Summative Report on Time Out of Play for Major and Minor League Baseball

An Analysis of 49,955 Injuries From 2011 Through 2016

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Background: Recent epidemiologic reports have demonstrated rising injury rates in Major League Baseball (MLB) and Minor League Baseball (MiLB). Although several studies have recently been published on specific injuries, the majority of injuries have not yet been formally studied.

Purpose: The purpose of this study is to (1) generate a summative analysis of all injuries that occur in MLB and MiLB, (2) identify the 50 most common injuries, and (3) generate focused reports and fact sheets on the characteristics of each of those diagnoses.

Study Design: Case series; Level of evidence, 4.

Methods: The MLB Health and Injury Tracking System was used to identify injuries occurring in MLB and MiLB players from 2011 to 2016. Injuries were defined as those that occurred during normal baseball activity and resulted in at least 1 day out of play. A multitude of player and injury characteristics were analyzed, and detailed reports of the 50 most commonly occurring injuries were generated.

Results: A total of 49,955 injuries occurred during the study period; 45,123 were non–season ending, and they resulted in 722,176 days out of play. The mean (median) days missed per injury was 16 (6) days. Overall, 39.1% of all injuries occurred in pitchers. The upper extremity was involved in 39% of injuries, while 35% occurred in the hip/groin/lower extremity. Surgery was required in 6.5% of cases, and 9.7% of injuries were season ending. Hamstring strains were the most common injury (n = 3337), followed by rotator cuff strain/tear (n = 1874), paralumbar muscle strain (n = 1313), biceps tendinitis (n = 1264), oblique strain (n = 1249), and elbow ulnar collateral ligament injury (n = 1191). The diagnoses that were most likely to end a player's season were elbow ulnar collateral ligament injury (60% season ending) and superior labrum anterior and posterior tear (50.9% season ending).

Conclusion: Contrary to prior reports relying on disabled list data, the annual number of injuries in professional baseball remained steady from 2011 to 2016. Similar trends were noted for the annual number of days missed and mean days missed per injury. Although the mean days missed per injury was high (16), the median was much lower at 6 days.

Keywords: Major League Baseball; Minor League Baseball; professional baseball; injury; epidemiology

In recent years, several epidemiologic reports have been published on injury rates in Major League Baseball (MLB).[9,10,15,18,20] Overall, these reports have demonstrated rising rates of injuries and increased time out of play each season. Although each of these has provided very valuable information for these elite athletes, they have not been without their limitations. Historically, these reports relied on data from the disabled list (DL), which was designed primarily as a roster management tool rather than a system for tracking injuries. Some of these works are also limited in that they report injuries based on specific body regions (shoulder, elbow, knee, back, etc) or injury mechanism (ie, sliding injuries), but they do not consistently provide information on specific diagnoses (such as shoulder dislocation, anterior cruciate ligament disruption, hamstring strain, etc). Finally, many are limited by their lack of injury data for Minor League Baseball (MiLB) players, who far outnumber those at the MLB level.

With the recent development and implementation of the Health and Injury Tracking System (HITS), many of these limitations can now be overcome.[19] This electronic medical record was initially implemented in 2010 after input and approval by the Office of the Commissioner of MLB, the MLB Players Association, and numerous health care and epidemiologic experts, and it has significantly improved the quality and utility of baseball-related research.[1,11,14] It permits inclusion of injuries from MLB and MiLB and allows classification of injuries based on specific diagnoses rather than general body region. Using HITS data,

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comprehensive reports on a number of commonly occurring injuries in professional baseball have recently been published, including on hamstring injuries,[1] traumatic brain injuries,[14] knee injuries,[11] hip/groin injuries,[8] sliding injuries,[5] and abdominal oblique injuries,[3] to name a few. Each of these works has improved our understanding of the effect of these injuries, and this information has proven valuable when treating and counseling players with these specific diagnoses. It is also very informative for baseball front office personnel who need to make critical decisions regarding roster management during the recovery process.

Although this work has been informative, it has brought to light how little is known about the epidemiology and effect of all other commonly occurring injuries/diagnoses that have not yet been analyzed in a comprehensive fashion. In a recent study, Ahmad et al[1] listed the top 10 time-loss injuries by diagnosis for the 2011 season, but this is limited to 10 diagnoses, does not include days missed (DM) for those injuries, and spans only a single season. Although detailed study into each of these injuries is warranted and likely to follow, it will take a significant amount of time if they are investigated singularly. Until that work is completed, baseball trainers, orthopaedic surgeons, sports medicine physicians, players, coaches, and other personnel do not have a robust, reliable, and evidenced-based reference that can be used to prognosticate recovery times for players with a given injury. Establishing these return-to-play times will also provide an objective baseline against which novel treatment and rehabilitation strategies can be compared. Accordingly, the purposes of this work were to (1) generate a summative analysis of the characteristics of all injuries that occur in MLB and MiLB, (2) identify the 50 most common injuries (based on specific diagnosis rather than body region), and (3) generate focused reports and fact sheets on the characteristics of each of those diagnoses with special attention given to return-to-play times. Ultimately, it is our hope that this work will be informative for current baseball trainers, physicians, players, coaches, and other personnel and that it will help direct future research efforts into the most impactful injuries.

METHODS

Before beginning, this work was approved by our institutional review board. With the assistance of the MLB Commissioner's Office, the HITS medical record system was queried to identify all injuries that occurred in MLB and MiLB baseball players between the 2011 and 2016 seasons. All data were collected and analyzed in a completely deidentified and anonymous fashion. The investigators were not aware of player names or teams. Only injuries that resulted in at least 1 day out of play were included. Other inclusion criteria were as follows: injury occurred as a part of normal baseball activity (games, practice, training, etc), player was active on an MLB or MiLB roster at the time of injury, and the injury was primarily musculoskeletal or dermatologic (lacerations, blisters, etc) in nature. Exclusion criteria were illnesses primarily medical in nature (cardiovascular, gastrointestinal, respiratory, etc), injuries not occurring during normal baseball activity, off-season injuries, and injuries that did not result in at least 1 day out of play.

For each injury event, a multitude of characteristics were analyzed. Player characteristics included age, level of play (either MLB or MiLB), position, throwing-side dominance, and batting-side dominance. Injury characteristics included date of injury, whether or not the injury was season ending, DM, injury acuity (acute vs overuse), body side (right vs left), body region, reinjury status, structure injured (bone, ligament, muscle, etc), diagnosis type (sprain, fracture, laceration, etc), injury mechanism, location on the field, season (pre-, regular, or postseason), activity leading to injury, and need for surgery. Events were classified as reinjuries if the player had experienced the same injury previously during the study period. Season-ending injuries are those in which the player was not able to return to play in a game during that year. For injuries with low season-ending rates ($<20\%$), only non–season-ending injuries were included in the DM calculations. This was done to reduce incidental inflation of mean DM for these injuries that typically do not require extended time out of play. For injuries with higher season-ending rates ($\geq 20\%$), both season-ending and non–season-ending injuries were included in the DM calculations.

The 50 most common diagnoses rendered were identified and ranked based on the number of injury events for that diagnosis. For this particular list, injuries diagnosed as "contusions" were not included due to the nonspecific nature of the term and the wide spectrum of pathologic conditions that it may represent. Accordingly, the most common contusions were ranked and summarized separately.

Statistical Analysis

Epidemiologic data are reported using descriptive statistics such as numbers, frequencies, means ± SD, ranges, and medians where appropriate. Trends over time are assessed for significance using linear regression modeling,

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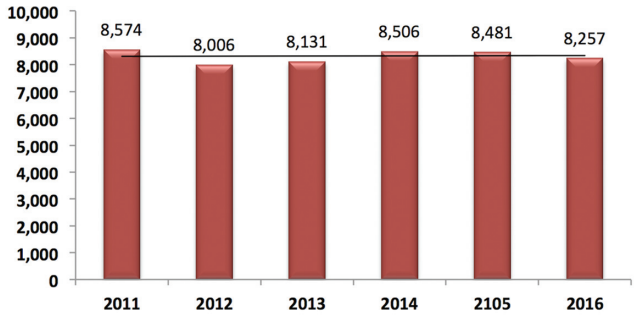

Figure 1. The annual number of injuries that resulted in time out of play for Major and Minor League Baseball remained steady over the course of the study (R^2 = 0.1069, P = .527).

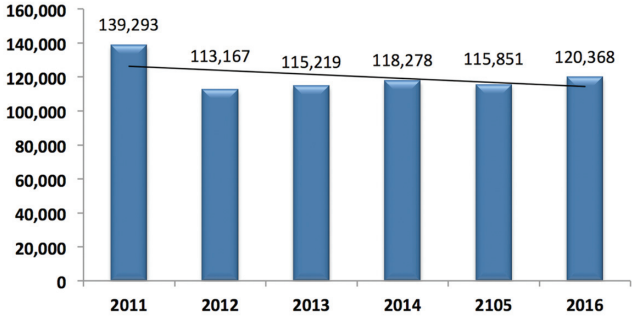

Figure 2. Annual number of days missed due to injury did not change significantly from 2011 to 2016 across all of professional baseball (R^2 = 0.0618, P = .635).

and the corresponding R^2 and P values are provided. For each of the top 50 injuries, DM are reported as means, medians, ranges, and a normal distribution curve is provided. Only P values less than .05 were considered to represent statistical significance.

RESULTS

Over the course of the 6-season study period, there were 49,955 injuries that met the inclusion criteria. The annual number of injuries (mean, 8326) remained steady from 2011 to 2016 (R^2 = 0.1069, P = .527) (Figure 1). They ranged from a low of 8006 in 2012 to a high of 8574 in 2011. The 45,123 non–season-ending injuries resulted in a total of 722,176 DM for a mean of 120,363 days out of play each year, and this did not change significantly over time (R^2 = 0.0618, P = .635) (Figure 2). The mean number of DM per injury was 16 (median, 6 DM), and this remained steady from 2011 to 2016 (R^2 = 0.1411, P = .463) (Figure 3).

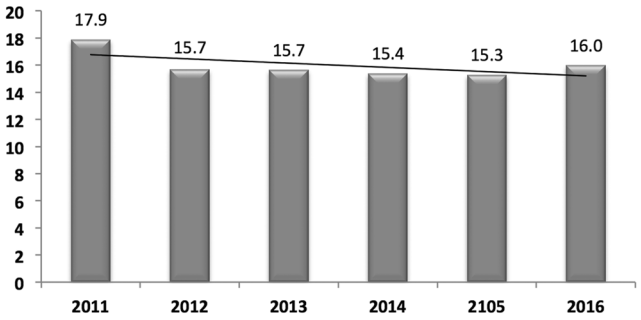

Figure 3. On average, players missed 16 days per injury (median, 6 days), and this remained steady during the study period (R^2 = 0.1411, P = .463).

The most common structure injured was muscle (31% of cases), followed by ligaments (9%) and tendons (8%) (Figure 4). A detailed breakdown of the body regions injured is provided in Figure 5. Of note, the upper extremity (shoulder/clavicle, hand/finger/thumb, elbow, wrist, forearm, and upper arm) accounted for 39% of injuries, while the lower extremity (upper leg, knee, ankle, lower leg/Achilles, foot/toes, hip/groin) was involved in 35% of cases. A classification of injuries by diagnosis type is provided in Figure 6.

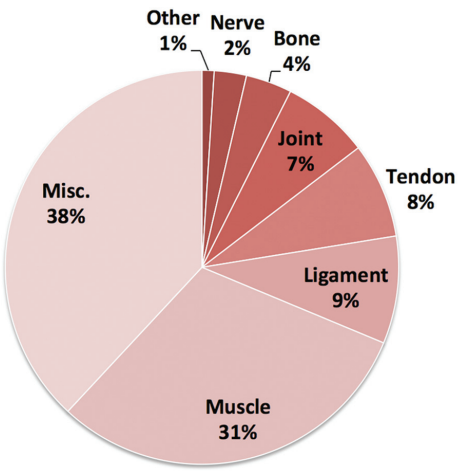

Figure 4. Injuries subclassified by the structure that was injured.

Table 1 outlines basic injury characteristics. The majority of these injuries were acute in nature (65.7%), were sustained in MiLB players (83.5%), occurred during the regular season (80.4%), and did not require surgical intervention (90.3%). Only 1.6% were listed as reinjuries, and 9.7% of all injuries were season ending. Pitchers (39.1%) were the most common position injured, followed by infielders (27.1%), outfielders (22.8%), and catchers (11.0%). When dividing by the number of positions in each of those categories (1 pitcher, 4 infielders, 3 outfielders, and 1 catcher), the percentage of injuries per actual position is as follows: pitchers, 39.1%; infielders, 6.8% (27.1%/4); outfielders, 7.6% (22.8%/3); and catchers, 11.0%. In professional baseball, "service time" is defined as the amount of time a player or players are listed on an active MLB roster. For additional perspective, pitchers were responsible for 53.3% of all service time during the study period, while position players represented the remaining 46.7%. Additional injury characteristics, such

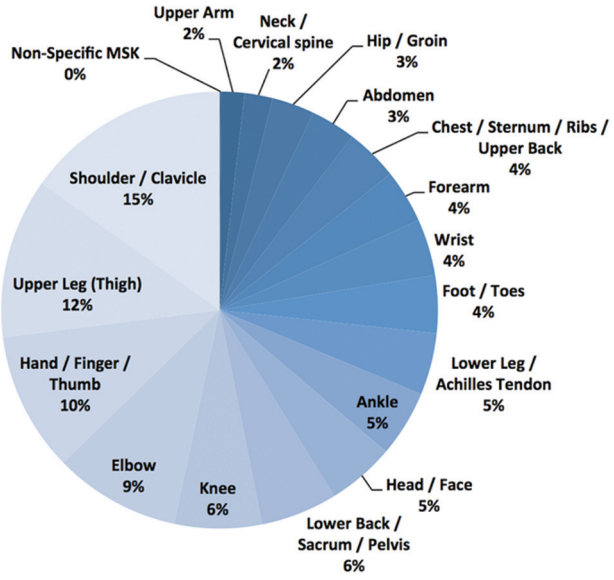

Figure 5. Categorization of events based on the body region injured. MSK, musculoskeletal.

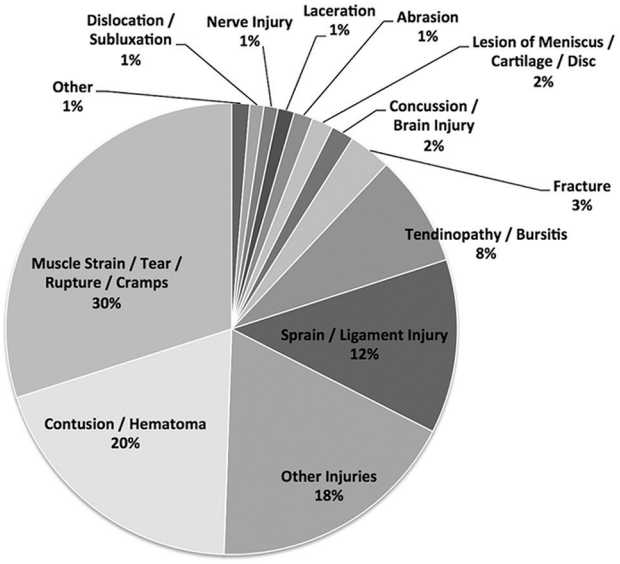

Figure 6. Breakdown of the types of diagnoses rendered.

as mechanism, location on the field, and activity leading to the injury, are provided in Table 2.

Of these 49,955 injuries, the most common was hamstring strain (n = 3337, 6.7%). This was distantly followed by rotator cuff strain or tear (n = 1874, 3.8%), paralumbar muscle strain (n = 1313, 2.6%), long head of the biceps tendinitis (n = 1264, 2.5%), and abdominal oblique muscle strain (n = 1249, 2.5%). Injury to the medial ulnar collateral ligament of the elbow was the sixth most common injury (n = 1191, 2.4%). The 50 most common injuries are listed in Appendix Table A1 (available in the online version of this article), and the 20 most common contusions are detailed in Appendix Table A2 (available online). It is worth noting that the DM calculations in this table include only non–season-ending injuries for injuries with <20% season-ending rates, and those with season-ending rates ≥20% included season-ending and non–season-ending injuries in DM calculations. The diagnoses that are most likely to end a player's season (≥20% season-ending rate) include elbow ulnar collateral ligament injury (60.0% season ending), superior labrum anterior and posterior tear (50.9%), elbow sprain (38.9%), lateral meniscal tear (31.1%), shoulder (glenohumeral joint) instability (27.0%), medial meniscal tear (24.1%), elbow medial epicondylitis (21.3%), ulnar neuritis (20.7%), and forearm flexor/pronator strain (20.0%). Similarly, these diagnoses result in higher rates of surgical intervention (Appendix Table A1, available online).

Finally, a comprehensive report of these top 50 injuries is included in the Appendix (available online). In this report, a number of variables are provided for each type of injury, including injury rank, total number of injuries, total DM, mean DM, median DM, annual number of injuries, a normal distribution of DM, and all injury characteristics listed in Tables 1 and 2.

TABLE 1
Basic Injury Characteristics

	n	%
Injury type		
Acute	32,807	65.7
Overuse	9875	19.8
Unlisted	7273	14.6
Reinjury		
Yes	817	1.6
No	49,138	98.4
Level of play		
Major League Baseball	8238	16.5
Minor League Baseball	41,717	83.5
Season		
Preseason	8256	16.5
Season	40,169	80.4
Postseason	1530	3.1
Season ending		
Yes	4832	9.7
No	45,123	90.3
Surgery required		
Yes	3243	6.5
No	46,712	93.5
Position		
Pitcher	19,535	39.1
Catcher	5473	11.0
Infielder	13,519	27.1
Outfielder	11,386	22.8
Designated hitter	42	0.1

DISCUSSION

Due to recent studies showing rising rates of specific injuries in professional baseball, increased attention is being

TABLE 2
Advanced Injury Characteristics

	n	%
Injury mechanism		
Noncontact	27,628	55.3
Contact with ball	9706	19.4
Contact with ground	4898	9.8
Contact with person	1978	4.0
Contact with bat	638	1.3
Contact with boundary	559	1.1
Other or unlisted	4548	9.1
Injury location on field		
Home plate area	11,687	23.4
First base area	4320	8.6
Middle infield area	4086	8.2
Third base area	1725	3.5
Pitcher's mound	9882	19.8
Outfield	5925	11.9
Foul territory	2879	5.8
Other or unlisted	9451	18.9
Injury activity		
Base running	5385	10.8
Sliding	2254	4.5
Batting	9842	19.7
Fielding	8972	18.0
Pitching	9624	19.3
Throwing	6918	13.8
Weight training/conditioning	2305	4.6
Observing	261	0.5
Other or unlisted	4394	8.8

paid to these causes of time out of play for both MLB and MiLB players. Unlike these prior focused reports, the current comprehensive analysis of 49,955 injuries indicates that the annual overall numbers of injuries, DM, and DM per injury actually remained steady from 2011 to 2016. For each of these parameters, the most significant year for injuries was actually 2011, as it demonstrated the greatest number of injuries, total DM, and DM per injury. The mean DM for all injuries was 16, but the distribution was positively skewed with the majority of injuries requiring less than 5 to 10 days out of play (see page 6 of the Appendix, available online). Overall, 39% of injury events occurred in the upper extremity, while the lower extremity accounted for 35%. Surgery was required for 6.5% of injuries, and 9.7% were classified as season ending. On a per-position basis, pitchers were injured 3.6 times more than catchers, 5.1 times more than outfielders, and 5.8 times more than infielders.

Like other epidemiologic reports in baseball,[9,10,18,20] upper extremity injuries occur more commonly than injuries in any other body region. In the first large epidemiologic report on injuries in professional baseball, Conte et al[10] reported that upper extremity injuries were responsible for 56% of DL assignments. This high rate of upper extremity injuries was confirmed in subsequent follow-up studies published in 2011 (51.4% of DL assignments)[20] and 2016 (50.3% of DL assignments).[9] It is worth noting that in the latter study, Conte et al[9] identified rising rates of elbow injuries that were outpacing a decreasing rate of shoulder injuries. Although these studies have driven a heightened concern for the shoulder, elbow, wrist, and hand in baseball, the current study suggests that these injuries are actually in a slight minority (39.1%) compared with all other injuries. This discrepancy may be the result of increased attention being paid to prevention of upper extremity injuries in recent years, or this may highlight one of the key differences in analyzing DL data compared with the HITS database. In the current investigation, upper extremity injuries demonstrated some of the highest surgical and season-ending rates. While they may not represent the majority of injuries in this study, they are the most significant in terms of time out of play. This increased severity makes these injuries more likely to be captured in a review of DL data, while less severe injuries could be missed in such a report. (With a few exceptions, an assignment to the DL historically required a minimum of 15 days out of play).

On the contrary, the current investigation identified a higher proportion of lower extremity injuries (35%) compared with previous reports, where they ranged from 25.3% to 30.6% of DL assignments.[9,10,20] Using the HITS database, Dahm et al[11] recently reported that lower extremity injuries were responsible for 32.2% of all injuries in professional baseball, which is more in line with the current study. This increased awareness has driven a number of recent investigations into hamstring,[1] knee,[11,12,18] and hip/groin[2,8,16,17] injuries. Based on the current report, these efforts appear to be appropriately directed, as 14 of the top 50 diagnoses involved the lower extremity/hip/groin (knee, 4; hip/groin, 3; ankle, 3; lower extremity muscle injury, 3; and Achilles tendon, 1), and hamstring injuries were by far the most common injury with 3337 occurrences and 46,706 total DM. While these findings are similar to the prior reports of Dahm et al[11] on knee injuries, Ahmad et al[1] on hamstring injuries, and Coleman et al[8] on hip/groin injuries, very little is known about ankle sprains, quadriceps strains, and gastrocnemius/Achilles injuries in baseball. Accordingly, these areas may be appropriate targets for future research.

Of all the body regions studied, relatively little has been published on back injuries in baseball players. While it is well established that lumbopelvic control is critical for optimal performance for hitters and pitchers,[6,7,13,21] much less is known about back injuries.[4,7,17] Back/vertebral injuries alone were responsible for 6 of the top 50 diagnoses, including: paralumbar muscle strain (#3), nonspecific low back pain (#13), parathoracic muscle strain (#24), sacroiliac dysfunction (#34), torticollis/neck spasm (#35), and cervical strain/whiplash (#48). Just as a strong, stable back and pelvis are required to transfer energy through the kinetic chain while throwing or batting, the same is true for abdominal musculature. Oblique muscle strains (#5) and intercostal strains (#21) were collectively responsible for 1642 injuries and 31,730 DM. Consistent with a recent report on oblique injuries in baseball,[3] this problematic injury does not seem to be on the rise (see the Appendix, page 11, available online), and the annual number of intercostal strains declined from 2011 to 2016 (Appendix, page 27, available online). These

observations may be the manifestation of increased attention paid to injury prevention in recent years.[3]

There are several limitations to this work that merit discussion. As with all studies relying on a database for injury surveillance, the accuracy of the data is dependent on those responsible for the input. In the case of HITS, data are input by the athletic trainers of MLB and MiLB who are well trained and experienced with the system and interact with it on a near-daily basis. Despite this experience and familiarity, the possibility for discrepancy in data entry does exist. Along those lines, this study represents a broad-reaching epidemiologic report. Although it provides a great deal of information regarding a multitude of injuries, there is no analysis of injury prevention measures, diagnostic accuracy, or treatment efficacy. Although that was beyond the scope of this investigation, those are critical topics that should be addressed in future studies. Finally, given the epidemiologic scope of this study, it was not able to precisely differentiate injuries based on more granular data, such as severity (ie, injury grade) or precise location (ie, midsubstance, muscle-tendon junction, or tendon insertion for hamstring strains). Moving forward, more focused analysis is needed for these more common and significant injuries.

CONCLUSION

Over the span of 6 seasons in professional baseball, nearly 50,000 injuries were responsible for 722,176 days out of play (the equivalent of nearly 4000 full-length MLB seasons). Contrary to multiple other reports, the annual number of injuries and DM actually remained steady. Consistent with prior studies, pitchers were the most commonly injured players; however, upper extremity injuries accounted for less than 40% of all injuries. Although the mean DM per injury was high (16 DM), the median was much lower at 6 days. Accordingly, prior investigations using DL data (which typically include only injuries with $\geq$15 DM) may have underreported the numbers of injuries while overstating the mean time missed per injury. This work has the potential to significantly improve prognostication of return-to-play times for injured players, inform future research into injury prevention measures, and provide baseline return-to-play times against which novel treatment strategies can be compared moving forward.

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