Impact of the 7-Day Disabled List Rule Change on Economics and Performance After Reported Concussion Injuries in Major League Baseball

Kiran Chatha,* MD, Ahmed Al-Mansoori,* MD, Eric Guo,† BSc, James D. Whaley,‡ MD, and Vani J. Sabesan,*§ MD

Investigation performed at the Cleveland Clinic Florida, Weston, Florida, USA

Background: The incidence of concussions is increasing in Major League Baseball (MLB), and the cost of these injuries in 2008 was reportedly as high as US$423 million. Team officials are more aware of concussion injuries, and one measure to address this issue was the creation of a concussion-specific 7-day disabled list (DL) in 2011.

Purpose: To evaluate concussion trends among MLB players and the impact of concussion-specific 7-day DL status on postinjury player performance and team financials.

Study Design: Descriptive epidemiology study.

Methods: From 2005 to 2016, a total of 112 players placed on the DL because of a concussion were identified using the MLB website and were verified using established news databases. Salary information for players was collected using MLB published data, and cost was calculated with a previously published formula utilizing the injured player's salary per game and adding the cost of his replacement. Performance metrics were compared before and after the rule change.

Results: The mean number of days on the DL decreased from 38.8 before 2011 to 29.2 after 2011. The mean annual cost per player before 2011 was $1.1 million and decreased to $565,000 after the rule change. Regression analyses demonstrated a downward trend in the mean cost ($R = –0.61$, $P < .001$). A comparison of postinjury performance metrics showed no significant differences with decreased time on the DL.

Conclusion: The minimum 7-day DL change has not had a negative impact on reporting; instead, it has demonstrated decreased time on the DL and lower associated team costs. Performance metrics demonstrated no differences compared with before the rule change, suggesting that players are not negatively affected by decreased time on the DL.

Keywords: Major League Baseball; concussions; performance impact; cost; rule changes

The success of a professional baseball team is measured by wins, which is largely dependent on the health of the players and their ability to perform at the highest levels. Epidemiological studies have shown higher rates of shoulder and elbow injuries in pitchers; however, concussions have become increasingly important.[4,9] The analysis by Posner et al[9] of injuries from 2000 to 2008 demonstrated that player injuries represent a financial impact of US$423 million in Major League Baseball (MLB).

In other sports leagues, such as the National Football League (NFL), the impact of concussions has been well studied, demonstrating that players are spending increased time recovering from concussion-related injuries, and they have more severe long-term consequences.[2] As professional leagues such as the NFL and MLB are high-value entities, it is prudent to understand what the financial impact is for specific injuries such as concussions, and how rule changes influence these types of injuries.

The MLB disabled list (DL) was first implemented in 1915 to manage the roster and assign healthy players instead of the injured ones to the roster. In 1984, the 15-day DL became the standard minimum for any injured player. As the incidence of concussion reporting and awareness surrounding concussions increased in the late 2000s, players were placed on the standard mandatory 15-day DL when suffering from a concussion. In 2011, MLB created a concussion-specific 7-day DL, in which players would only be required to be out for 7 instead of 15 days when suffering a concussion injury. Additionally, in 2010 the MLB Players Association put into effect the Health and Injury Tracking

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System (HITS) to follow injuries such as concussions in the context of medical histories.[6]

Concussions have significant sequelae and have been shown to change a professional baseball player's career trajectory significantly if left unreported. MLB has recognized these barriers to reporting and has adjusted rules surrounding contact and DL placement accordingly. However, to date, no analysis has been conducted examining the effect of the concussion-specific 7-day DL, compared with the minimum 15-day standard DL, among MLB players. Our hypotheses were that (1) the introduction of the 7-day DL requirement would decrease team costs, (2) the requirement would have a positive impact on reporting, and (3) player performance after the injury would not be affected by a shorter DL time.

METHODS

A retrospective review of MLB players placed on the DL for a concussion was performed for the seasons beginning in 2005 through 2016. All concussion injuries were identified using the official MLB injury reporting system (from MLB.com) and were verified with news databases. Recorded variables included the player's position, date of placement on the DL, days on the DL, salary of the injured player in the season, and salary of his temporary replacement. Temporary replacements were identified through corresponding roster moves after the placement of a player on the DL. The cost of a player who is placed on the DL was calculated utilizing an established formula, multiplying the daily salary of the injured player with the number of days on the DL and adding in the cost of his replacement.[3] The daily salary was calculated by dividing the annual salary by 182 days, which represents the amount paid per game in the season. Additionally, the cost of the replacement player was calculated utilizing the reported salary of each player. Players were stratified based on position for concussion incidence over the study period.

To further assess concussion trends, we looked at cost and time on the DL from 2005 to 2016 based on position played, excluding those who played multiple positions or designated hitters. To assess the performance and efficacy of the 7-day DL rule, we compared preinjury and postinjury metrics for earned run average, walks plus hits per inning pitched, batting average, and on-base percentage before and after the initiation of the 7-day DL rule. Position-specific player metrics were included for 1 season before the injury and for the season after the reported concussion. Players who did not return to play were excluded from the analysis.

Statistical Analysis

Descriptive statistics included were mean annual costs (US dollars) and days on the DL. Linear regression analyses were used to assess trends over time in concussion rates and costs. Paired t tests were used to compare the concussion incidence before and after the initiation of the 7-day DL rule as well as to assess statistical significance between preconcussion and postconcussion performance metrics. Analysis of variance was used to compare costs and time on the DL between positions. Alpha was set at .05. All statistical analyses were performed using SPSS Software (version 24.0; IBM).

RESULTS

From 2005 to 2016, there were 112 players with a concussion identified on the DL. The mean age of these players was 28.8 years. We found an overall decreasing trend in both the number of days spent on the DL and the cost associated with players having a concussion (Figure 1). During the study period, the incidence of concussion injuries increased from a mean of 3.7 cases per year before the DL rule change to 13.0 per year after the rule change ($P = .003$). The mean number of days spent on the DL decreased from 38.8 before 2011 to 29.2 from 2011 onward. Regression analyses comparing the number of days on the DL and mean yearly cost demonstrated that the mean cost of concussions decreased significantly through our study period ($R^2 = 0.47$, $P < .001$). There was also a significant correlation between mean cost and mean number of days on the DL ($R^2 = 0.78$, $P < .001$).

Regarding the financial impact of concussion injuries, there was a decreasing trend since the implementation of the 7-day DL rule in 2011. The mean cost of a concussion injury was approximately $638,000 over the study period. The mean annual cost of a roster player being placed on the DL was $450,320, while the mean annual cost of a replacement player was $192,305. The mean annual cost of placing a concussed player on the DL before 2011 was approximately $1.1 million; this decreased to approximately $565,000 from 2011 to 2016. The overall mean annual cost of placing players on the DL was $744,360, ranging from a low of $198,002 in 2016 to a high of $1.6 million in 2010.

When examining concussed players based on position, 34% of reported concussions occurred in outfielders, 33% in catchers, 20% in infielders, 8% in pitchers, and 4% in basemen. Concussions among fielders increased over the study period ($R = 0.602$), while those among pitchers and

[§]Address correspondence to Vani J. Sabesan, MD, Levitetz Department of Orthopaedic Surgery, Cleveland Clinic Florida, 2950 Cleveland Clinic Boulevard, Weston, FL 33331, USA (email: sabes001@gmail.com) (Twitter: @VaniSabesanMD).

*Levitetz Department of Orthopaedic Surgery, Cleveland Clinic Florida, Weston, Florida, USA.

[†]Department of Orthopaedic Surgery, Wayne State University School of Medicine, Detroit, Michigan, USA.

[‡]Beaumont Health System, Detroit, Michigan, USA.

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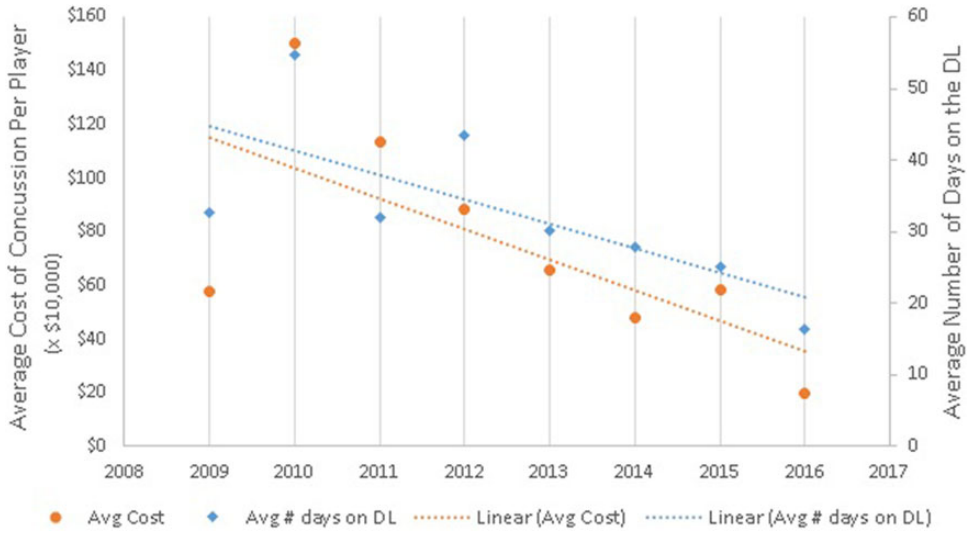

Figure 1. The mean cost of concussion injuries per player per year and the mean number of days spent on the disabled list (DL) because of a concussion injury.

TABLE 1
Cost and Time on the Disabled List by Position

Player Position	Mean Cost per Injury per Player, US$	Mean No. of Days on Disabled List per Injury
Pitchers	750,755	53.6
Fielders	698,471	27.3
Catchers	552,263	30.1
P value	.851	.064

TABLE 2
Player Performance Measures Before and After the Initiation of the 7-Day Disabled List Rule in 2011[a]

Postconcussion Performance Measures	Mean Before 2011	Mean After 2011	*P*
Batting average	0.20	0.24	.70
On-base percentage	0.34	0.32	.60
Earned run average	4.9	3.2	.08
Walks plus hits per inning pitched	2.0	1.3	.09

[a]Data calculated for the period 2005-2016.

catchers remained relatively stable ($R = 0.279$ and $R = 0.300$, respectively). When examining cost based on player position, pitchers had the highest number of days on the DL and concussion-associated costs, followed by fielders and catchers (Table 1). There were no significant differences in the number of days or cost of concussions based on position.

When comparing the performance metrics between injured players before and after the 2011 rule change, no significant differences were seen (Table 2). The postconcussive batting average was 0.20 from 2005 to 2011 and 0.24 for the period of 2012 to 2016 ($P = .70$). Similarly, before 2011, the mean postconcussive on-base percentage was 0.34 compared with 0.32 after 2011 ($P = .60$). For performance metrics in pitchers, there were also no significant differences. The earned run average was 4.9 from 2005 to 2011 and 3.2 from 2012 to 2016 ($P = .08$), while the walks plus hits per inning pitched were also similar at 2.0 from 2005 to 2011 and 1.3 from 2012 to 2016 ($P = .09$).

DISCUSSION

To date, a number of studies have evaluated the impact of concussions on performance in professional athletes; however, there has been limited research on the impact of concussions in MLB players. The 7-day DL rule was implemented to specifically track concussion injuries and decrease required time on the DL because players were no longer on the DL for a minimum of 15 days. Overall, our data demonstrated a rise in the number of reported concussions in players during the study period from 2005 through 2016, with a decrease in associated costs and no significant impact on performance metrics.

While there are no previous studies evaluating concussion rates in MLB players specifically, an epidemiological study of concussions in United States high school and collegiate athletes demonstrated that increased awareness and understanding of the diagnosis were positively correlated with increased concussion reporting.[5] It appears that the concussion-specific 7-day DL rule provides a better platform for reporting and tracking concussions in MLB, a key component of protecting players' long-term health. Our results also showed a downward trend in mean costs for concussion injuries, which may suggest a shorter time on the DL for concussion-specific injuries. A closer look at salary costs before and after the 2011 rule change revealed that the mean salary cost for concussed players decreased by approximately 50%, despite increased reporting incidence and salaries.

Scientific confirmation on the exact period required for returning to previous performance levels after a concussion in MLB is not well established; however, recent studies have found that the majority of injured players take 7 to 10 days to recover.[1,8] Our results agree with such reports, demonstrating no significant differences in postconcussive performance metrics after the concussion-specific 7-day DL rule change. As such, it would seem that the 7-day DL rule has allowed for the development of a flexible, economical system in which players feel safe reporting their symptoms and have adequate time to recover. The early detection of concussions is aided by mitigating the underreporting of symptoms, which may have been encouraged with the decrease in the mandatory number of days that a concussed player spends on the DL. In addition, the creation of the HITS has allowed for information regarding concussion injuries to be stored and reviewed over a period of time to allow for future rule adjustments as well as improved tracking of performance effects.

Although our study has uncovered some valuable financial trends associated with concussion reporting and rule changes, it is not without limitations. Currently, the decision to place a player on the DL is through a certified physician examination after the injury; thus, our examination is limited to reported and treated concussion injuries among MLB players. The largest limitation is that all data collected from MLB regarding days on the DL and salaries before the initiation of the HITS injury tracking system were restricted. While NFL-based concussion studies have been able to conduct long-term follow-up regarding concussions, there has been little research into the long-term sequelae of baseball-related concussions, which limited our data to reported statistics regarding performance during the period of the player's active career.[7]

CONCLUSION

This study has demonstrated that the initiation of a league-wide concussion injury reporting system benefits players, teams, and ultimately the league, both physically and fiscally. Players who are able to report their injuries without fear of reprisal can be treated early and as often as necessary without seeing a significant difference in performance or a detrimental financial impact.

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