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PROFESSIONAL BASEBALL ATHLETIC TRAINERS SOCIETY

IN THE SPOTLIGHT: RICK SMITH

The Foundations of Our Society: Service, Education and Relationships

By: Magie Lacambra M.Ed., ATC, Gatorade Team Sports Manager

Founding the Professional Baseball Athletic Trainers Society (PBATS) was a major league risk. When Rick Smith and his fellow PBATS charter members held their first meeting in 1981 it was without support of Major League Baseball (MLB).

When Smith first joined the Los Angeles Angels organization in 1976 by way of their Double-A affiliate, the El Paso Diablos, PBATS wasn't even a thought. After two seasons with the Diablos, Smith was called up to the Big League Angels in California. Three years later he took a trip to Florida where he attended perhaps the most important meeting of his entire 45-year career.

"During the Winter Meetings of 1981 we were not allowed at the MLB hotel," says Smith. "Management within MLB thought we were forming a union and were vehemently opposed."

The athletic trainers did not let this stop them. They got their own rooms at a different hotel across town and met in one of the staff suites. Here, at this unsanctioned conference in Hollywood, FL, PBATS was born.

What the Commissioner and the rest of MLB brass failed to understand at the time was that PBATS wasn't founded to pick a fight with MLB. It was founded to help improve it. PBATS was formed with education as its foundational goal and continues to hold this same focus today.

"I try to pass along to the young athletic trainers to not forget where you came from," says Smith. "Do not forget what it took, what it takes and what it is going to take to be here and stay here. ... As founding members, we put our careers on the line to get to where we are today."



And, where we are today is nothing short of remarkable, especially for those, like Smith, who helped to build PBATS up from a hotel room floor. For starters, the Society is now welcomed and respected by the MLB front office. The Commissioner's door has been opened wide. Smith still gets goose bumps when he thinks of how far PBATS has come and all of the significant, quality work the Society has accomplished.

"We give scholarships to young athletic trainers, we host educational seminars and we are partnered with reputable companies," shares Smith. "We are now an integral and respected partner of MLB. The Commissioner meets with us and wants our input to make the game safer for players and staff."

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IN THE SPOTLIGHT: **RICK SMITH: CONTINUED ...**

Smith credits the success of PBATS to the passion of longtime Society members Charlie Moss, Jeff Cooper, Dave Pursley, Larry Starr, Gene Gieselmann, Bill Buhler, Richie Bancells, Herm Schneider, Rick Griffin, Jeff Porter, Jamie Reed and Gene Monahan.

“Their vision, ideas and relationships have made our group what it is today,” says Smith. “Our executive board drives our bus. If the bus is going to continue moving forward, we as members have to be willing to do the work and go the extra mile.”

Smith is quick to point out that his and PBATS’ accomplishments were not made in a vacuum. He is a firm believer that relationships and giving back are crucial to everyday life as well as key factors of PBATS’ success. Neither Smith nor the Society ever could have achieved the status they hold today without the generosity of outside influencers.

Dr. Lewis Yocum is one of those outside influencers. “Lew,” as Smith affectionately refers to him, worked alongside Smith as the Angels’ team orthopedist for 36 years.

“Lew was a dear friend and strong supporter of PBATS,” says Smith. “Lew was willing to put his name on the line for PBATS.”

Dr. Yocum, along with Dr. Robert Kerlan and Dr. Frank Jobe, saw PBATS as vital to the longevity of MLB, and showed their support by sticking their necks out to preserve the Society during its formational period. In addition to these physicians, PBATS’ corporate partners have played a crucial role in the organization’s long climb to legitimacy.

“We couldn’t be here today without the support that Bill Schmidt from Gatorade provided when we were first starting out,” says Smith.

Smith considers himself a worker and embodies the same values he ascribes to PBATS. He relates his longevity with the Angels organization to his work ethic, as well as the relationships of those he has worked with, including athletic trainers Ned Bergert, Adam Nevala, Eric Munson and Geoff Hostetter, as well as team physician Craig Milhouse.

“I am lucky to have worked alongside very smart medical providers who are also really good people,” admits Smith. “I have had a wonderful career in baseball. I have been a part of the growth of PBATS. I have been able to stay with one organization. I am a member of the ‘club,’ the World Series club. I was fortunate to have my wife Janell and son Karcher with me during the World Series in 2002, and that was very special. I could not have done any of this without their

support, as well as that of my daughter Michelle and grandson Rocco.”

However, one of Rick’s crowning achievements involves a different ring. It came in December 2019, back at the MLB Winter Meetings (in San Diego this time around), when he received his PBATS Service Ring.

“That was a really proud moment,” says Smith. “I preach service. Not only service to our players, but to our members and young athletic trainers who want to work in baseball.”

Alumni Feature: Gene Gieselmann

By: Jacob Newburn, Texas Rangers, MS, LAT, ATC

PBATS Hall of Fame inductee and former St. Louis Cardinals athletic trainer Gene Gieselmann kept his team healthy for almost three decades. Retiring in 1997, he witnessed three National League pennants and a World Series Championship, all while fighting for athletic trainers to be recognized by the MLB Hall of Fame. Gieselmann's perspective on athletic training reveals not just key takeaways from his career but also what is to come.

Q: What do you see as your biggest accomplishment as an athletic trainer?

A: We've all had something we accomplished with player rehabs, but for me, being a charter member of PBATS is the biggest thing. In the beginning, athletic trainers didn't communicate well when they came into town, and we strove to change that. There was no regular interleague play back then, and you didn't know guys in the other league. PBATS was a way for us to intermingle, share ideas and educate one another on things happening in our field across the league. I have been elected into the Missouri and St. Louis Sports Halls of Fame, but being inducted into the PBATS Hall of Fame means everything to me, more than any other award I have received.

Q: Over your career, how has athletic training changed?

A: There are more hands on deck now. It used to be two hands; now there are two, three or even four athletic trainers with each team. We used to do it all by ourselves. I would leave for the field 2 1/2 hours before the first bus so that I could care for injured players, and when the regular bus arrived, I took care of the game guys. Similar to today, but back then there was only one athletic trainer. Also, media coverage has changed. There is more scrutiny, more cameras on you when you're on the field.



Q: What advice would you give to a young athletic trainer getting started in the field?

A: Get as much education as you can. Learn from your peer group, do the best possible job, and be honest with players and management. The organization and front office have invested time and money into players, and they are depending on us to protect their investment and keep it on the field. We owe it to them to prepare ourselves and do the best job possible.

Q: What do you see as the biggest challenge facing PBATS and baseball athletic trainers going forward?

A: It is your responsibility going forward to continue the work that the charter members of PBATS started. It was all about education and trying to better ourselves and learning more so we could be better athletic trainers. You guys today don't have to worry about the financial and political issues we dealt with starting this organization, so you can concentrate on education, friendship and building professional relationships with one another. You can't put a dollar value on the friendships you make in this game and I hope PBATS continues to invite alumni back to the meetings for our input.

NEWS AND NOTES

2019 PBATS Major League Athletic Trainer 20 Year Service Award

George Poulis – Atlanta Braves



Pictured L-R: Ron Porterfield, George Poulis

2019 PBATS Major League Team Physician 20 Year Service Award

Dr. Patrick DeMeo – Pittsburgh Pirates

Dr. Steven Erickson – MLB Umpires

Dr. William Raasch – Milwaukee Brewers

Dr. Edward Snell – Pittsburgh Pirates

2019 PBATS Hall of Fame Inductees

Dr. James Andrews – Tampa Bay Rays



Pictured L-R: Joe Benge, Mark Vinson, Ken Crenshaw, Jamie Reed, Ron Porterfield, Dr. James Andrews, Paul Harker, Joel Smith, Mike Sandoval, Aaron Scott

Gene Gieselmann – St. Louis Cardinals



Pictured L-R: Keith Joynt, Chris Conroy, Brad Henderson, Gene Gieselmann, Adam Olsen, Jeremy Clipperton

PBATS Past President's Award

Mark O'Neal (2014 – 2019)



2019 PBATS President's Distinguished Service Award

Ken Crenshaw – Arizona Diamondbacks



Pictured L-R: Ron Porterfield, Ken Crenshaw

2019 PBATS Minor League Athletic Trainer of the Year

Chris McDonald – Detroit Tigers



Pictured L-R: Ron Porterfield, Chris McDonald

2019 PBATS Major League Staff of the Year

Oakland Athletics – Nick Paparesta, Jeff Collins, Brian Schulman



Pictured L-R: Brian Schulman, Nick Paparesta, Ron Porterfield, Jeff Collins

2019 PBATS Minor League Athletic Trainers of the Year – Individual League Awards

LEAGUE	ATHLETIC TRAINER	MAJOR LEAGUE TEAM	MINOR LEAGUE AFFILIATE
Coordinator	Patrick Serbus	Cincinnati Reds	–
International League	Chris McDonald	Detroit Tigers	Toledo Mud Hens
Pacific Coast League	Brad LaRosa	Oakland Athletics	Las Vegas Aviators
Eastern League	Caleb Daniel	Toronto Blue Jays	New Hampshire Fisher Cats
Southern League	Tyler Moos	Cincinnati Reds	Chattanooga Lookouts
Texas League	BJ Downie	Seattle Mariners	Arkansas Travelers
Florida State League	Matthew DenBleyker	Pittsburgh Pirates	Bradenton Marauders
California League	Michael Powell	Arizona Diamondbacks	Visalia Rawhide
Carolina League	Nate Stewart	Houston Astros	Fayetteville Woodpeckers
Midwest League	James Edwards	Chicago Cubs	South Bend Cubs
South Atlantic League	Darren Yoos	Washington Nationals	Hagerstown Suns
New York – Penn League	Joseph Olsiewicz	St. Louis Cardinals	State College Spikes
Northwest League	Dominic Alejandre	Texas Rangers	Spokane Indians
Appalachian League	Manny Ozoa	New York Yankees	Pulaski Yankees
Pioneer League	Chelsea Willette	Los Angeles Dodgers	Ogden Raptors
Arizona League	Derrick Decker	Texas Rangers	AZL Rangers
Gulf Coast League	Cody Derby	Detroit Tigers	GCL Tigers - West
Dominican Summer	Oscar Orengo, Jr	San Diego Padres	DSL Padres

2021 All Star Game Athletic Trainers

National League

George Poulis – Atlanta Braves

Adam Olsen – St. Louis Cardinals

American League

Matt Lucero – Texas Rangers

Mark Vinson – Tampa Bay Rays

2021 Futures Game Athletic Trainers

Chris McDonald – Detroit Tigers

Nick Flynn – Atlanta Braves

Treatment of Oblique Strains

By: Mark Vinson, MEd, ATC, CSCS

Oblique strains are a common injury in baseball. The actions of both hitting and throwing require tremendous activation of the oblique muscles in order to produce the acceleration required for these high speed rotation movements. A 2017 study using data collected from MLB's Health and Injury Tracking System (HITS) looked specifically at the prevalence of oblique injuries and the average return to play for pitchers and position players.¹ The study found that the two most common mechanisms for injury were hitting (47%) and pitching (35%). Pitchers averaged 26 days missed per injury while hitters averaged 21 days missed per injury.

Acute oblique strains are characterized by pain and soreness with trunk rotation and often involve pain with coughing or sneezing. Timelines for return to play can vary depending on the severity of the injury. However, a typical treatment plan involves rest for the first one to three days, followed by light activity for the first week. Rehabilitation involves core strengthening and progressing into low resistance, slow and controlled rotational exercises as long as the athlete is asymptomatic.

Rotational movements in a pool are an example of lower resistance, controlled exercises. Performing underwater medicine ball rotations or swinging a bat in the pool can provide resistance through a full range of motion, while protecting against reaggravation of injury due to lower speeds.

In addition to progressive loading of the oblique muscles, emphasis should be placed on maintaining range of motion in the thoracic spine and hips.

At 10-14 days post-injury, higher speed functional activities may be initiated if symptoms are no longer present with coughing or sneezing and with eccentric loading of trunk rotation. Eccentric loading can be achieved through manual resistance exercise (MRE) with an athletic trainer/therapist providing resistance through the range of motion (see Fig. 1).

A common progression for pitchers includes "sock throws" where a sleeve is placed over the hand and wrist with a ball placed in the hand. The pitcher then goes through the throwing motion, releasing the ball into the sock.

Once the pitcher is able to complete sock throws without pain, then he is able to progress to a flat ground throwing program. Gradual increases in distance and the volume of throws should be monitored to prevent setbacks due to overtraining.

For hitters, an example of a progression may start with "dry swings" using a fungo (lighter weight) bat. If there is no discomfort with a fungo bat, then the dry swings can be repeated using a regular weight bat. From dry swings, the hitter can progress to hitting off the tee with a fungo bat, followed by hitting off the tee with a regular bat. Increases in volume (number of swings) should be implemented slowly before progressing to soft or front toss and finally progressing back into regular batting practice. This progression typically lasts another seven to 10 days and includes recovery days designed to limit all rotational activities on those days.

During the rehabilitation phase, many modalities can be utilized to help with recovery. In addition, taping or wrapping the rib cage and abdominals may provide support and reduced discomfort. Various methods for using kinesiology tape for the obliques are available online. One particular method involves a very simple application of one or more strips on the affected side in a diagonal fashion starting at the posterior wall of the thorax and extending down toward the umbilicus (see Fig. 2).

For additional support, the tape may be covered with an elastic bandage or a neoprene support.



Fig. 1



Fig. 2

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Mental Health, A Biopsychosocial Approach

By: Josiah Igono, Ph.D., CSCS



Mental health has become a buzz word in modern day vernacular. We are now seeing more vulnerability in this area than any point in history, particularly with athletes. Mental health exists on a continuum, and it must be treated as such. Although mental health may deal with things such as depression, anxiety, suicide, substance abuse disorders, eating disorders and psychosis, this will not be the emphasis of this article. Instead, the biopsychosocial model will be presented as a means of mitigating problematic areas that athletes may face and encourage the formation of new behaviors that may augment one's mental health. This article will address what mental health is, why it is important and how to maintain a healthy mindset.

One of the common definitions of health is the state of being free from illness or injury. Furthermore, mental health is defined as a continuum ranging from having good mental health to having a mental disorder (National Council for Behavioral Health, 2015). In theory, an individual who is mentally healthy is someone whose mind is somewhat free from anything that would cause it harm or danger. It is important to understand these definitions on a granular level, because mental health is widely viewed as a negative construct. Viewing mental health as simply a negative construct is both an injustice and inhibits people from getting the help they may need (Robinson et al., 2019). Moreover, it prevents individuals from improving their current position regardless of

where they are on the continuum. Barring mental disorder, there are many things that may affect one's mental health. Among these include psychological stress, lack of sleep, hyper-interaction with information and social media, and environment.

For many athletes, prolonged bouts of psychological stress may affect overall mental health. There are various forms of stress (eustress, chronic stress, acute stress, distress, etc.). Whereas the appropriate application of stress causes growth, an overload of stress can cause damage, brokenness or worse. It is important for athletes to be able to think clearly, and to manage mood, emotions and feelings. Stress is closely related to psychological well-being (Xiang et al., 2019), and when compromised, can be a detriment to one's mental health.

It is well known that the lack of sleep can compromise one's physical well-being (Patrick et al., 2017). Sleep has been found to be a predictor of depression, with individuals who are sleep deprived being at more risk of depression than their counterparts (Myers & DeWall, 2015). The lack of sleep also compromises one's psychological and cognitive functioning. Sleep deprivation also inhibits reaction times, and increases errors on visual attention tasks (Myers & DeWall, 2015) which is of high consequence to athletes. When an individual is not well rested, these preceding areas inhibit higher levels of performance. Ultimately, a chronic lack of sleep eventually compromises one's mental health.

In our technologically advanced society, research indicates that we are dealing with information overload, and are spending an average of 20-30% of our computing and mobile time on social media, respectively (Nielsen, 2012; Scheinbaum, 2018). These numbers have the potential of becoming even more magnified for athletes, as they are entrenched in a proverbial glass bowl of performance and undergo constant scrutiny. With voluminous information being readily available, and potential interactions with thousands (sometimes millions) of followers which the athlete may never physically meet, having frameworks in place to manage information uptake and social media consumption is imperative.

SPORTS MEDICINE: CONTINUED ...

A healthy environment is critical in the maintenance and growth of a healthy mindset. There are several factors that go into creating a healthy environment. An athlete's support system, home life, nutrition, hydration, relationships, medication if necessary, spirituality and his or her ability to healthily recover from the rigors of professional and personal responsibilities are vital. Some models in literature, such as the biopsychosocial model, first developed by George Engel, suggest that when these disparate areas are addressed, it will yield an individual who is mentally healthy (Kusnanto et al., 2018). It is important for an athlete's environment to edify, encourage and facilitate the rejuvenation of both body and mind.

For athletes who are experiencing stress, activities such as meditation, prayer, mindfulness, diaphragmatic breathing, yoga, reading, laughter and activities involving music may be beneficial for overall mental health. For athletes who struggle with sleep, forming a sleeping routine with the aid of professionals, which includes eliminating substances that affect sleep, and organizing/rearranging the sleeping environment may be beneficial. Well-rested athletes typically have more energy, sustained endurance, faster reaction times and improved performance (Myers & DeWall, 2015). Sie and colleagues (2013) suggest that when it comes to online networks, individuals should keep a balance between an appropriate amount of information sharing and interaction in their respective networks, along with a trustworthy and supportive following. Athletes who adhere to this advice may see improved balance in the handling of information and their social media interactions.

Mental health is a complex phenomenon, and a complex model such as the biopsychosocial model may be beneficial in addressing mental health issues that many athletes face. This model may add value in restoring balance for athletes, as it incorporates elements that positively influence one's biology, psychology and environment. Are you achieving peak levels of mental health? Ask yourself the following:

- Are you typically free from long bouts of psychological stress consisting of both duration and intensity?
- Are you getting quality sleep on a regular basis?
- Do you have a healthy balance in mediating interactions involving social media and information consumption?
- Do you have an environment that healthily addresses your home life, nutrition, hydration, relationships, medication if necessary, spirituality and your ability to recover from the rigors of life?

If you answered "no" to one or more of these, please consider some of the solutions presented here. There is also an array of health professionals who can be of assistance regardless of where you are on the mental health continuum (i.e., doctors, performance coaches, nutritionists, social workers, counselors, psychiatrists, psychologists and other mental health professionals). Mental health is no longer a stigmatized subject with minimal answers. It is a multifaceted construct with multiple solutions.

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New Perspectives on Nutrition and Athlete Immune Health

By: Neil P. Walsh Ph.D., FACSM

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An upper respiratory infection (URI), such as a common cold, might only present an unwelcome nuisance for many of us. However, a URI and other infections might limit an elite athlete's availability to train and take part in major competition. (Table 1). Recent research highlights prominent risk factors for infection in elite athletes and reveals the connection between immune health and athletic performance (Table 2). (Drew et al., 2017; Hellard et al., 2015; Svendsen et al., 2016; Wentz et al., 2018).

Why infection is incompatible with success in elite sport.

- Medal winners suffer fewer and shorter URI
- Infection is the 2nd most common reason to present to a team medic, after injury
- Sickness correlates negatively with training volume
- Illness accounts for 1/3 of all lost training days
- 2/3 of illnesses result in "time loss" from training and competition; 1/3 of illnesses result in "performance restriction"
- Recent below-the-neck symptoms increase the likelihood of not finishing an endurance event
- Heavy exercise can extend an ongoing infection
- Heavy exercise during infection, or after incomplete recovery, can lead to medical emergencies ...
 - Rhabdomyolysis¹
 - Myopericarditis²
 - Exertional heat stroke

Table 1. Why infection is incompatible with success in elite sport. URI = upper respiratory infection; ¹Rhabdomyolysis = breakdown of muscle tissue that can lead to renal failure; ²Myopericarditis = acute inflammation of the pericardium usually caused by an infection.

Why Does Nutrition Influence Immunity and Infection?

The immune system's ability to clear viruses, bacteria and other pathogens, termed "resistance," is dependent upon an adequate supply of energy from important fuel sources including glucose, amino acids and fatty acids. In addition to fuel requirements, cell proliferation requires nucleotides for DNA and RNA synthesis and amino acids for protein synthesis. Micronutrients such as iron, zinc, magnesium and vitamins C and E play important roles in nucleotide and nucleic acid synthesis and antioxidant defenses that limit tissue damage. Antioxidant availability can be particularly important during heavy exertion or infection when oxidative stress increases.

Ten risk factors for infection in athletes.

1. Autumn and winter — common cold and flu season
2. Poor hygiene and exposure to sick people
3. Recent symptoms
4. Air travel
5. Life stress, depression and anxiety
6. Low energy availability
7. Poor sleep
8. Increases in training load, e.g., training camp
9. National vs. International level
10. Low mucosal immunity (saliva/tear immunoglobulin-A)

Table 2. Ten risk factors for infection in athletes.

A New Theoretical Perspective on Nutrition and Athlete Immune Health

Traditionally, immunologists have focused their efforts on understanding the immune weaponry (Figure 1) at our disposal in the fight against infectious pathogens. A new model for exercise science is presented in Figure 2 describing not only resistance but also "tolerance," which is defined as the ability to endure a microbe (Walsh, 2019). Key to effective tolerance is a proportionate immune response; an overly exuberant immune response can cause excessive tissue damage and unnecessarily allocate energy resources away from vital functions. Vice versa, a weak immune response increases susceptibility to damage from the pathogen. Homeostasis is achieved by an appropriate balance of resistance and tolerance that allows us to fight infection — in this case, cell signals indicate that a response is necessary but also allow for maintaining a healthy relationship with the mutualistic bacteria in our gut. This new theoretical perspective may improve our understanding of how sick we will become when we have an infection (in terms of severity and duration), and more clearly elucidate a role for nutrition, particularly in terms of tolerance (Figure 2).

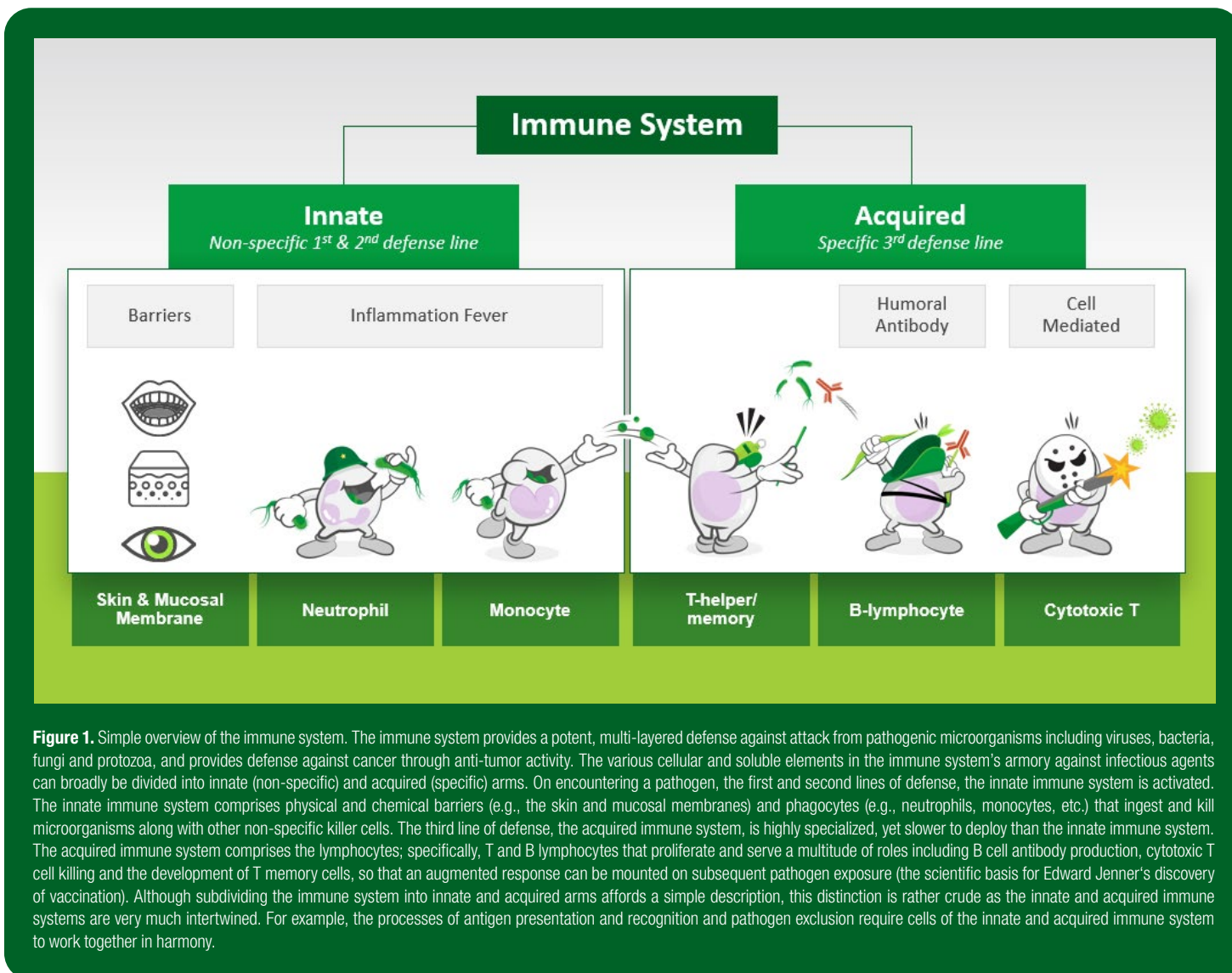


Figure 1. Simple overview of the immune system. The immune system provides a potent, multi-layered defense against attack from pathogenic microorganisms including viruses, bacteria, fungi and protozoa, and provides defense against cancer through anti-tumor activity. The various cellular and soluble elements in the immune system's army against infectious agents can broadly be divided into innate (non-specific) and acquired (specific) arms. On encountering a pathogen, the first and second lines of defense, the innate immune system is activated. The innate immune system comprises physical and chemical barriers (e.g., the skin and mucosal membranes) and phagocytes (e.g., neutrophils, monocytes, etc.) that ingest and kill microorganisms along with other non-specific killer cells. The third line of defense, the acquired immune system, is highly specialized, yet slower to deploy than the innate immune system. The acquired immune system comprises the lymphocytes; specifically, T and B lymphocytes that proliferate and serve a multitude of roles including B cell antibody production, cytotoxic T cell killing and the development of T memory cells, so that an augmented response can be mounted on subsequent pathogen exposure (the scientific basis for Edward Jenner's discovery of vaccination). Although subdividing the immune system into innate and acquired arms affords a simple description, this distinction is rather crude as the innate and acquired immune systems are very much intertwined. For example, the processes of antigen presentation and recognition and pathogen exclusion require cells of the innate and acquired immune system to work together in harmony.

Nutritional Supplements for Immune Resistance: If it ain't broke, don't fix it!

As logic would dictate, support for nutritional supplements to improve immune resistance and thus decrease pathogen burden comes largely from studies in those with impaired immunity. This population can include the frail elderly and clinical patients, particularly in those with poor nutritional status (Bermon et al., 2017). Additionally, over the past 25 years or so, exercise immunologists have actively researched nutritional supplements to improve immune resistance in athletes (Table 3). For much of this period, there was a broad acceptance among exercise immunologists that immunity was impaired in athletes under heavy training, prompting the search for nutritional countermeasures.

A more contemporary view is that the evidence supporting immuno-suppression in athletes is lacking. So it is not surprising that supplements targeted toward immune resistance show limited benefits for athlete immunity and host defense (Table 3). One exception is the therapeutic effect of zinc lozenges for treating the common cold. A recent meta-analysis showed that dissolving zinc lozenges in the mouth (75 mg/day elemental zinc) reduced URI duration by around three days when taken fewer than 24 hours after the onset of symptoms and for the duration of the illness (Hemilä, 2017).

However, in his research, Hemilä points out that the optimal zinc lozenge dosage and composition need to be determined; many over-the-counter lozenges contain

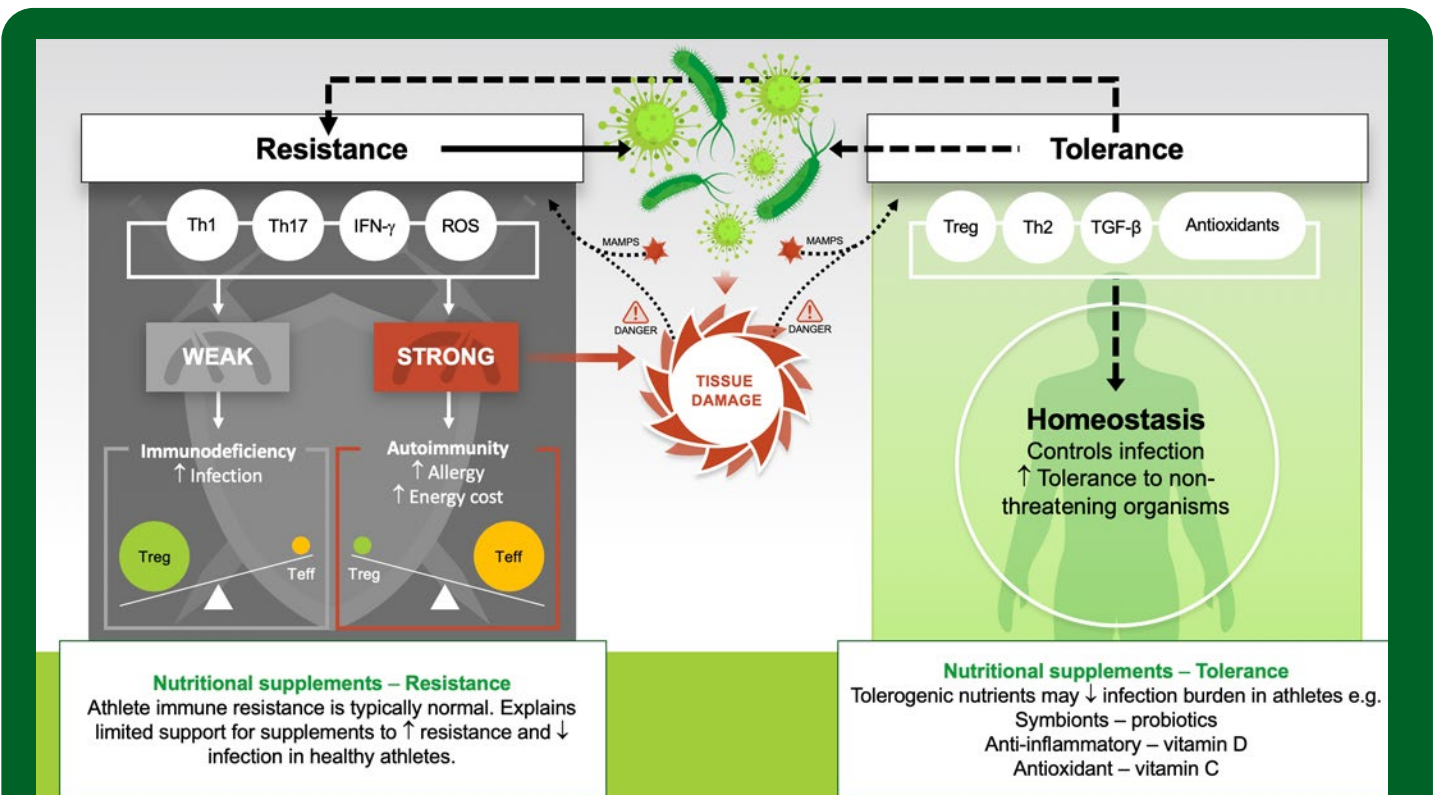


Figure 2. Model of resistance and tolerance in host-pathogen interactions and the value of nutritional supplementation. Dark shaded area on the left (arrows with solid lines) shows classical view of immune resistance where the immune weaponry protects the host by attempting to reduce the pathogen burden, through cell-mediated killing and release of ROS for example. Weak resistance results in immunodeficiency and increased risk of infection. On the other hand, an overly exuberant immune response to a pathogen causes tissue damage and wasteful diversion of energy resources away from other important functions. An overly strong immune response is associated with autoimmunity and allergy. In this simple model, homeostasis is achieved by balancing effector and regulatory sides of the scales. This classical model of immune homeostasis overlooks important tolerogenic interactions with the pathogen. The concept of tolerance, the ability to endure microbes, (light shaded area on the right and arrows with broken lines) has been adopted from ecological immunology where work in invertebrates shows important tolerogenic interactions between the host and microbes, the findings of which are generalizable to vertebrates. Pathogens influence the magnitude of the immune response by displaying conserved molecules called microbe-associated molecular patterns (MAMPS), and by stimulating the release of danger signals from damaged tissue. Tolerance in this model dampens defense activity (upper broken arrow) yet controls infection at a non-damaging level, with the added benefit of a lower energy cost. This explains how we tolerate commensal bacteria rather than eliciting an immune response to obliterate the large abundance of bacteria in the gut. This model also helps to explain why nutritional supplements with tolerogenic effects may reduce the burden of infection (e.g., reduced severity and duration) in otherwise healthy athletes. Adapted from Walsh (2019). IFN- γ = interferon gamma; ROS = reactive oxygen species; Teff = Effector T cells; Treg = regulatory T cells.

too little zinc or contain substances that bind zinc. Although the exact mechanism(s) requires elucidation, zinc may act as an antiviral agent by increasing interferon gamma and decreasing the docking of common cold viruses with binding sites. The therapeutic effects of zinc lozenges for treating URI have also been ascribed to antioxidant and anti-inflammatory properties of elemental zinc in the lozenge; as such, zinc lozenges may also have tolerogenic effects on immunity.

Tolerogenic Nutritional Supplements: The New Targets

Tolerance in this model dampens defense activity yet effectively controls infection at a non-damaging level. It also facilitates homeostatic regulation of beneficial intestinal microbial communities (Figure 2). Looking

through this lens, it is easy to see why studies involving nutritional supplements with tolerogenic properties have yielded some positive effects for reducing the burden of infection in otherwise healthy athletes (Table 4). Probiotics and prebiotics might have tolerogenic effects by influencing intestinal microbial communities and the common mucosal immune system. The antioxidant effects of vitamin C and the anti-inflammatory effects of vitamin D might improve tolerance, mitigating against excessive tissue damage during infection and as mentioned previously, the therapeutic effects of zinc lozenges for treating the common cold, though principally considered to reduce the pathogen burden and improve resistance, might also be attributed to antioxidant and anti-inflammatory, or tolerogenic, properties of zinc.

Nutritional Supplements and Immune Resistance ¹		
Supplement ²	Proposed Mechanism	Evidence for Efficacy ³
Zinc	Zinc is required for DNA synthesis and is an enzyme cofactor for immune cells. RNI is 7 mg/day for women and 9.5 mg/day for men. Zinc deficiency results in impaired immunity (e.g., lymphoid atrophy) and zinc deficiency is not uncommon in athletes. Antiviral effects of zinc lozenges.	No support for "preventing URI." Regular, high-dose zinc supplementation can decrease immune function and should be avoided. Strong support for "treating URI." Dissolving zinc lozenges in the mouth (75 mg/day elemental zinc) shortens common cold by ~33%; zinc must be taken < 24 h after onset of URI. Optimal lozenge composition and dosage to be determined. Side effects include bad taste and nausea.
Glutamine	Nonessential amino acid that is an important energy substrate for immune cells, particularly lymphocytes. Circulating glutamine is lowered after prolonged exercise and very heavy training.	Limited support. Some evidence of a reduction in URI incidence after endurance events in competitors receiving glutamine supplementation (2 x 5 g). Mechanism for therapeutic effect requires investigation. Supplementation before and after exercise does not alter immune function.
Carbohydrates (drinks, gels)	Maintains blood glucose during exercise, lowers stress hormones, and thus counters immune perturbations.	Limited support. Ingestion of carbohydrate (30–60 g/h) attenuates stress hormone and some, but not all, immune perturbations during exercise. Very limited evidence that this modifies infection risk in athletes.
Bovine colostrum	First milk of the cow that contains antibodies, growth factors and cytokines. Claimed to improve mucosal immunity and increase resistance to infection.	Limited support that bovine colostrum blunts the decrease in mucosal immunity and in-vivo immunity after heavy exercise. Some evidence in small numbers of participants that bovine colostrum decreases URI incidence. Further support required.
β-glucans	Polysaccharides derived from the cell walls of yeast, fungi, algae and oats that stimulate innate immunity.	Limited support. Effective in mice inoculated with influenza virus; however, studies with athletes show no benefit to immunity and equivocal findings for risk of URI.
Echinacea	Herbal extract claimed to enhance immunity via stimulatory effects on macrophages. There is some in-vitro evidence for this.	Limited support. Small reduction in URI incidence but no influence on URI duration in general population. Ambiguous findings from small number of studies in athletes. Further support required.
Caffeine	Stimulant found in a variety of foods and drinks (e.g., coffee and sports drinks). Caffeine is an adenosine receptor antagonist and immune cells express adenosine receptors.	Limited support. Evidence that caffeine supplementation activates lymphocytes and attenuates the fall in neutrophil function after exercise. Efficacy for altering risk of URI in athletes remains unknown.

Table 3. Nutritional supplements and immune resistance¹ in athletes: proposed mechanism of action and evidence for efficacy. Adapted from Walsh (2019). URI = upper respiratory infection; RNI = reference nutrient intake. ¹Resistance reduces the pathogen burden, e.g., immune weaponry protects the host. ²Supplement must come from a reliable source and be tested by established quality assurance program (Maughan et al., 2018). ³Readers are directed to the consensus statement of The International Society of Exercise Immunology for further discussion regarding the evidence for efficacy of these supplements (Berman et al., 2017).

Nutritional Supplements for Improving Immune Tolerance ¹		
Supplement ²	Proposed Mechanism	Evidence for Efficacy ³
Probiotics	Live microorganisms, which when administered orally for several weeks can increase the numbers of beneficial gut bacteria. Associated with a range of potential benefits to gut health and tolerogenic effects. Prebiotics are typically non-digestible carbohydrates that increase beneficial gut bacteria.	Moderate-strong support in athletes with daily dose of ~10 ¹⁰ live bacteria; meta-analysis shows ~50% decrease in URI incidence and ~2 d shortening of URI; minor side effects. Unclear whether probiotics reduce gastrointestinal distress and infection, e.g., in travelers' diarrhea. Limited support for prebiotics to decrease risk of URI in athletes.
Vitamin C	An essential water-soluble antioxidant vitamin that quenches ROS. Recommended daily intake for adults is 90 mg for males and 75 mg for females (USA).	Strong support for "preventing URI" in athletes. Meta-analysis shows ~50% decrease in URI incidence when taking vitamin C (0.25–1.0 g/day). No reported side effects. However, unclear if antioxidants blunt adaptation in well-trained. High vitamin C doses (gram doses) likely required if initiating vitamin C supplementation after onset of URI to compensate for increased inflammatory response. High vitamin C doses during URI have been shown to reduce URI duration. Further research required.
Vitamin D	Anti-inflammatory. An essential fat-soluble vitamin known to influence several aspects of immunity (e.g., expression of antimicrobial proteins). Skin exposure to sunlight accounts for 90% of the annual source of vitamin D. RNI is 5–15 µg/day.	Moderate-strong support. Evidence for deficiency in some athletes and soldiers, particularly in the winter (decreased skin sunlight exposure). Deficiency has been associated with increased risk of URI. Meta-analysis shows some benefit of supplementation to decrease URI incidence. Recommend monitoring and 1,000 IU/day D3 autumn-spring to maintain sufficiency where necessary. Increased risk of adverse outcomes supplementing > 4,000 IU/day ³ .

Table 4. Nutritional supplements for improving immune tolerance¹ in athletes: proposed mechanism of action and evidence for efficacy. Adapted from Walsh (2019). URI = upper respiratory infection; RNI = reference nutrient intake; ROS = reactive oxygen species; PUFA = polyunsaturated fatty acids. ¹Tolerance dampens defense activity yet controls infection at a non-damaging level. ²Supplement must come from a reliable source and be tested by established quality assurance program (Maughan et al., 2018). ³Readers are directed to the consensus statement of The International Society of Exercise Immunology for further discussion regarding the evidence for efficacy of these supplements (Bermon et al., 2017).

Nutritional Supplements for Improving Immune Tolerance ¹		
Supplement ²	Proposed Mechanism	Evidence for Efficacy ³
Polyphenols e.g., Quercetin	Plant flavonoids. In-vitro studies show strong anti-inflammatory, antioxidant and anti-pathogenic effects.	Low-moderate support. Some evidence of reduction in URI incidence during short periods of intensified training; albeit, in small numbers of untrained subjects. Limited influence on markers of immunity. Putative anti-viral effect for Quercetin. Further support required.
Omega-3 PUFAs	Found in fish oil. Claimed to exert anti-inflammatory effects post-exercise by regulating eicosanoid formation, e.g., prostaglandin. Prostaglandin is immunosuppressive.	Limited support for blunting inflammation and functional changes after muscle damaging eccentric exercise in humans and no evidence of reducing risk of URI in athletes. Some evidence oxidative stress actually increased in athletes supplementing n-3 PUFA.
Vitamin E	An essential fat-soluble antioxidant vitamin that quenches exercise-induced ROS.	No support in athletes. Improved in-vivo immunity and reduced URI incidence in the frail elderly but no benefit in young, healthy humans. One study actually showed that vitamin E (and β-carotene) supplementation increased the risk of URI in those under heavy exertion. High doses may even be pro-oxidative.

Table 4. Nutritional supplements for improving immune tolerance¹ in athletes: proposed mechanism of action and evidence for efficacy. Adapted from Walsh (2019). URI = upper respiratory infection; RNI = reference nutrient intake; ROS = reactive oxygen species; PUFA = polyunsaturated fatty acids. ¹Tolerance dampens defense activity yet controls infection at a non-damaging level. ²Supplement must come from a reliable source and be tested by established quality assurance program (Maughan et al., 2018). ³Readers are directed to the consensus statement of The International Society of Exercise Immunology for further discussion regarding the evidence for efficacy of these supplements (Bermon et al., 2017).

Ten recommendations to limit the infection burden and maintain immunity in athletes.

1. Where possible, avoid sick people, particularly in the autumn-winter
2. Ensure appropriate vaccination schedule¹
3. Ensure good hand hygiene² and avoid self-inoculation by touching the eyes, nose and mouth
4. Do not train or compete with below-the-neck symptoms
5. Monitor and manage all forms of stress including psychosocial and physical
6. Aim for 7–9 h sleep each night
7. Eat a well-balanced diet with adequate protein intake (1.2–1.7 g/kg/BM/day)
8. At the onset of a common cold dissolve zinc lozenges in the mouth (75 mg/day elemental zinc)
9. Consider vitamin C supplementation during heightened infection risk, e.g., traveling for important competition (0.25–1.0 g/day)
10. Consider probiotic supplementation for illness prone/traveling athlete (~10¹⁰ live bacteria/day)

Table 5. ¹Appropriate vaccination schedule should be discussed with the general practitioner; resources include www.cdc.gov/vaccines and www.nhs.uk/conditions/vaccinations. ²Hand hygiene advice can be found at www.cdc.gov/handwashing.

Summary

This new perspective sharpens the focus on nutritional supplements with beneficial tolerogenic properties that might reduce the infection burden in otherwise healthy athletes. These supplements include probiotics and vitamins C and D. Further research is required demonstrating the benefits of candidate tolerogenic nutritional supplements to reduce the infection burden in athletes — without blunting training adaptations and without side effects. When considering nutritional supplementation, athletes must check that the supplement came from a reliable source and is tested by an established quality assurance program (Walsh, 2018). Finally, to limit the infection burden and to maintain immune health, athletes should follow the simple practical recommendations in Table 5.

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