pitchers should engage in year-round conditioning.
-Pitchers should not return to the mound once he/she has been removed as a pitcher.
-Pitching in "showcases" should be discouraged.
-Pitchers should not pitch for more than one team per season.
-Baseball pitchers should only compete in throwing sports for nine months a year.

Finally I'll comment on some emotional considerations in baseball. Children are fairly egocentric, meaning that they believe that what they do is responsible for whatever happens. Kids have a strong desire to please adults, especially parents and coaches. Coaches and parents that play on this desire may push the child too far. Be careful to pick up signs of stress, such as difficulty eating and sleeping, moodiness, and even repetitive injuries. A repetitive injury may be a sign that the child is tired of the sport. If this is the case, the rehabilitation process can be very difficult.

Therefore, I think it's important for parents and coaches to keep baseball interesting and fun. Give the kids information, but don't make it too technical. Break a training session into short segments, and vary the routine frequently.

In summary, I would emphasize that the shoulders and elbows of young pitchers are at risk for overuse injuries. Risk factors include throwing too many pitches, throwing breaking pitches, and throwing year-round. Parents, and you as coaches, play an important role in preventing these injuries.