Prediction of Injury in Professional Baseball

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Nate Silver: The Signal and the Noise

"Prediction is important because it connects subjective and objective reality."

Why do we care about Forecasting Injuries?

• Risk Assessment is a form of prediction
• Interventions (Prevention)
• Trades
• Amateur Draft
• Free Agent Signings
• Waiver Wire
• Releases and Roster Management
**Categories of Risk Factors**

- Medical History
- Demographics
- Usage
- Biometrics
- Performance Metrics
- Psychological

**Medical History**

- Probably the highest risk factor and may be the highest predictor of future injury.
- Injury Outcomes
- Re-injury rates
- Surgery Outcome
- Systemic

**Demographics**

- Age
- Position
- Height, Weight, BMI, Body Fat
- Country of Origin
- College or High School Draft
- Years as a Professional
- Contract Status
Usage- Fatigue

• Pitches per inning, game, season and career
• High stress Innings- Leverage
• Rest between outings
• Increase in usage by year
• Number of Appearances
• Starter versus Relievers
• Position Players metrics?

Biometrics

• Range of Motion- Wilk
• Humeral Retroversion
• Strength- Dynamometer
• X-Ray
• MRI
• Functional Movement Screens
• Balance Testing
• Arm Length
• Biomechanics

Performance Metrics (>130 variables)

Changes in Individual
### Performance Metrics - Velocity

<table>
<thead>
<tr>
<th>Study</th>
<th>Metric</th>
<th>Mean</th>
<th>Median</th>
<th>1st Quartile</th>
<th>3rd Quartile</th>
<th>Max</th>
<th>Min</th>
<th>SD</th>
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</thead>
<tbody>
<tr>
<td>Study A</td>
<td>Speed</td>
<td>800.0</td>
<td>790.0</td>
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<td>Distance</td>
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<td>1150.0</td>
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<td>45.0</td>
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</tbody>
</table>

### Performance Metrics - Velocity v2

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<th>Study</th>
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</thead>
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<td>1200.0</td>
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<tr>
<td>Study C</td>
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<td>55.0</td>
<td>70.0</td>
<td>75.0</td>
<td>50.0</td>
<td>15.0</td>
</tr>
</tbody>
</table>
Studies that have Predicted

- Predictors of Ulnar Collateral Ligament Reconstruction in Major League Baseball Pitchers. Whiteside et al.

Fastball Pitch Velocity Helps Predict Ulnar Collateral Ligament Reconstruction in Major League Baseball Pitchers

Keller N, Chalmers, *y* MD, Brandon J. Eichborn, MD, Brian Ball J, MD
Anthony A. Remaley MD, and Nikhil N. Verma y MD

- **Methods:** MLB Pitchers 2007-2015. Pitch Velo, number, type (PitchFx), demographics. Examined all UCLr prior to 2007 and after 2012. Put in 3 categories, "control", "pre-injury", "postoperative". 1327 Pitchers included with 309 (26.8%) underwent UCLr. 145 had pre-injury data.
  - **Multivariate Regression showed:**
    - Peak pitch velocity was the primary independent predictor of whether a pitcher underwent UCLr ($P < .001$)
    - Mean velocity ($P = .013$), body mass index ($P = .010$), and age ($P = .006$) being secondary predictors.
    - However, a model constructed with these variables only explained 7% of the variance in UCLr rates.
    - **Pitch counts** were not significant predictors

Major League Baseball pitch velocity and pitch type associated with risk of ulnar collateral ligament injury


- **Methods:** 83 MLB pitchers who underwent primary UCLr reconstruction were evaluated. Average Pitching velocity and percent of pitch type thrown (fastball, curve ball, slider, and change-up) were evaluated 2 years before and after surgery. Data were compared with 83 control pitchers matched for age, position, size, innings pitched, and experience
- **Conclusion:**
  - MLB pitchers who pitch a high percentage of fastballs may be at increased risk for UCL injury because pitching a higher percent of fastballs appears to be a risk factor for UCL reconstruction.
  - Pitching more than 48% fastballs was a significant predictor of UCL injury, because pitchers over this threshold required reconstruction ($P = .006$).
  - MLB pitchers requiring UCL reconstruction do not pitch at higher velocities than matched controls, and pitch velocity does not appear to be a risk factor for UCL reconstruction.
Predictors of Ulnar Collateral Ligament Reconstruction in Major League Baseball Pitchers

David Whiteside,* PhD; Douglas N. Martin, PhD; Adam S. Lepley, PhD; ATC; Ronald F. Zernicke, PhD; and Grant C. Goulet, PhD

• Methods: 104 MLB UCLr pitchers compared to 104 age-position matched control group. Used binary logistic regression and machine learning computer

• Results: 6 Performance Metrics that were statistically significant risk factors
  1. Fewer games between consecutive games (fatigue)
  2. Smaller repertoire of types of pitches
  3. Less pronounced horizontal release points
  4. Smaller stature (height)
  5. Greater mean pitch velocity
  6. Greater mean pitch counts per game

Summary/Opinion

• We are doing better with determining some risk factors in UCL but have not done the same yet for other body parts.
• Using public data is a limitation but HITS Database is getting more robust.
• Risk Factors is not directly linked yet to probability of risk.
• Will need machine learning predictive software to look at 100's of variables and have the computer determine the patterns and probability.
• Good news is that we are not that far off.

Thank You