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CATS NEWSLETTER
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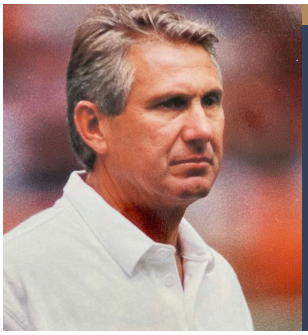
College Athletic Trainers' Society

IN THE SPOTLIGHT: DONALD LOWE

By: Kristen Mostrom (University of Rochester)



Donald Lowe

Current Position: CATS Founder, Chairman of the Board

Education History:
Undergrad: Kent State 1964 earned his BS Major: Physical Education; Minor: Biology
Master's Degree/Graduate Assistant: Kent State 1969

Regardless of how many years you have been an athletic trainer or where in the country you reside, the renowned Don Lowe has probably been brought up a time or two. Whether it be his involvement with New York State or EATA, his numerous Hall of Fame Awards from different organizations, his time with the USOC, or being the visionary and founder of CATS, Don is no stranger to the world of athletic training. I had the wonderful privilege and opportunity to sit down with Don virtually and get to know how he became the Athletic Trainer and person he is today.

Don always knew he had a strong passion for athletics. Initially, he considered coaching college basketball, until he met one of his mentors, Otho Davis, who led him to the profession of athletic training. Otho had a tremendous influence on Don's career path. Otho shared his knowledge and experience with Don, who then passed this expertise on to all the athletic trainers who have worked under him. Don would later go on to work with the basketball team at Kent State, teach a year of high school biology, and then realize the college setting was where his passion truly was. He became an assistant athletic trainer which eventually lead to Head Athletic Trainer at Kent State. His career continued to grow after that.

As a member of CATS, or any organization for that matter, one is encouraged to have a general grasp of the history of the organization and membership. Don went in depth with his rationale for why and how CATS was created. In the late 1980s and early 90's, he witnessed the Professional Football Athletic Trainers Society (PFATS) have a significant impact within their setting. PFATS was able to positively influence care to professional football players, instill a quality of life for the professional football athletic trainer, and encourage overall wellness for their members. Don paid close attention to this organization, as he had numerous colleagues in this setting. He became jealous of this brilliant idea and started to question why there wasn't a similar organization within the college setting. PFATS was successful and encouraging, so why couldn't the collegiate setting follow suit? Don became the driving force for creating the College Athletic Trainer's Society. Don began numerous conversations with

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some of the greatest and well known in our line of work; he discussed with his mentor, Otho Davis, who was working with the Philadelphia Eagles at the time, Paul Grace at MIT, Chris Patrick at Florida, Fred Hoover at Clemson, and Jay Shoop at Georgia Tech, just to name a ew. These individuals also became excited, encouraged with the idea and wanted to help Don pursue his vision and passion. In 1992, at the annual NATA Convention, the 1st CATS meeting commenced in Denver, Colorado. It was held in Don's hotel room. CATS began with a very small group of highly educated and exceedingly experienced athletic trainers, in hopes that it would progress from there.

However, with every great idea, there are challenges, barriers, and tribulations. CATS experienced just that. Following the development of a Board of Directors, the largest hurdle was spreading the message to athletic trainers in the collegiate setting and getting them to understand what Don was trying to accomplish. He wanted to encourage members to join something that was foreign and get them to ignore the negative rumors about CATS.

Don explained what he envisioned the goal of CATS to be, both when the idea first evolved and what CATS currently is today. CATS allows the college athletic trainer an opportunity to have a voice and focus on the needs of these professionals. This society places a strong emphasis and focus on the health and welfare of the student athlete and the medical support and resources of the institution. Every setting has unique issues. The college setting was ignored for so long, something needed to be done. CATS has provided affordable, targeted educational opportunities for college athletic trainers. It has provided data and strategies to arm athletic trainers for the difficult conversations with administration in their pursuit of well-deserved higher salaries. It also strongly promotes quality of life and has had a strong voice within the NCAA.

Don continued explaining how CATS began as a small society. His goal was to be small and intimate, provide a meeting space where we can learn from one another, and it still aims to be today. Even in its growth, Don wants to continue prioritizing the college athletic trainer. Monetizing the Society has never been the goal. The success, and the future, of any organization comes from the top, and Don believes this is being achieved, especially with the overwhelming support by their members, sponsors, exhibitors and leadership.

Don continuously credits Josephine Lee, Executive Director, for her drive and passion focused on what CATS can and would do for the college athletic trainer. She made it her aim to display and encourage CATS' success and how it would benefit the membership. Scott Anderson, CATS President, has played a huge role in improving the health and safety of athletes, working with other associations. This interaction, relationship, and leadership only continues to expand our profession. Don also appreciates and acknowledges current and past officers and board members who helped build and grow CATS into what it is today.

CATS is not the only achievement Don is proud of within his career, saying that he wants the "satisfaction to try to become one the of the best athletic trainers in the country. I feel I worked very hard to achieve that." Don always strived to lead an excellent athletic training program no matter where he worked. He instilled in his staff a spirit of service: the ability to provide the best quality care to each and every student-athlete. He believed in mentoring and molding young minds so they, too, would become great athletic trainers. Don is especially proud of the program he developed at Syracuse for over 25 years. He would always encourage the correct mindset and positive attitude about what it is one can become if you put the time and effort into something you are passionate about. He states, "This profession is hard work, very time consuming, and no short cuts can be taken if you want to be successful." Don encourages the time and work it takes to keep pushing your institutions forward, to increase the staff size which will, hopefully, reduce workload, and finally fight for appropriate and worthy compensation.

Don admits becoming an athletic trainer was not always easy, just like any profession in which you truly want to excel. He had certain individuals along the way that were role models and mentors. As mentioned above, Otho Davis played a huge role in his life. Don described Otho as a very intelligent man: he thought globally and had a tremendous vision and outlook, not only within athletic training but with life in general. Otho would have the gift of thinking ahead, would have the desire and drive to be successful. Don feels so fortunate Otho was in his life and taught him everything that he did. Another mentor that Don has

had throughout the years was Dr. Tony Adamle, a General Practitioner who played college football and went on to attend medical school while he was playing professional football. The ideas and knowledge he learned from Dr. Adamle were so innovative and applicable to the profession and in life. Don considered Dr. Adamle to be ahead of the professional curve in cultivating the art of athletic training.

A few final thoughts from Don: "10% of people that start off at something are going to fail, 70% of people just want a job, and 20% of people are really going to excel in their profession. We see two types of people in this profession, ones where this is just a job and ones that are very motivated. Success is not an individual thing. My success was because of those people I surrounded myself with, my lovely wife Mary who has always supported my career and given me numerous ideas for CATS, my wonderful children, and my heritage of where I came from and the education I received. I was frequently exposed to good young athletic trainers' that wanted to work. This has all contributed to my success."

NEWS AND NOTES

CATS Symposium for Athletic Trainers & Team Physicians

Dates: July 15-17, 2021

Location: The Orleans Hotel & Casino, Las Vegas, NV

For more information, please visit:

https://www.collegeathletictrainer.org/Symposiums

CATS Family Scholarship

Application deadline: May 15, 2021

The CATS Family Scholarship exemplifies the relationship and cooperative efforts between CATS and its corporate sponsors. With these scholarships, our organization has created an opportunity to reward children of CATS members while assisting their parents in sharing some burden in the cost for higher education. Children of CATS members can apply for a $2,000 scholarship.

For more information and to download the application, please visit:

https://www.collegeathletictrainer.org/Scholarships

COVID-19 VACCINE: AVAILABILITY FOR ATHLETES AND WHAT TO DO

Yvette Rooks, MD, Head Team Physician & Assistant Director in the University Health Center, University of Maryland

Drew Duckett, MS, ATC, Associate Director of Healthcare Emergency Operations, Associate Head Athletic Trainer, Boston University

Pharmaceutical companies worked at top speed to address the COVID-19 pandemic, successfully developing a vaccine in record time using messenger RNA (mRNA) technology that has been used for almost two decades in cancer treatment. At the time of writing, tens of millions of COVID-19 vaccine doses have been shipped and administered across the U.S. Vaccination is a top priority, so the federal government is providing the vaccine to state governments at no cost. Cost to patients is dependent upon the source for vaccination; however, in most cases the vaccine will be administered free of charge (no cost to patient). In cases where there is a charge

for vaccination, patients can expect to pay no more than $25 to cover insurance company fees. Many doctors are stressing urgency and recommending healthy patients get vaccinated as soon as possible.

Last-mile vaccine distribution varies from state to state. While the federal government set guidelines on priority groupings, it was left to the states to ultimately decide who is eligible and when. Many states, at least 22 at the time of writing this article, have discontinued, or have initiated plans to discontinue, priority groupings, opening vaccination eligibility to everyone 16 years and older. As priority groups vary by state, so do those authorized to administer the vaccine. Perhaps some of our colleagues in the collegiate setting are already providing vaccinations on campus. Others may have the opportunity as the vaccines become more widely available over the next few months. The timing of the ramp up is a unique challenge for higher education. Wide access to the vaccine will be approaching when most colleges and universities are completing their final quarter or semester. This means many student athletes will be departing campus for destinations across the world, and a prime opportunity to vaccinate will close. While this is a challenge, it is an opportunity for athletic trainers and team physicians to promote health care system literacy that is common in many of our mission statements. For instance, a student athlete who would fit into the general population of one state may be immediately eligible in another. Helping student athletes navigate the health care system by informing and educating them on these possibilities and nuances is vital for coordinating their care. This is not to say athletic trainers and team physicians should be seeking and booking appointments for them, but instead providing student athletes with the tools to successfully navigate the health care system.

More vaccines are expected to become available to providers such as doctors' offices, retail pharmacies, hospitals and Federally Qualified Health Centers (FQHC) in the coming weeks and months. There are currently three COVID-19 vaccines available in the United States, two of which are up to 95% effective in preventing all disease and require two doses given 21 to 28 days apart (the Pfizer vaccine and the Moderna vaccine, respectively). Johnson & Johnson is the strong point of being 85% effective against severe illness. The Johnson & Johnson vaccine is notably a single-dose vaccine. Lastly, AstraZeneca has a vaccine that has been widely distributed in Europe and other parts of the world but has yet to gain Emergency Use Authorization in the United States. At the time of writing this article, AstraZeneca has indicated through a press release that the vaccine is at least 76% effective.

None of the vaccines contain the live virus (SARS-Co-w), so you cannot get COVID-19 from the vaccine nor will taking the vaccine cause you to test positive for COVID-19. The vaccines also do not contain implants, microchips, tracking devices or fetal tissue. The vaccines are composed of normal ingredients, including fat, salts and sugar, as these vaccines are designed to aid the body's immune system in fighting COVID-19. The federal government is partnering with manufacturers to increase the ability to quickly make and distribute enough COVID-19 vaccines.

Many question the safety of vaccines for many reasons, but the COVID-19 vaccine is as safe as other vaccines. The COVID-19 vaccine's clinical trials involved tens of thousands of people of different races, ethnicities and ages, and the FDA and CDC are conducting ongoing safety monitoring in the U.S. While there are some side effects, medical professionals think the side effects are minimal in comparison with the actual COVID-19 virus. The side effects include pain (swelling) at the injection site, fever, chills, tiredness and headache that should go away in a few days. Those who have had severe allergic reaction with vaccines in the past should take precaution around the vaccine. Others question which vaccine to take. Health experts continue to state the vaccine that is available and offered is the one we should take. We discuss efficacy of vaccinations above as they vary a bit in terms of preventing all disease; however, it is important to know every vaccine has reported very high efficacy in preventing severe disease and death. This is the metric that is most important and what will pull us out of the pandemic state. While they may vary a bit, all approved vaccines are viable options. There are several other vaccines that are in late-stage trials and a few others that have been authorized in other countries, but they are beyond the scope of this article.

Don't put your mask and hand sanitizer away yet, because at present it is unclear if vaccinated people can still carry and transmit the virus even when they are not sick. Additionally, it may take up to a year to vaccinate 80% of the US population and achieve herd immunity, which will severely hamper the virus' ability to spread and proliferate. Once fully vaccinated, it will take 1 to 2 weeks for the body to develop full immunity and provide protection against COVID-19. Vaccinated patients still need to practice infection precautions such as wearing mask, frequently washing hands, using alcohol-based hand sanitizers and social distancing. This is because vaccines do not stop the coronavirus from entering the body, but vaccines do prevent the development of moderate-to-severe COVID-19.

We should educate our patients and student athletes on the importance, benefits and risks of vaccinations while remembering the personal choice to vaccinate. Although all of the vaccines discussed have proven to be safe and highly effective in most adult patient populations, student athletes who are pregnant or have had history of severe allergic reaction are encouraged to discuss COVID-19 vaccination risks with their provider before vaccination. Patients and student athletes who have been diagnosed with COVID-19 previously, regardless of previous symptoms during the course of illness, are advised to get the vaccine as reinfection is still possible given natural immunity is not guaranteed or may not last very long. Even though the COVID-19 vaccine is now available, this is not the end of COVID-19.

AN OVERVIEW OF DRY NEEDLING

Gregg Boughton, MS, ATC, CSCS
George Fox University

Dry Needling is a relatively new therapeutic intervention within the sports medicine community that dates back thousands of years. The use of dry needling traces back to the use of needles to treat diseases by the Chinese via acupuncture. Dry needling has grown in popularity and is being utilized as an effective means of treatment for a variety of neuromuscular dysfunctions.

Erik Marsh, Assistant Athletic Trainer at the Air Force Academy for Hockey and Golf, works as a contracted instructor with Structure and Function Education, which is a system of dry needling developed by Sue Falsone, ATC, PT. According to Erik, "the question always arises: how is this different than acupuncture? While both use the same tool (monofilament needle) the philosophies behind the selection of that tool is different. In Chinese acupuncture history, the Taoist concept of health aimed for perfect harmony between the opposing forces of Yin and Yang. Acupuncture points were grouped into a system of channels (heart, stomach and kidney) which run over the body, conducing the flow of qi, or vital energy, thus improving health. In the west, like many of our treatments, it is based in physiological cause and effect. I will insert needles directly into the swelling to reduce it, or into a muscle belly or tendon to decrease pain, etc." In the West, the use of dry needles emerged from the use of injections of anesthetic to treat painful musculoskeletal conditions.

How does it work? Erik describes it this way:

"Whenever a needle is inserted into someone, we can affect the body locally, segmentally, or systemically. As with any injury, when a needle is inserted, a lesion is created and tissues are broken (skin, muscle and fascia). By doing this, there is a release of Bradykinin, CGRP, histamine nerve growth factor, substance P, Nitrous Oxide and Adenosine. These are all inflammatory chemicals released by the body to help manage pain and tissue damage. CGRP, Nitrous Oxide and Adenosine are also strong vasodilators. When we insert a needle locally into tissue, we are tapping into the gate control theory and the conditioned pain

modulation theory to control pain. Conditioned pain modulation theorizes that pain inhibits pain, so by inserting the needle an additional noxious stimulus is created, not allowing either to be interpreted as a strong pain signal to the brain, similar to what we attempt to do with e-stim."

He also states that the process of dry needling is not as difficult as one would think. It does, however, require very good knowledge of 3D anatomy and technique. Dry needling is the one modality out there that will keep your anatomy honest. It is very important from a safety standard to know what tissue you want the needle to go into, and, more importantly, what tissue you don't want the needle to go into, thus requiring a solid base of 3D anatomy.

Erik went on to say that he is often asked by his athletes why the use of needling makes them feel better so much faster.

"With my needles I am creating a stimulus that signals the brain to more quickly move through its inflammatory process. I am attempting to regulate the inflammatory chemicals I mentioned earlier to move the body quicker though the inflammatory phase into an anti-inflammatory phase, thus achieving a quicker resolution. This is the systemic effect of needling. There is evolving evidence using FMRI and chemical studies that show needling mechanisms or creating lesions can affect the hypothalamus-pituitary-adrenal or HPA axis causing the release of more anti-inflammatory neural chemicals pushing us quicker to resolution."

Sheri Lampin is also an assistant athletic trainer at the Air Force Academy for the men's and women's cross country teams, as well as track and field. She uses dry needling as a part of her therapeutic interventions and has found much success.

"For track and cross country, the use of dry needling is great for the overuse injuries they sustain. Dry needling, along with prescribed rehab exercises, seems to return the athletes to activity faster than traditional methods of rest, rehab and other traditional modalities. The main areas I've dry needled in track and cross country are shins for MTSS and different muscles around the hip due to running on our indoor track. I wouldn't necessarily say that track and cross country have more injuries that need dry needling, but dry needling is definitely a great tool for them and their overuse injuries."

Erik concurs. He thinks that dry needling has certainly changed some of the traditional things he has utilized in his practice.

"I have had a great success rate since I started needling over 5 years ago. Needling and the Stecco Method of Fascial Manipulation are my go-to pain regulating modalities I use in my practice. Between those two interventions that has become my daily mainstay. I don't use too many electric modalities anymore and my use of ice has decreased, as well. I am not saying I don't use them, just not as often as I did 10 years ago. In fact if, I do use stim, it is usually attached to my needles."

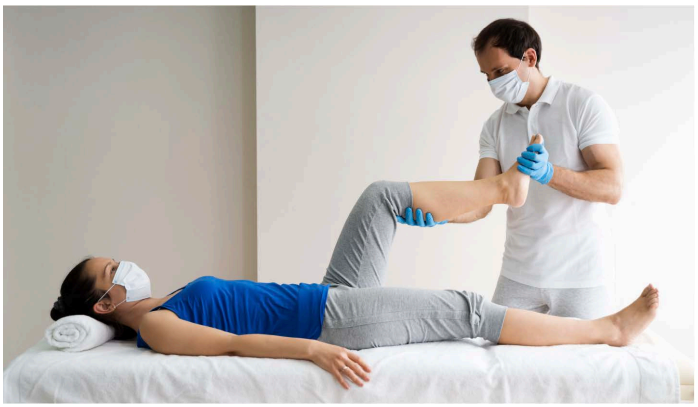
Contraindications to the use of dry needling include:

- Metal allergy
- Blood and systemic disease
- Needle phobia
- Cancerous tissue
- True lymphadium
- Specific to the low back (moderate scoliosis, spina bifida, laminectomy, laminotomy)
- Implants (breast, calf, etc.)
- Patients with cognitive impairment are not truly able to give consent to treat.

One of the main sticking points in the use of athletic trainer–performed dry needling is within each state's athletic training practice act. There are some states that do not allow dry needling. Always make sure that you consult with your state association and read your state practice act to ensure you are working within your state's scope of athletic training.

CONTINUED CHANGE OF AT ROLES DUE TO THE COVID-19 PANDEMIC

Eric Pitkanen, MS, ATC



"Oh, so you just tape a lot of ankles, then?"

This is the response nearly all athletic trainers have received when we tell a person with no knowledge of sports medicine who we are and what we do. On a bad day the response may even be, "So you're like a personal trainer." We have all taken it personally at times, it's hard not to, but even before the pandemic the narrative started to change. Like many of my colleagues, I have worked to take less offense to those with little knowledge and use these opportunities to promote who we are, what we do and how much really goes into athletic training.

The NATA defines athletic trainers as "highly qualified, multi-skilled health care professionals who render service or treatment, under the direction of or in collaboration with a physician. As part of the health care team, services provided by athletic trainers include primary care, injury and illness prevention, wellness promotion and education, emergent care, examination and clinical diagnosis, therapeutic intervention and rehabilitation of injuries and medical conditions."

While an accurate description of what we do, it is not a full encapsulation of what we really do. The day-to-day job of an athletic trainer can include any combination of parts emergency management, rehabilitation, treatment, diagnosis of acute and chronic injuries, practice coverage and, lest we forget, administrative duties. Now we have to offer a seat at our already full table to a global pandemic.

Athletic trainers are elite multi-taskers and logistical savants. The constant change in landscape already associated with college athletics gave the athletic training community a leg up on the unknown. But that unknown proved even more vast than we could have anticipated and brought more uncertainty than any of us have ever dealt with or could imagine. Will we be at school? Will we play? Can we even practice? How does testing work? Who pays for testing and supplies? Who is writing safety protocols? Who is communicating the seemingly daily changes? These are just some of the myriad questions that came with this pandemic for athletic trainers, not even counting the concern about the health and safety of those around you and around the country.

Athletic trainers responded to the challenges of the pandemic by expanding the scope and effectiveness of remote care: we became distance educators for our student-athletes. We did Zoom training room sessions, evaluations and rehabs digitally from afar. We also spent significant time planning with upper administration about how to adapt to either a prolonged shutdown or a phased return to campus and sport, often serving critical roles on task forces concerned with such logistics.

One of the best things to come out of this pandemic is that athletic trainers finally got a chance to show the rest of the medical world that we are actually health care professionals with a one-of-a-kind skill set perfectly suited to pandemic conditions. Relationships were built with deans and presidents, health centers and county health administrators. Some of us became campus COVID-19 coordinators and gave away our athletic training duties for the immediate future. We fostered meaningful partnerships with the rest of the medical community to enhance the well-being of our student-athletes. These collaborations started new conversations, elicited new relationships and enhanced the visibility of athletic training within the medical field at large.

The skills cultivated by athletic trainers allowed them to occupy roles much bigger than those offered in the NATA definition. Athletic trainers were enlisted in nearly all facets of the planning, development, implementation and management of COVID-19 safety protocols for their departments. Working directly with

administrators, athletic trainers had a significant hand in putting together the safety protocols that are in place within each of our institutions. And with a lot of hard work and a little bit of luck, we set out on a journey to bring sports back to life.

From every level of athletic training, the needle moved more towards the administrative and less toward the clinical. Whether at Division I and playing sports in normal seasons or at Division III where we are playing three seasons in one, the day-to-day changed. State and local protocols changed monthly and thus practices, competitions and testing had to change to meet those needs. Most institutions added daily COVID-19 confirmations that had to be managed by the sports medicine team in addition to their clinic life; this has proved burdensome for most. We became the COVID-19 police and spent significant time monitoring student-athletes and coaches to ensure policy compliance. This shift in day-to-day duties has redefined the current role of the athletic trainer.

The ebb and flow of clinical and administrative roles has presented significant challenges, especially at understaffed schools, where athletic trainers are tasked with covering three sports seasons simultaneously after a long hiatus from competitive sports. With nearly 25% of my current student-athletes being treated for an injury, we are running out of time in the day and space in the facility to provide adequate care to all of our student-athletes, especially as more continue to get injured.

What roles have to give to keep up? The answer is simple: none of them. COVID-19 will be with us for a while, but as we continue to make progress against it, there is a light at the end of the tunnel that we may return to order sooner than later. For us in this world, it is an all-out sprint to the finish, and there is no one that is more perfectly qualified to pull it all together than us. It will no doubt stress us beyond our normal limits, and already has for most. But this community was built on the service of others and the pride we take in that service. And our time has come to show who we are and what we are capable of.

Before the pandemic, the answer to “What is an athletic trainer?” was pretty easy to define, but now more than a year into the pandemic, the answer could not be less clear. The only thing that is clear is that we are needed now more than ever.

References:
1. Unknown. Athletic training (2019, July 30). Retrieved March 16, 2021 from http://www.nata.org/about/athletic-training

HYDRATION AND TEAM SPORT COGNITIVE FUNCTION, TECHNICAL SKILL AND PHYSICAL PERFORMANCE

Kelly A. Barnes & Lindsay B. Baker, GSSI

KEY POINTS:

- Team sport athletes are at risk of training and competing in a hypohydrated state when fluid losses are large and/or there are challenges with fluid availability or opportunity to drink.
- Technical skill and cognitive function are essential to team sport athlete performance and may be impaired with hypohydration, especially when combined with heat stress.
- The mechanism of cognitive impairment with hypohydration is not fully understood. It may be that the symptoms often associated with hypohydration (e.g., thirst, headache, fatigue, negative mood) are a distraction to the individual performing the cognitive tasks.
- Decrements in cognitive function, skill and physical performance in team sports are more likely to occur when hypohydration levels are > 2% body mass loss, but there is significant inter-individual variability in the effect of hypohydration on team sport performance.

INTRODUCTION

Athletes lose body fluid during exercise primarily through sweating. The body fluid balance between sweat losses and fluid intake during exercise may lead to these athletes training and competing in a hypohydrated state. The environmental conditions, body size, protective equipment and exercise demands of team sports vary considerably, leading to a large inter-sport variability in sweat losses. However,

even within sports, there can also be large inter-individual variability in sweat losses. The published guidelines on exercise and fluid replacement recommend drinking during exercise to prevent greater than 2% body mass loss (BML), and since sweating rates and sweat electrolyte losses differ greatly between athletes, hydration plans should be individualized (Maughan & Shirreffs, 2010; McDermott et al., 2017; Sawka et al., 2007; Thomas et al., 2016).

It is clear that hypohydration of more than 2% BML, especially in hot and humid environments, can impair endurance performance (Cheuvront & Kenefick, 2014; Sawka et al., 2007). This Sports Science Exchange article will focus on the impact of hypohydration on team sport performance, which is less established. Performance in team sport is a combination of both physical and mental domains. The mental domains include sport-specific technical skills that are related to precision and motor control, such as shooting, passing and dribbling, but also cognitive aspects including, but not limited to, motor response and reaction time, visuomotor function, executive function, memory and information processing. The physical demands of team sports include sprinting, lateral movements, jumping and intermittent high-intensity running, to name a few. These are defined in Table 1 (Nuccio et al., 2017).

TEAM SPORTS TERMS	DEFINITION OF TERMS
Team Sports	Team sports depend on the collective effort of individual players performing certain physical and mental skills in efforts to outperform an opposing team. These sports include brief high-intensity physical efforts combined with intermittent physical activity over a prolonged period. They also require the execution of sport-specific skills and the ability to sustain that skill performance throughout the duration of the competition. Team sports also involve varying levels of cognitive demand.
Cognition	Cognition is the processes the mind uses to take in, digest, discern and use information. Cognition includes domains of sensation & perception, motor skills, attention/concentration, memory, executive functioning, processing speed and language skills.
Sport-Specific Technical Skills	Sport-specific skills are performance related activities that rely on an interconnected, complex process of physical and cognitive function. These skills include skills like shooting, passing and dribbling.
Physical Demands	Physical components of team sports include elements important for team sports but not specific to any one sport, such as lateral movements, sprinting, jumping and anaerobic power.

Table 1. Team sport performance terms and definitions (Nuccio et al., 2017).

SPORT-SPECIFIC RISK FOR HYPOHYDRATION

Sport-specific risks for hypohydration are based on environmental conditions, exercise intensity, and the availability and opportunity for fluid intake, as seen in Figure 1 (Belval et al., 2019; Nuccio et al., 2017). Of the sports reviewed, those with the highest risk for hypohydration were soccer, lacrosse and rugby, followed by American football, Australian rules football, ice hockey and field hockey. Basketball, Gaelic football, cricket, baseball, softball, beach volleyball, court volleyball, futsal, netball, water polo and badminton were classified as lower risk (Belval et al., 2019; Nuccio et al., 2017). However, there can be high variability in the risk for hypohydration within sports due to different environmental conditions across the sport season and locations of play, playing positions (body size, physical demands) and fluid availability/opportunity to drink during training and competition.

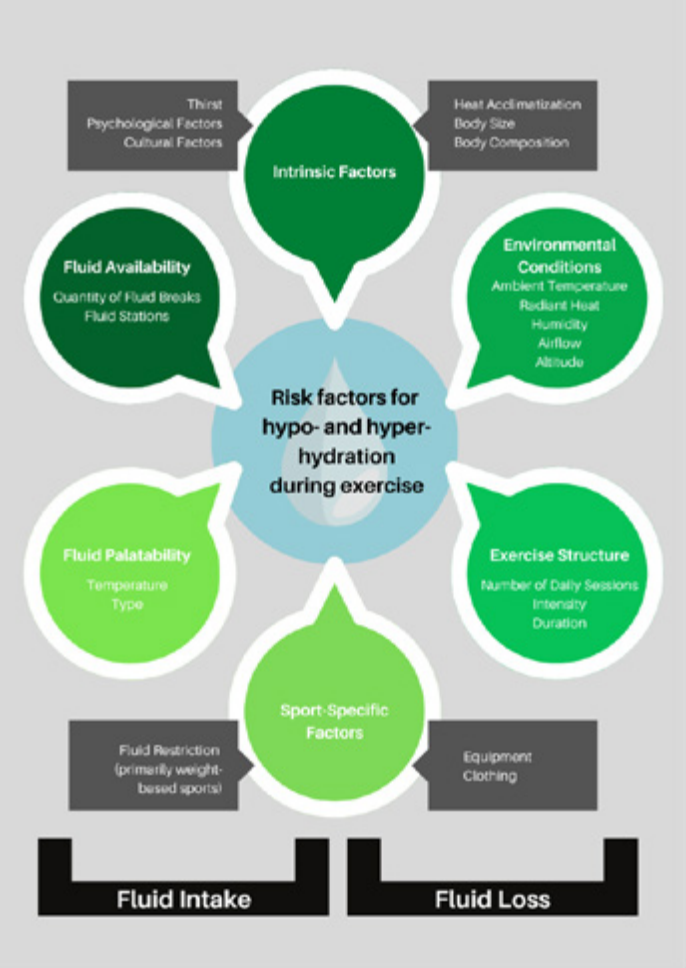


Figure 1. The factors that increase the risk for fluid imbalances (hypohydration or hyperhydration) in team sport athletes.

HYPOHYDRATION AND MENTAL/PHYSICAL DOMAINS OF TEAM SPORTS

The literature is mixed regarding the impact of hypohydration on the mental aspects of team sports. Some have found decrements to certain aspects of cognition and technical skills (Baker et al., 2007a, b; D'Anci et al., 2009; Dougherty et al., 2006; Hoffman et al., 1995; MacLeod & Sunderland, 2012), whereas others have found no performance impairment (Adam et al., 2008; Edwards et al., 2007; Ely et al., 2013; Grego et al., 2005; McGregor et al., 1999; Serwah & Marino, 2006). Wittbrodt et al. (2018) suggested that there is a potential dose-response relationship between body water loss, via fluid restriction, heat stress, exercise or exercise + heat stress, and cognitive-motor deficits, indicating that as the percent BML increases, the cognitive impairment also increases. A study on military personnel found that declines in cognitive performance typically start around 2% BML and increase with greater levels of dehydration (Gopinathan et al., 1988) – similar to the physical performance decrements seen in endurance athletes (Cheuvront & Kenefick, 2014; Gopinathan et al., 1988). However, another group reported that dehydration up to about 3%, without heat stress, is unlikely to impair cognitive or psychomotor function in military personnel (Adam et al., 2008). Table 2 summarizes the literature on the effects of hypohydration on cognitive domains and team sport technical skills. Of the sports studied (baseball, basketball, cricket, soccer, rowing, football, lacrosse and tennis), there seems to be some performance decrements in shooting/bowling accuracy, decision-making speed, reaction speed, memory, vigilance and fine motor speed, whereas passing and concentration were less affected. A point to note is that most of the cognitive assessments were standard cognitive tests and not sport-specific, with the exception of the cognitive tests done on field hockey athletes (MacLeod & Sunderland, 2012).

Some of the physical components of team sports include elements important for team sports, but not specific to any one sport, such as lateral movements, sprinting, jumping and anaerobic power. The impact hypohydration has on these physical domains has mixed results in the literature. Overall, sprinting speed seems to be slower when hypohydration is mild to moderate vs. euhydration (Baker et al., 2007b; Davis et al., 2015; Devlin et al., 2001; Dougherty et al., 2006; Gamage et al., 2016; McGregor et al., 1999). The other performance measures impaired with hypohydration were lateral movement speed (Baker et al., 2007b; Dougherty et al., 2006) and combination drill speed (Baker et al., 2007b). However, some studies found no differences in sprinting speed (Ali et al., 2011; Ali & Williams, 2013; Carvalho et al., 2011) or combination drill speed (Dougherty et al., 2006). The research on distance covered during a Yo-Yo test is equivocal, with one study in soccer players showing no difference between prescribed water (-0.3% BML), ad libitum water (-1.1% BML) and no fluid (-2.5% BML) intake, and another study showing a decrease in distance covered when no fluid was given (-2.4% BML) or only mouth rinse (-2.1% BML) vs. water intake (-0.7% BML) (Edwards et al., 2007; Owen et al., 2013). Most studies found no significant difference between the no fluid and fluid trials in regards to maximum jump height, peak jump power or anaerobic power (Baker et al., 2007b; Burke & Ekblom, 1984; Dougherty et al., 2006; Hoffman et al., 1995, 2012; Yoshida et al., 2002), yet some showed decreased aerobic power with hypohydration, especially during later tests or with higher levels of fluid losses (Hoffman et al., 1995; Yoshida et al., 2002). Figure 2 indicates the percentage of studies showing an effect of hypohydration in each category of team sport performance.

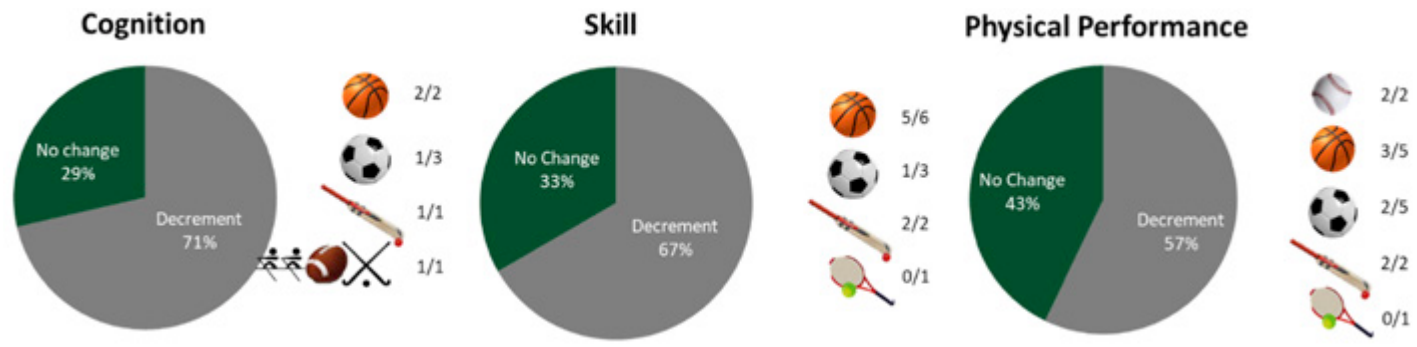


Figure 2. The percentage of studies that reported a decrement or no change with hypohydration during exercise per team sport performance domain. The values next to each team sport equipment indicate the number of studies that found some decrement out of the total number of studies.

SKILL/COGNITIVE DOMAIN	PERFORMANCE RESULT	PERFORMANCE IMPAIRMENT	NO SIGNIFICANT DIFFERENCE
BASKETBALL			
Shooting	↓ ↔	***fewer shots made, lower percentage of shots made*** (Baker et al., 2007b; Brandenburg & Gaetz, 2012; Carvalho et al., 2011; Dougherty et al., 2006)	(Baker et al., 2007b; Hoffman et al., 1995, 2012) ***number of shots made, percentage of shots made***
Reaction Speed	↓ ↔	***more errors on tests, slower response time during tests, slower lower body reactive agility – Quick Board*** (Baker et al., 2007a; Hoffman et al., 2012)	***hand-eye reaction test - Dynavision D2*** (Hoffman et al., 2012)
Vigilance	↔	(Baker et al., 2007a)	***n/a***
SOCCER			
Passing	↔	***n/a***	(Ali et al., 2007; Owen et al., 2013)
Dribbling	↓	(McGregor et al., 1999)	***n/a***
Shooting	↔	***n/a***	(Owen et al., 2013)
Concentration	↔	***n/a***	(Edwards et al., 2007; McGregor et al., 1999)
Reaction Speed	↓	***Sternberg test*** (Bandelow et al., 2010)	***n/a***
Memory	↓ ↔	***working memory*** (Bandelow et al., 2010)	***visuospatial working memory - Corsi block test*** (Bandelow et al., 2010)
Fine Motor Speed	↔	***n/a***	***finger tapping test*** (Bandelow et al., 2010)
CRICKET			
Bowling	↔	***n/a***	(Ali et al., 2007; Owen et al., 2013)
TENNIS			
Hitting	↔	***n/a***	(Ali et al., 2007; Owen et al., 2013)
FIELD HOCKEY			
Field Hockey Skills	↔	***n/a***	(Ali et al., 2007; Owen et al., 2013)
Decision-Making Speed	↓	(McGregor et al., 1999)	***n/a***
ROWING, LACROSSE, AMERICAN FOOTBALL			
Vigilance	↓	***continuous performance test*** (D'Anci et al., 2009)	***n/a***
Memory	↔	***n/a***	(D'Anci et al., 2009)
Reaction Time	↔	***n/a***	(D'Anci et al., 2009)
Visual Perception	↔	***n/a***	(D'Anci et al., 2009)
Executive Function	↔	***n/a***	***mental math, map recognition*** (D'Anci et al., 2009)

Table 2. Summary of the effects of hypohydration on skill and cognitive demands in team sport athletes. (↓ indicates performance decrements with dehydration, and ↔ indicates that there was no significant difference in performance between the dehydration group and the control).

REHYDRATION AFTER EXERCISE-INDUCED DEHYDRATION

An additional area that is less explored is the effect that rehydration after dehydrating exercise has on cognitive/skill sport performance. Cian et al., (2000) found that dehydration via exercise alone and heat stress alone caused performance decrements (increased response times and short-term memory decline), but those decrements disappeared after 3.5 hours when compared with a euhydrated control. During the 3.5 hours after exercise, the perception of fatigue was higher with both methods of dehydration and improved with fluid ingestion. When the subjects were rehydrated after the dehydration period, they were able to maintain long-term memory, whereas long-term memory declined when dehydrated (Cian et al., 2000). A study with healthy college age individuals also found that when individuals were dehydrated via fluid restriction, Profile of Mood States (POMS) scores (vigor) and cognitive performance (short-term memory and attention) were impaired. After rehydrating these individuals, the POMS scores, short-term memory, attention and reaction were all improved (Zhang et al., 2019). More work is needed to determine the lasting effects of hypohydration on cognitive and skill domains after athletes rehydrate post-exercise.

MECHANISMS OF HYPOHYDRATION-RELATED IMPAIRMENTS IN SOME STUDIES

The potential mechanisms for the effects of hypohydration on cognition and team sport skill are not fully understood. It has been suggested that symptoms associated with hypohydration, such as thirst, headache or negative mood may be a distraction to the individual performing the cognitive tasks and contribute to a decline in performance (Cheuvront & Kenefick, 2014). The fatigue and increased perception of exertion that often accompany hypohydration could also explain some of the performance impairments reported (Nuccio et al., 2017). However, perhaps due to genetics or training adaptations, some individuals, though thirsty, exerted and fatigued, may be better than others at increasing concentration to overcome the distractors (Cheuvront & Kenefick, 2014).

Heat stress could exacerbate the symptoms and cognitive performance impairments of hypohydration. Some research suggests that there are separate effects of exercise heat stress and exercise heat stress combined with dehydration on cognition tasks. A moderate increase in body core temperature has the potential to improve cognition (Schmit et al., 2017), potentially due to increased cerebral blood flow (Hocking et al., 2001). However, there may be a threshold in which cognitive performance begins to decline with thermal strain, and this may be based more on subjective feelings of discomfort rather than objective measurements of the environment or body temperature (Gaoua et al., 2017). In a recent study, visuomotor performance declined with exercise heat stress, with additional impairments when dehydration was added (Wittbrodt et al., 2018). Furthermore, brain activation increased with dehydration but not exercise heat stress alone (Wittbrodt & Millard-Stafford, 2018; Wittbrodt et al., 2018), suggesting a greater effort was needed to complete the cognitive tasks.

LIMITATIONS

Summarizing the effect of hypohydration on team sport performance can be challenging. For example, acute exercise has a small, positive, short-lived effect on cognitive performance (Chang et al., 2012). Elevated body core temperature, concomitant with exercise and hypohydration, can also affect cognitive function (Bandelow et al., 2010). Additionally, the technical skill, cognitive and physical performance tests being administered must be sensitive enough to detect true changes due to nutritional interventions (Lieberman, 2007). Taken together, the effect of hydration status on team sport performance has been mixed. However, it seems that hypohydration is more likely to impair cognition, technical skill and physical performance at higher levels of BML (> 2%) and when the method of dehydration involves heat stress (Figure 3).

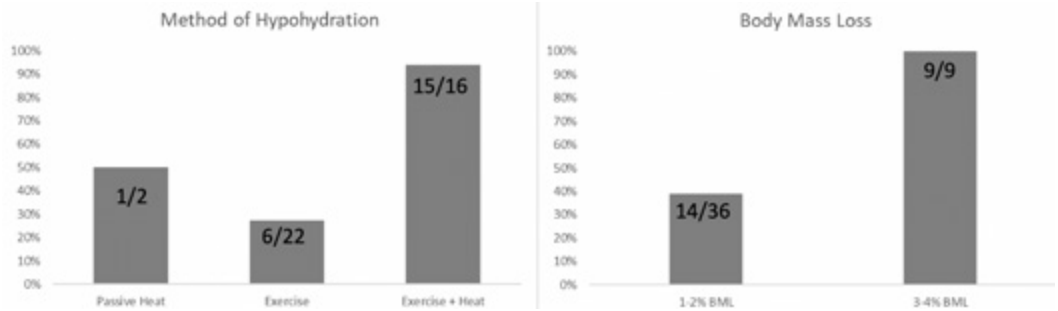


Figure 3. The percentage of studies that reported impaired performance by type and level of hypohydration. BML, body mass loss; values in each bar indicate the number of studies that found some decrement out of the total number of studies.

PRACTICAL APPLICATIONS

- The factors that are most associated with an increased risk of hypohydration in team sports are summarized in Figure 4. When at least two of these risk factors are met, it is likely that there will be skill/cognitive implications for team sport performance. If all three are met, then it is highly likely that team sport performance will suffer (Nuccio et al., 2017).
- Athletes and practitioners should strive to understand individual fluid losses during team sport play and provide customized hydration plans accordingly.
- When cognitive, skill and physical domains are critical, athletes should keep BML under about 2%, especially when environmental conditions are hot and humid. To do this, athletes should be given access to fluid and adequate opportunities to drink.

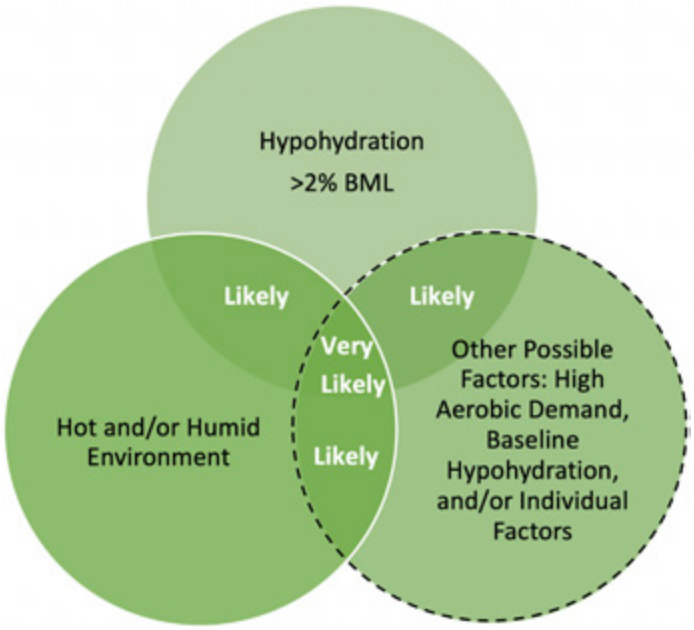


Figure 4. Venn diagram showing the likelihood of performance impairment with hypohydration (Nuccio et al., 2017). BML, body mass loss.

SUMMARY

There is large intra- and inter-sport variability in athletes' sweat losses. Access to fluid and the opportunity to rehydrate during training and competition is also varied between sports. This can result in some team sport athletes performing in a hypohydrated state. The effect of hypohydration on team sport performance has been mixed. However, it seems that hypohydration is more likely to impair cognition, technical skill and physical performance when the body mass deficit is > 2% and combined with heat stress. The mechanism underlying these decrements is not completely understood but may be based in both perception and physiology. To mitigate the risk of performance decrements, athletes should strive to replace individual losses to stay within 2% BML when possible.

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SPORTS SCIENCE: NUTRITION FOR RECOVERY IN TEAM SPORTS

Meagan Nielsen, MS, RDN, CSSD, LDN, USAW Dietitian and Bridget Sopeña, MS, GSSI Senior Scientist

Let's just come out and say what we already know: Collegiate athletic seasons are LONG. It seems inevitable that come mid-season, many players will start to feel "off" in one form or another. Fatigue may creep in and athletes want to know how they can stay feeling good, performing well and injury-free for the rest of the season. Because of the duration of college athletic seasons, it is important to complement medical care and recovery modalities by focusing on proper recovery nutrition, in order to keep players on their "A-game." Meals and snacks prior to games help to fuel performance, whereas a proper post-game fueling routine will support recovery prior to the next game. Performance staff are often tasked with post-activity nutrition on top of providing athletes with medical and recovery care; therefore, setting basic and practical nutrition goals is key. Focusing on the three Rs of recovery (refuel with carbohydrates, repair with protein and rehydrate with fluid) will help to support your players' recovery and keep them performing longer.

REFUEL: CARBOHYDRATES

The stored form of carbohydrate in muscle, known as glycogen, is the first to be used for energy during most moderate- or high-intensity team sport activities. When those fuel stores become depleted without being restored through foods and fluids, that may lead to decreases in performance.[1] The brain and central nervous system also depend on carbohydrates as a fuel source. When deficient in carbohydrate, the athlete may begin to feel fatigued and can lack concentration; therefore, reaction time and performance will suffer.[2] Given that these are all attributes to making plays or reviewing film before the next game/competition, it is imperative that athletes select quality carbohydrates for their recovery plate. "Quality" carbohydrates refer to sources that provide superior nutrients and fiber versus the more refined sources that lack substance. *See Table 1 for dosage, sources and benefits*

The amount of carbohydrate each player needs post-game will also depend on their sport, position and playing time. For instance, in baseball, pitchers and catchers who are involved in every play for multiple innings will likely have a greater need to refuel than their fellow teammates who may not have seen as much action. A carbohydrate-rich diet should be adequate to replenish muscle glycogen in most post-game scenarios.[1]

Rather than focusing on the exact gram amount that each player needs, help them to visualize their plate. For example, starters or higher minute players who performed more should aim to fill about 2/3 of their plates with carbohydrate choices, while the lower-action teammates can aim for 1/4 of their plate being carbohydrate. Additionally, a practical way for athletes to get some quick-acting carbohydrates is to consume a "team shot" of tart cherry juice at the end of the game. Tart cherry not only provides energy, but it also has been shown to deliver antioxidants and anti-inflammatory properties via anthocyanins and flavanols.[3] It may also help promote a calming effect to enhance sleep quality, which could offer additional benefits on and off the field as a student and athlete.

Table 1 Carbohydrates

DOSAGE	QUALITY SOURCES	BENEFITS
2/3 of recovery plate for high-minute players 1/4 of recovery plate for all other players	Brown rice, whole wheat pasta, corn tortillas, fruit, vegetables, beans	Replenish glycogen, support demands of training and recovery

REPAIR: PROTEIN

Muscle protein is constantly being broken down and used by the body during exercise and throughout everyday activities. Unlike muscle glycogen, amino acids, which are the building blocks of protein, are unable to be stored in the body for later use. Because of this, protein sources must be consumed by the athlete to replenish their muscle and lean body mass.[1] Upon learning this, there seems to always be that one player on the team who then overeats protein at his meals. The exact amount of protein an athlete needs will vary based upon body mass, but research suggests that 0.25-0.3 g/kg of a complete protein is appropriate to provide the necessary amino acids to support recovery and muscle protein synthesis. Intake above this amount will not result in greater gains in strength or mass. It is imperative to encourage the players to break up their protein intake to smaller meals or snacks every 3 to 5 hours throughout the day, rather than one large portion post-game. This not only will allow for a constant stream of amino acids to be absorbed into the blood and delivered to the body throughout the day, but it also allows adequate plate space for the other nutrients needed in a post-game recovery meal. The actual amount of protein needed by each athlete will vary based on their body weight and composition, but in general, each athlete should be encouraged to fill about of their recovery plate with protein. Complete protein sources, which contain all of the essential amino acids that the body does not make itself, will be ideal to support muscle growth and maintenance. Be sure to provide lean proteins that are grilled, baked or boiled rather than breaded, deep-fried and/or smothered in heavy sauces. See Table 2 for dosage, sources and benefits.

Table 2 Protein

DOSAGE	QUALITY SOURCES	BENEFITS
0.25-0.30 g/kg BW 1/4 of recovery plate	Poultry, beef, fish, eggs, tofu, whey protein powder	Supports muscle protein synthesis

REHYDRATE: FLUID

Dehydration during practice and games may not only negatively affect performance, it may also delay recovery from a previous game or competition. As little as 2% dehydration is associated with impaired performance in stop-and-go sports.[6] Performance measures such as skill, agility and running have been found to be negatively affected, and players also have increased feelings of fatigue as they accumulate a body water deficit. This is especially important when competing in hot and humid conditions, and for the players who are more active and/or wear more gear in games or competitions.

Rapid post-game rehydration is especially important when there is a short time frame between the end of the game and the start of the next (e.g., tournament play, double-headers or going from a night game to day game the following day). During this limited recovery time, defined as less than 12 hours,150% fluid replacement is recommended.[5] A drink volume greater than sweat loss must be ingested to restore electrolytes and fluid balance. However, when recovery time is extended, body-water balance is typically achieved with ad libitum food and fluid consumption during post-game recovery meals.[5]

Because sweating rates and sweat electrolyte concentrations vary from sport to sport and player to player, customized fluid replacement strategies are recommended. It is also important to note that rehydrating with fluids that contain electrolytes can provide benefits over water alone and are important for retention, thirst stimulation and electrolyte replacement.[7] Another option for improved electrolyte consumption while rehydrating is to consume salty foods with water. Refer to table 3 for hydration assessments and rehydration techniques and recommendations:

Table 3

OCCASION	ASSESSMENT TECHNIQUE	DEFINITION	RECOMMENDATION
During Game	Change in body mass	Pre and post body mass in minimal clothing Retest in various intensities, durations and environmental conditions	Avoid >2% dehydration Consume beverages with sodium for replacement and thirst stimulation
Post-game (Recovery)	Change in body mass	Difference between pre and post body mass	50% fluid replacement (24 oz for each 1 lb lost) Consume beverages with sodium and/or snacks/meals with sodium to replace losses, stimulate thirst, retention

Source: Sawka, M.N., L.M. Burke, E.R. Eichner, R.J. Maughan, S.J. Montain, and N.S. Stachenfeld (2007). American College of Sports Medicine position stand. Exercise and fluid replacement. Med. Sci. Sports Exerc. 39:377-390.

KEY TAKE-AWAYS

- Refuel your players post-game through quality carbohydrate sources to replenish glycogen and support the demands of training and recovery.
- Repair your players' muscles via quality protein sources to support muscle protein synthesis.
- Rehydrate with 150% fluid losses based on the individual player's body weight change from pre to post game.

CONCLUSION

Encourage players to focus on the 3 Rs of recovery: replenish with carbohydrates, rebuild with protein and rehydrate with fluids. By providing the guidance and nutrient-dense options after each game or competition, the players may learn to enjoy new foods while also improving their recovery throughout the season.

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