Review Article

Challenges of Medical Care Delivery in Professional Sports: Lessons From Professional Baseball

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Abstract

Team medical management for professional sports teams is a demanding and high-risk activity. Every different sport has unique features and the stresses athletes place on themselves, be it from collisions or repetitive stress, result in specific challenges for the medical team and team organization in general. Injuries in professional sports are costly both to the player and organization. The challenges of managing a professional baseball team exemplify these concerns and correlate well with other professional sports. Multiple strategies exist for improvement of medical care in baseball based on observed deficiencies in player evaluation, injury prevention, and injury treatment, which will require prospective evaluation to determine their success. These include draft strategies, individualized motion and strength analyses, customized in-season and off-season training programs for individuals, and standardized treatment protocols for injuries all based on best practices. Best practices are currently poorly defined in all of these areas.

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The challenges of delivering medical care in professional sports are notable because of the many unique features of each sport and the length of the playing and training season. This is especially true of baseball that begins in February and ends either at the end of September or October depending on the team's success. The medical team in the middle of this scenario is tasked with maintaining the individual player's health and maximizing his performance while protecting the team's competitive abilities. The multiple tasks of the medical team include assessment of potential and current players, development of an organized program for injury prevention and treatment that is consistent throughout the entire organization, which in baseball includes Major and Minor league teams, and timely communication and coordination of health care with team administrators. Despite this, currently, no literature exists regarding the optimum organization for such a medical service or an exact delineation of responsibilities for such a service. Few articles exist regarding this type of organization in college sports and Olympic teams. This article attempts to discuss optimal organization of a medical service for professional sports using baseball as an example.

Cost of Injuries

Injuries pose notable challenges not only to the health of the professional

baseball player but also to the welfare of the team in general. The cost of salaries for injured players on the Disabled List (DL) to Major League Baseball (MLB) over the 3-year period of 2013 to 2015 was over $1.6 billion dollars for an average of over $536 million/yr. On average, 439 Major League players are placed on the DL each year, and they spend an average amount of about 56 days on it.[1] The team is required to continue paying the injured player's salary even when he is not playing. The total number of days on the DL league-wide in 2014 was 26,192 with a mean of 873 days/team. The amount of time spent on the DL for each team, however, varied from a minimum of 409 days to a maximum of 2,281 days for a variation of over 500%. This wide variation even occurs within the same organization year to year related to varying team demographics, trauma, and intangible factors as well. This is a multifactorial problem and can vary widely despite the best efforts of the medical team. Some injuries, such as those that are traumatic may not be avoidable, but injuries caused by issues of conditioning and fatigue may be decreased by improvement in conditioning programs during the season and off season.

Unique Aspects of Professional Baseball

Professional baseball is unique in multiple ways including the number of teams in an organization (Rookie ball, Single A, Double A, Triple A, and Major League), the large number of players of varying ages within an organization, and the long length of the season. Developmental leagues in other sports are often outside the purview of the professional team such as in football where developing professional players are found on the fields of college campuses or basketball where many players develop in leagues sometimes outside the United States. Successful performance in baseball involves a notable amount of rotational movement and depends heavily on hand-eye coordination.[2] It is not an endurance sport, and collisions are more rare than in football or soccer. Injuries are often related to repetitive movements, microtrauma, and volume of activity such as pitching. However, even relatively small injuries can keep a baseball player from hitting a baseball and render him ineffective. An oblique muscle strain can disable a batter and a fingertip blister can disable a pitcher, whereas football players can often continue to play with a broken bone, for example. A variety of positions exists, and each of them stresses players differently. Pitchers have up to a 34% higher incidence of injuries compared with position players.[1] As in other sports, specific stresses vary according to the position.

Proactive Medicine

Sports medicine in its most rudimentary form involves the management of the injured athlete. A reactive approach to sports medicine is no longer acceptable in the current sports environment at any level, and sports medicine now involves not only the evaluation of injuries but also programs to optimize the player's health and performance. This approach involves the development of more comprehensive programs that include preparticipation evaluations, injury prevention, and management of medical issues.[3] The goals of modern-day sports medicine programs include training programs to maximize potential in young players and improve overall performance and to prolong the career of the aging athlete through modified training programs. Thoughts regarding the types of programs and how they should be introduced vary throughout professional baseball without a consensus or a mechanism to share strategies.

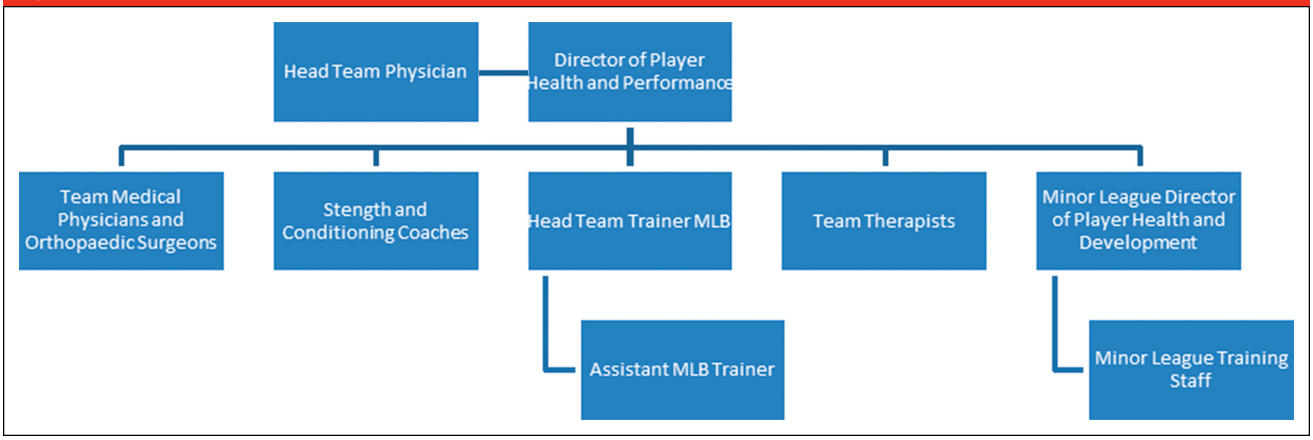
Consistency of Treatment

Consistent treatment of professional athletes requires a coordinated effort throughout the entire organization including at a minimum physicians, physical therapists, athletic trainers, strength and conditioning coaches, and team coaches. This coordinated effort requires an identifiable agreed-upon care plan, which is updated on a regular basis to match best practices throughout the sport. Treatment coordination can lead to decreased injuries, as has been demonstrated in other sports such as soccer,[4-9] and programs for uninjured players can lead to decreased injury and more rapid return to play after injury.[4,5,7-9] A collaborative effort in the creation of treatment protocols enhances the buy-in from both coaches and trainers who often have differing opinions regarding rehabilitation and return to play. A lack of conflict among the staff leads to greater confidence by the player regarding the rehabilitation program. The creation of an identifiable document allows for easier fine-tuning of the protocols once these have been established and found to be effective.

Consistent Grading of Draft Selections and Free Agent Signings

Selection of draft candidates is critical to the long-term success of any professional organization including baseball. It is the life blood of a team that allows the development of young players who will hopefully contribute to the team's success in future years. A commonly held belief in professional baseball is

Figure 1



Recommended organizational tree for professional baseball medical team. MLB = Major League Baseball

that, even without any medical issues, "it takes 20 to get one." In other words, for every 20 draft choices, a team will obtain one impact player who actually makes it to the Major League. Knowledge of preexisting medical issues, injuries, and previous surgeries by the medical staff is a critical component of the predraft evaluation and helps the organization understand the implications of the potential draftee's or Free Agent's previous treatments. Mistakes in either direction, for example, failing to draft a talented player who could contribute to the team or drafting someone whose medical issues keep him from ever playing, can be costly to the organization. There is currently no standardized method of evaluation used by MLB. Evaluation of players is done primarily by chart review and on an individual basis by physicians. Although an Electronic Health Record (EHR) is used in the care of players throughout the season, no such instrument is used in the evaluation of players for the draft. The draft evaluation routine used in professional baseball is very different from the method used in the National Football League. Combine in which players are examined by groups of physicians, and the rating is determine after a more thorough evaluation of the Prospect. Brophy et al[10] have demonstrated a correlation between the grading of players and ultimate performance in the National Football League. No such correlation has been proven with the current system being used in MLB. McGahan et al[11] recently published a series outlining the shortcomings of the current system in MLB. A wide variation was found among MLB physicians as to the grade that hypothetical draft choice received. Improvement in the current system is critical to providing better information to the scouting staff and to allow better allocation of resources.

Physicians currently use published return-to-play data after specific injuries based on general athletic populations but not specific to the professional baseball player. Reasonable data are available for surgeries in baseball players such as elbow ulnar collateral ligament reconstruction,[12-14] rotator cuff surgery,[15,16] labral repair[17-19], and anterior cruciate ligament surgery,[20,21] which constitute a large number of the surgeries performed on potential baseball draftees. The incidence of ulnar collateral ligament surgery has reached epidemic proportions in recent years, but the results of surgery have also improved.[22] Up-to-date data on the long-term success of this surgery are not fully available leading to a lack of consensus on the risk associated with drafting a player or signing a free agent after this surgery.

Health data on players entering the draft could be recorded in an EHR that could later be compared with longevity of play, injury recurrence, and ultimate level of play achieved to help determine risk. This attempt would require the use of an EHR on draft records either by individual teams or in a league-wide fashion. These data would be especially helpful in postoperative patients after major joint surgery. A Combine for the top 200 to 500 prospects could be considered with mandatory imaging studies on the top candidates.

Preseason Physical Evaluation

Preseason physical evaluations are critical to setting the stage for a season-long conditioning program. In baseball, this occurs at Spring Training. Many current screening programs in Spring Training involve the identification of pathology in the player and treatment programs geared

toward their treatment. This is an example of a reactive and not a proactive program. Because each player will have specific deficits unique to them, a spring training assessment on each individual player to glean information regarding previous injury history, posture, muscle imbalances, core stability, joint mobility/stability, muscular flexibility, range of motion (ROM), strength, functional deficits, and agility is critical. Commercially available products primarily developed in the National Basketball Association exist for evaluation of these issues in individual players but have not been validated in baseball and have not been routinely adopted around the league.[23] An evaluation system such as this must be specific and efficient and target specific identifiable findings that have been proven to have a notable prognostic value for injury. The benefits of this information are twofold. First, deficits that may place the player at risk for injury during the long season can be identified, and this information can be used to design a training program specific for that individual player. Programs in soccer and women's basketball focused on improving specific areas of weakness in individual players have been successful in decreasing the incidence of hamstring and anterior cruciate ligament injuries.[4,8]

Second, this testing sets baseline measurements of ROM and strength of all the major joints and trunk unique to that particular player, which will allow the medical staff to identify changes that may be harbingers of more serious problems to follow. Baseline information on ROM and strength for each player can be evaluated and used for comparison with subsequent values recorded throughout the season on a regular basis (Table 1). Changes in flexibility and strength in an individual player can be a warning sign of impending decompensation, and early intervention can often avoid the progression to injury.

Table 1

Specific Measurements at Spring Training Physicals

Visual posture assessment with pictures for reference	Thoracic extension and rotation
Shoulder AROM/strength	Neck ROM
Static/dynamic scapular assessment	Ankle mobility
Shoulder IR/ER PROM for comparison bilaterally	Overhead squat
Breathing assessment	Single leg squat
Rib flare	Core stability
Hip ROM/strength bilaterally	—

AROM = active range of motion, ER = external rotation, IR = internal rotation, PROM = passive range of motion, ROM = range of motion

A standardized intake evaluation with consistent methods of measurement could be of notable benefit to MLB and could be modified by validation studies over time. Data tracking is necessary to prove the benefits of a program such as this.

Maintenance Program In-season for Personnel

Variation in physical demands differs markedly among players of specific sports with greater variation noted in sports such as football and baseball than in soccer or basketball. In baseball, in-season demands and playing schedules vary markedly between starting pitchers, relievers, and position players, and the maintenance programs for each must be tailored based on their needs. Reasonable conditioning is necessary to maintain strength through the long season. Programs such as this have been shown to decrease the incidence of injury in multiple sports.[4,5,7-9] The overall goal of training program design for all player populations should be to promote movement symmetry with high levels of dynamic control. Throwers have more specific needs related to active recovery and/or preservation of dynamic shoulder stability, which can be supplemented on top of progressive, total body conditioning program, and targeted corrective exercise program based on individual movement profile (ie, Movement Efficiency Test). Starting pitchers typically pitch every 5 days according to most rotations in the league currently. A structured program for each day is necessary to allow recuperation from the start and prepare the player for the next start (Table 2).

Relievers, in contrast will pitch more frequently but for shorter periods than starters. Each pitching schedule stresses the pitchers in its own way, and the program for relievers must be planned to account for the fact that they do not have longer periods of recovery between outings (Table 3). Treatment of relievers is more complicated based on whether they are a long reliever or short reliever. Continual communication with the coaching staff regarding each pitcher is extremely important to help guide treatment based on whether the player has a high probability of throwing on any given night. The medical staff may have to alert the coaching staff regarding potential injury if a player is exhibiting any abnormal fatigue or tightness anywhere in their throwing arm.

Some variability exists in the league, and these programs are typically determined by a coordinated effort between the coaching and

Table 2

In-season Training Program for Starting Pitcher

Day 1: Post pitch[a]	Soft tissue/trigger point work; stretch throwing upper extremity; hips and thoracic rotation; RTC/scapular stabilizations; forearm manuals or exercise routine
Day 2[b]	Player's choice of long toss or pitcher's catch; light rotator cuff work ie, Thrower's 10 or manual resistance; diaphragm; corrective exercise to maintain proper postural alignment
Day 3: Side session	Stretch throwing upper extremity and hips; flush massage to throwing arm; closed chain scapular/cuff work; deceleration toss
Day 4	Pitcher's catch; corrective and movement prep
Day 5: Pitch	—

RTC = rotator cuff

[a] Stretching of the throwing shoulder will be structured based on the player's level of laxity, which is determined through the assessment process. Players who have a tendency toward laxity in their shoulders will have a focus on stabilization and may not be stretched at all. Pitchers with a tendency to tighten up after throwing may need more stretching and soft tissue work. These tendencies must be observed by training staff and are subjective in nature.

[b] Program will be adjusted based on whether a player throws his side session on day 3 or day 4, and good coordination with the strength and conditioning staff is critical for the timing of upper and lower body training sessions and implementation of all corrective exercise.

Table 3

In-season Training Program for Relief Pitchers

1 inning (25 pitches or less)	Stretch throwing upper extremity and hips; soft tissue/trigger point work; diaphragm; light scapular/RTC stabilizations
2 innings (40 pitches or less)	Stretch throwing upper extremity and hips; soft tissue/trigger point work; diaphragm; light scapular/RTC stabilizations
3 or more innings >50 pitches	Stretch throwing upper extremity and hips; soft tissue/trigger point work; diaphragm; Thrower 10 or manual resistance

RTC = rotator cuff

These are general guidelines and each player will have individual needs that will have to be addressed based on a postgame assessment of how they feel and what the medical professional sees after assessment.

Good communication with the strength and conditioning staff is extremely important to help guide their program and focus on minimizing fatigue.

training staff, but an overall team-approved structure to assure consistent management is critical to ultimate success. This type of program is also very reassuring to the players that health maintenance is a team priority. Programs for position players are more general but can be designed to target specific deficits identified at spring training.

Individualized programs should be developed based on baseline data from intake physical examinations and tailored to the player's specific position. The effectiveness of these programs can be compared with historical injury data and updated on an ongoing basis based on success.

In-season Evaluations

The highest rate of injury during the regular season occurs in the first month of the baseball season (April) and the lowest rate in September, suggesting that deconditioning and rapid increase in workload early in the season play a notable role.[1,24] These injuries are often preceded by a prodromal condition characterized by weakness in certain muscle groups, loss in ROM and signs of soft tissue inflammation.[25,26] For example, the importance of hip rotation in both the push-off and landing leg and its effect on stresses in the upper extremity has been recently investigated.[27,28] Changes in ROM and strength of the shoulder during the season have been well-documented, and their contribution to injury is known.[25,26,29] Weakness of shoulder external rotators and the supraspinatus muscle and glenohumeral internal rotation deficit have been associated with a higher risk of injury in professional baseball players,[25,26] and identification of the player in the "pre-superior labrum anterior posterior glenohumeral internal rotation deficit" stage can be effective in avoiding progression to notable structural damage.

Systematic evaluation of all players beginning in spring training and continuing monthly throughout the season with comparison with their individual baseline studies is critical toward allowing early identification of problems and timely treatment through modalities, stretching, strengthening, and possible rest (Table 4).

Treatment Programs After Injury

The growing database of information regarding the management of injuries has exploded with the introduction of a league-wide electronic medical record. This data mining has recently been started on a systematic fashion by MLB based on incidence of injuries and effect on the player and club. A recent publication regarding

the management of hamstring injuries[30] reflects the great power of data in helping guide management of these common injuries. These data will become increasingly available with regard to other injuries as these studies are completed. Studies such as these serve as a roadmap to best practices with the management of the most common injuries seen by the medical staff. These data can be further mined to identify teams who are "best performers" within the league who have achieved a more rapid return to play of their players after specific injuries than others. Treatment protocols used by these teams could be scrutinized for possible adoption as best practices league-wide.

End-of-Season Evaluation

Careful end-of-season evaluation allows the team and player to assess the impact of injuries incurred that season, lingering physical problems, and overall conditioning issues. By repeating the Spring Training and mid-season assessment, an individualized program can be created at this time to take advantage of the off-season to manage any lingering problems and improve specific physical issues to help avoid recurrent problems in the upcoming season. The player can incorporate the corrective exercises provided from the end-of-season assessment before beginning their off-season strength and conditioning program to correct any alignment issues so they will not continue to strengthen dysfunctional patterns when they begin their off-season program.

Creation of Off-season Training Programs

Off-season programs will vary greatly from one sport to another. The proper off-season training program for a baseball player will depend on his age, stage of career, physical issues, and injury history. Young players who are drafted into professional baseball usually enter the organization over the summer after the spring draft and are not accustomed to continuous play for the length of the professional season. After summer and early fall instruction, these younger players require a period of relative rest away from baseball activities. The off-season is especially important at this stage of career to build the conditioning required to compete over a very long season. Journeymen players who have been in the league for several years may benefit from off-season play in one of various winter league programs to expose players to a higher level of play and showcase their development to management. Veteran players often require the off-season to rest and rehabilitate issues related to the previous season. Rest is a relative term and indicates a temporary respite from the stresses of throwing and hitting. This is a critical time when specific stretching, strengthening, and agility drills can be introduced on an individual basis. The reintroduction of batting in cages is variable, but most players do not pick up a ball until sometime around January 1st in preparation for Spring Training. Notable variation exists in these programs, which are often only loosely defined by the training staff allowing players to use a variety of practitioners to assist them with their

Table 4

In-season Evaluations

Pitchers
Loss of active cervical lateral flexion (bilaterally)
Rib flare with decreased oblique activity on that side
Loss of shoulder strength/scapular function
Loss of shoulder IR from baseline (dominant shoulder)
Loss of elbow extension
Loss or thoracic mobility
Loss of MVIC grip strength bilaterally
Pelvic obliquities + SI dysfunctions
Loss of hip extension/abduction (dominant/drive leg)
Loss of hip IR (nondominant/landing leg)
Loss of ankle dorsiflexion
Pitch velocity decrease (ave. last 2 innings) >5%
Position players
Loss of MVIC grip strength bilaterally
Loss of thoracic mobility
Rib flare with decreased oblique activity to that side
Asymmetries in hip IR/ER/extension
Pelvic obliquities + SI dysfunctions
Decreased hamstring flexibility
Loss of knee extension/flexion
Feet flattening and/or tibial lateral rotation during two leg squat
Knee valgus during one leg squat
Loss of ankle dorsiflexion

ER = external rotation, IR = internal rotation, MVIC = maximum voluntary isometric contraction, SI = sacroiliac

Table 5

Medical Team Structure
Medical Director or Director of Player Health and Performance (possible dyad model)
Team physicians (Orthopaedic and medical team at each club within the organization)
Consulting physician panel
Head ATC and Assistant ATC at major league level
Physical Therapist at major league club level
Director of minor league training staff
Assistant ATCs (minor league coordinator and ATCs at each team within the organization)
Physical Therapist (long-term rehabilitation specialist for entire organization)
Strength and conditioning coaches
Chiropractor (contract for select home games only)
Massage Therapist (contract for select home games only)
Customization according to team desires and needs with oversight by Medical Director

ATC = Athletic Trainer Certified

program. The training program developed by the staff must take into account the stage of the player's career, any physical issues identified at end-of-season physicals, and other off-season obligations that the player will have to the organization. Adequate rest is critical to successful participation in the next year season. Focused stretching and strengthening specific for that player, which may not be appropriate during the season, may help avoid injury during the next. Programs are designed in coordination with coaching staff and administration taking into account participation in fall and winter leagues. Players can be evaluated at Spring Training to determine whether goals are met. Adoption of off-season training programs requires acceptance and compliance by the players and cannot be forced on players without their consent and that of the Player's Association. Players have the right to obtain medical and surgical care independent from the team, and monitoring and coordination of this care is critical for team planning purposes.

Medical Team Structure

Creation of a uniform system of care throughout the organization requires an organized medical team that embraces a proactive role of injury prevention and evidence-based treatment of injuries seeking to emulate best practices (Figure 1). The responsibilities of the medical team include the development of a cohesive health care system for the players at all levels of the organization and their families. In addition, coordination of care with club administrators and coaches is an essential function. This includes timely communication on all the medical issues within the organization. The leaders of this department play a primarily administrative role to coordinate care for the organization, and although this role has traditionally been filled by a physician, a medical degree is not essential at this top coordinating role. Indeed, more and more professional teams are moving to other health care professionals because the time demands of this position have exceeded the availability of many team physicians. The exact title has morphed to more appropriate ones such as Health Coordinator or Director of Player Health and Performance. It is critical for everyone in the organization to understand their role and work within their scope of practice. It is not appropriate for nonphysicians to make medical decisions. A dyad structure with an administrator and an MD is often extremely efficient to allow management of medical and related administrative issues by these two members at the top of the medical team. The organizational chart must be established and set into motion before the season begins and must be made up of all the critical personnel necessary to create a well-balanced and comprehensive program (Table 5). Once the season has started, the volume of work of the training and strength and conditioning staff becomes overwhelming, and these programs must already be in motion for them to be practical. The Director of Player Health's role is to help establish Club policies for all of the issues discussed above and ensure that each team member understands his or her role. This plan is made with the input of all of the appropriate medical staff and training personnel. Coordination of all medical staff including Minor League personnel, strength and conditioning coaches, and rehabilitation staff is critical to assure that variations of care do not exist in the organization and that protocols are agreed upon by all members of the treatment and coaching teams. Disagreements can be sorted out and best practices determined in the off season. The Director of Player Health also serves as a critical link for coordination with the Team Manager and General Manager regarding medical and administrative issues relative to the individual player. A network of referral physicians is also critical to manage the myriad of other medical issues that can occur to the players and

their families. A referral network typically exists in all professional sports to direct both players and their families for care necessary outside the spectrum that the team has to offer directly. This ensures that quality care is available for all varieties of health care needs including women's services and mental health issues.

Summary

The creation of a comprehensive medical service in professional sports organization has the potential to improve player health and overall club welfare by instituting programs that can optimize player health throughout the organization. The medical team must develop a proactive stance toward the prevention of injury through identification of physical deficits in players that may place that player at risk for injury or may be an indication of an imminent decompensation. This will allow the creation of individualized training programs to maximize player function and minimize their chance of injury. Standardized protocols are required throughout the entire organization to assure that players are treated according to best practices to minimize treatment variation and hopefully decrease time on the DL. Management protocols should be data driven and simulate the best practices throughout the country. Risk assessment for draft choices must be data driven. The Medical Team's other responsibilities include adequate preseason assessment, creation of in-season training programs individualized for each player and position, development of standardized protocol for the management of injury and rehabilitation of surgeries based on league-wide best practices, the assessment of physical condition at the end of the season, and creation of an off-season training program to optimize the players health for the upcoming season. These recommendations are made based on recognized deficiencies in currently used systems, but the effectiveness of the strategies recommended here will require prospective evaluation for validation.

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