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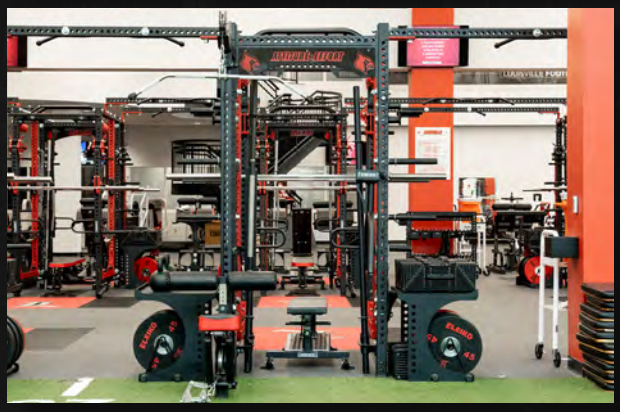

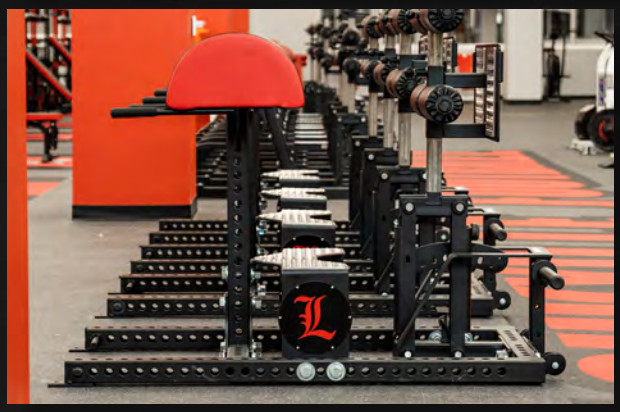

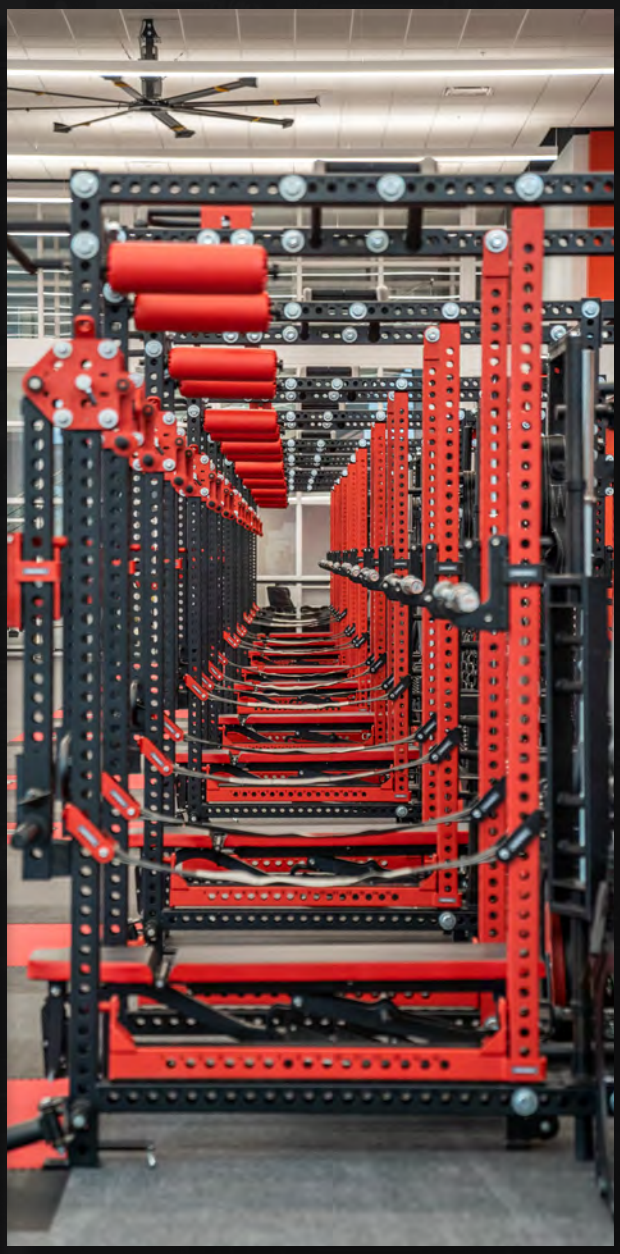

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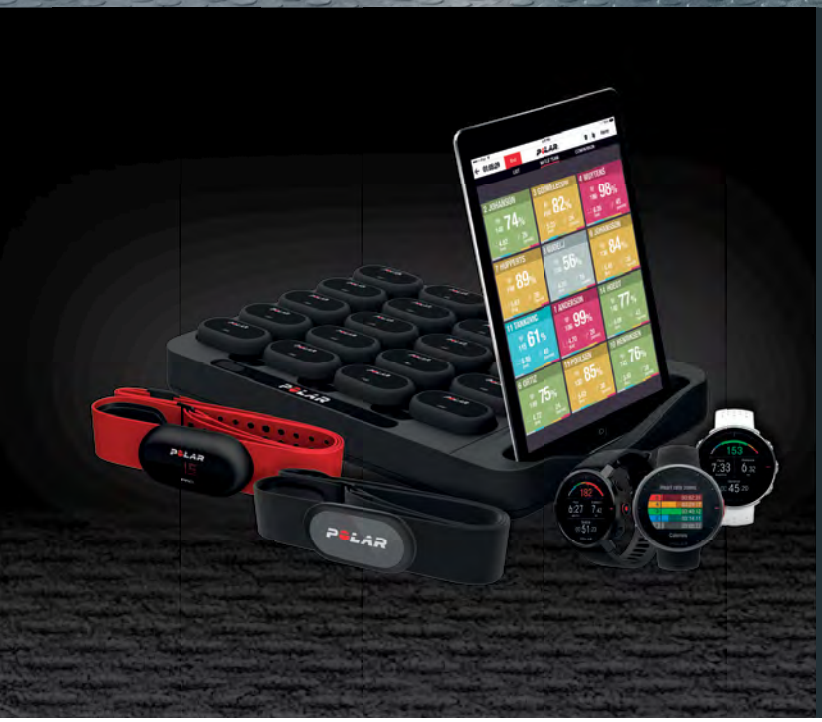

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THE IMPORTANCE OF BOUNDARIES AND ROLES FOR COACHES

ANDY GILLHAM, PHD, CSCS,*D, CMPC

One consistent theme across strength and conditioning research is that sport coaches are frequent sources of stress for strength and conditioning coaches (6,12). The basic job description and realities of the job for strength and conditioning coaches (e.g., relying on the athletes to train and perform well, long hours, multiple bosses) are generally simply accepted as part of the job (10,11,12,15). Accepted as they may be, that does not mean they are without stress (10). The purpose of this article is to help alleviate some of the stress between strength and conditioning coaches and sport coaches by considering the importance of boundaries as viewed through the lens of better identifying job roles with a specific focus on how omissions of communication can be detrimental.

In a general sense, a "boundary" in this article simply means some line of demarcation. There is a more clinical definition of "boundary," though that is more of a clinical definition and is likely of less value to the day-to-day operations of a strength and conditioning facility. The research on roles and expectations can provide some guidance (4). Sport coaches and strength and conditioning coaches ideally work collaboratively and closely for the improved performance of athletes and teams, which often blurs the lines between personal and professional interactions. This is not a new conundrum for strength and conditioning coaches. The juxtaposition seems to be between historical precedents and traditions, and the more recent multidisciplinary of sport (5,9).

THE CONTEXT

As the strength and conditioning field has grown, there are more circumstances strength and conditioning coaches find themselves in, which makes it difficult to create any sort of exhaustive list of contexts or prepare an article to target all contexts. Assumptions on context for the purposes of this article are: a) the strength and conditioning coach knows who the sport coach is and there is a degree of collaboration expected between them, b) there is some level of administrator that exists on the organization chart above both the sport coach and strength and conditioning coach, c) the strength and conditioning coach wants to remain employed in a similar position within the strength and conditioning field and, d) the strength and conditioning coach truly wants to do a good job at helping athletes improve and perform their best.

The general solution to most all interpersonal problems is to communicate more. While that may be true in a general sense, it is also wholly nondescript for the strength and conditioning coach currently locked in a professional disagreement with a particular sport coach. It is likely true that some increased communication will be necessary on the strength and conditioning coach's part, though that is not simply a frequency-only piece. The hope is that this article will provide some actionable topics for communication that perhaps have not been previously addressed by the strength and conditioning coach that can increase the frequency of the communication, while more specifically targeting the effectiveness of the communication. The frequency versus effectiveness topic has been examined in various settings outside of sport (e.g., supervisor-to-supervisee) (1). Frequency versus effectiveness has also been examined within sport psychology research on intrapersonal self-talk (3). A simple example of the dichotomy is that an athlete repeatedly saying "I'm great! I got this!" may yield a large frequency count for self-talk while not believing those statements at all and thus the effectiveness is low. Similarly, a coach, either sport or strength and conditioning, that consistently "checks in" or "touches base" may have high frequency of communication. Though if there is little content beyond, "How are you?" "Getting your homework done?" included in those messages, the effectiveness may be rather low. Increasing effective communication that reaches beyond mere pleasantries or small talk from a strength and conditioning coaches to athletes was a key finding in a recent study (16). A reflective question for the strength and conditioning coach is to consider the balance between their own habits regarding the frequency and effectiveness levels of communication to the athletes, sport coaches, and the strength and conditioning coach staff colleagues.

ROLES AND EXPECTATIONS

In group dynamics, a sizeable portion of frustrations can come from roles and the expectations associated with those roles (4). Two key components of roles are role clarity (e.g., the degree to which both parties understand the expectations of the role) and role acceptance (e.g., the degree of buy-in for both parties to accept and attempt to execute those expectations) (4). One of the most classic examples of conflict between strength and conditioning coaches and sport coaches is when a sport coaches instructs the strength and conditioning coach on how an athlete should be training—essentially thereby telling the strength and conditioning coach how to execute their own job tasks (6,12). Previous research has shown the sport coach is unlikely to have sufficient knowledge of strength and conditioning training principles and safety (13). At its heart, this is a role clarity problem. Both the sport coach and strength and conditioning coach believe it is within their role to provide guidance for how the athlete should train.

In considering whose role it is to provide guidance for the athlete training, the simplest answer is that both the sport coach and the strength and conditioning coach should have a voice. A starting point to making that successful is to have effective communication to establish boundaries that can lead to maximizing the athlete and team performance. Some potential situations or scenarios include: a) is it a case where the sport coach fully describes his/her hopes for athlete playing style in-competition, and then the strength and conditioning coach designs programs to develop the athletes to be better physiologically prepared to execute that style of play? or b) is it a case where the sport coach takes priority for on-field activities and the strength and conditioning coach takes priority for the strength facility activities? Those are both examples of boundaries that could be set. Similarly, perhaps there is a time component boundary wherein the strength and conditioning coach is primarily responsible for all athlete development until the last 20% of the competitive season, at

which point the sport coach takes priority. The reality is that there probably is not a single best way to approach this classic conflict between SCC and sport coaches. Equally as true though is that the communication to establish those boundaries must be present in any viable solution so that roles can be clearly defined. Even in the case when the strength and conditioning coach judges the sport coach to be vastly overstepping a boundary, the strength and conditioning coach can then have proper notes and documentation of that meeting to help with whatever problems may arise in the future.

Roles can change over time though, which continues to highlight the importance of effective communication. There are reported instances where sport coaches will deny or mandate a certain training activity early in the sport coach and strength and conditioning coach collaboration only to reverse course and allow the strength and conditioning coach to modify athlete trainings as they see fit in subsequent seasons (6). This has also been reported when sport psychology consultants work with sport coaches (8). As support personnel, it is important for strength and conditioning coaches, and other allied professionals, to remember sport coaches have the "win-loss record" attached to their name and job performance ratings. This has led to some strength and conditioning coaches commenting that sport coaches are the their "real boss" even if the organizational chart shows differently (6). However, none of that means the strength and conditioning coach should simply be subservient to the sport coach in all matters (9). A successful professional collaboration between the sport coach and strength and conditioning coach must have identified boundaries and roles.

Two additional areas for frequent disagreement between sport coaches and strength and conditioning coach are the warm-ups before practices and whether or not the strength and conditioning coach travels with the team. In both cases, the concepts of role clarity and role acceptance seem relevant. Without taking a side here as to how these options "should" go, the critical piece again becomes one of effective communication leading to boundaries deemed by both the sport coach and strength and conditioning coach as acceptable. If the sport coach wants the strength and conditioning coach to lead and supervise the pre-practice warm-up for the athletes, then the strength and conditioning coach should probably oversee setting up that warm-up routine if other responsibilities allow. As a prerequisite to that design process for the warm-up, the sport coach and strength and conditioning coach should address whether the strength and conditioning coach even has the time to go to practice or not, and how long the strength and conditioning coach can stay. Few strength and conditioning coaches have only single team responsibilities and thus time at one place, such as a team's warm-up pre-practice, inherently prevents that same strength and conditioning coach from training other athletes, designing trainings for athletes, supervising the strength facility, and any other responsibilities elsewhere. A logical source for poor role clarity on that topic is the strength and conditioning coachinadequately explained his/her other responsibilities to the sport coach, which makes sense given the power dynamic often cited between sport coaches and strength and conditioning coaches. Essentially, the strength and conditioning coach is biased toward saying "yes" to the sport coach requests, which may yield stress and time constraints on the part of the strength and conditioning coach (9).

In many cases, the debate around the SCC traveling with the team to competitions also stems from this notion of role clarity. If the strength and conditioning coach has no identified role during competition, then why should the strength and conditioning coach travel with the team? If the pre-practice warm-up is typically executed without the strength and conditioning coach, then why would the strength and conditioning coach be present for the pre-competition warm-up? There may be alternative reasons the strength and conditioning coach needs to travel with the team, so the message here is not to avoid it entirely. Rather, the message here is to think more critically of the context and ask appropriate questions that promote more effective dialogue. The sport coach may also need to be explicitly reminded of the strength and conditioning coach's other role expectations from other sport coaches or the head strength and conditioning coach. Much like the pre-practice warm-up removed the strength and conditioning coach's opportunity to fulfill other responsibilities, traveling with the team for a competition removes even more opportunities for other home-based role expectations to be completed. Again, the point here is not to argue for a particular setup or outcome. Rather, the point is to encourage the strength and conditioning coach to ensure a more complete description of strength and conditioning coach roles within the facility and department to the sport coaches. That effective communication may need to come from the head strength and conditioning coach and go to the head sport coach to avoid undue pressures on assistant level strength and conditioning coaches and assistant level sport coaches. A final note on this may be to consider the budget implications. If a sport coach wishes for a strength and conditioning coach to travel with the team, perhaps that sport coach then covers the costs from his/her sport budget for the head strength and conditioning coach to have coverage in other areas due to the traveling strength and conditioning coach.

TECHNOLOGY COMMUNICATION

Technology has made communication simple and quick, thereby typically increasing communication frequency. Just as true though is that technology has also added layers of complexity to the effectiveness of communication. There is no debate about how easy it is to fire away a quick text or even an email. In both cases though, the initiator of the conversation typically does so on his/her own schedule without much thought given to the recipient's schedule and much can be lost in simple text-based communication. This again highlights the need for certain questions to be asked early in the sport coach and strength and conditioning coach collaboration to improve the effectiveness of the communication. Below are a few scenarios for how this collaboration can be improved.

- **Scenario**: Sport coach sends texts at off-hours (e.g., early morning, late night).
  - » **Strength and Conditioning Coach**: Hey coach, what are your expectations for those 10:00 pm texts you send me? Are you expecting a response then, or is the next morning okay? And so you know, my morning usually starts around 4:30 am, so how early in the morning can I text you back?
- **Scenario**: Sport coach sends a excessively long text.
  - » **Strength and Conditioning Coach**: Thanks for that information coach. There's a lot going on there and I don't want to miss any of it. What's a good time for a quick phone call or in-person chat to get this squared away?
- **Scenario**: Sport coach sends sensitive athlete information or topics via text/email.
  - » **Strength and Conditioning Coach**: Thanks for including me in that coach. Does the athletic trainer/sport psychologist know that? Let's loop them in tomorrow and meet about this.
- **Scenario**: Sport coach wants to know why the strength and conditioning coach did not like/retweet/reply to a team-based social media post.
  - » **Strength and Conditioning Coach**: That was a cool post coach. Do you want me to like/retweet/reply all your and/or the team's posts?

The commonality across these scenarios is that the strength and conditioning coach likely felt a boundary was crossed that then prompted some degree of a stress response by not knowing how to best respond. If the sport coach is informally, at least, viewed as the boss, then the assumption is generally that a response must be adequate, useful, and timely; employees generally do not want to let down their supervisor. However, that cycle can get negative quickly due to most strength and conditioning coaches having multiple teams they provide services for, which means multiple sport coaches reaching out at off-hours of the day, with too much information, and information that is best suited to a verbal conversation.

CONCLUSION

Modeling the behaviors expected from strength and conditioning coaches is a key component of role clarity and mentorship within strength and conditioning and general sport coaching (2,7). If the formal organizational chart boss (head strength and conditioning coach) does the same thing, the informal boss (sport coach) does that has already been used as a what-not-to-do example, that strength and conditioning coach's role clarity will drop substantially. If the head strength and conditioning coach wishes to point out boundary, role, or communication complications from sport coaches to strength and conditioning coaches, the head strength and conditioning coach should then be diligent about also not repeating those same complications to his/her own staff. More research attention has been paid to developing strength and conditioning coach and part of advancing the field is to get rid of some negative habits from the past (14,17). Thus, a challenge is presented to assess your own degree of boundary crossing and frequency versus effective communication as a leader amongst the strength and conditioning staff.

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ABOUT THE AUTHOR

Andy Gillham is the Performance Psychology Specialist at Sanford Sports Science Institute in Sioux Falls, SD. Previously he owned his own consulting practice. Gillham works with coaches and administrators on systematic coach evaluation and providing coach and program professional development. His PhD is in Sport and Exercise Psychology from the University of Idaho and he has Bachelor of Science degree and Master of Science degree from University Wisconsin-LaCrosse. He has been a Certified Strength and Conditioning Specialist® (CSCS®) through the National Strength and Conditioning Association (NSCA) since 2003 and is a Certified Mental Performance Consultant (CMPC). Gillham works across competitive levels ranging from youth through professional levels for both coaches and athletes. Beyond his applied work, Gillham has published 36 articles in academic journals and is an Editorial Board member for International Journal of Sports Science and Coaching, International Sport Coaching Journal, *and* NSCA Coach.

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UPPER BODY POWER IN MIXED MARTIAL ARTS

MARC TANGEMAN, MS, CSCS, ANDREW SHIM, EDD, CSCS,*D, AND IAN BONDER, MS, CSCS,*D

INTRODUCTION

Since the 1990s, the Ultimate Fighting Championship has grown in popularity. Often referred to as Mixed Martial Arts (MMA), this regulated sport incorporates various striking, pushing, pulling, and grappling movements/attacks during competition (18). Consisting of three rounds with each round lasting 3 – 5 min (amateur to professional non-title events), these matches rely on a competitor's ability to perform high-intensity spurts of muscular strength, power, and "explosive" speed (18). These intense actions underscore the need for MMA athletes to acquire specific physical characteristics for competition.

Due to a combination of wrestling and boxing techniques, MMA athletes frequently perform upper body limb actions during competition. These striking actions can inflict damage to an opponent and score points for the athlete to potentially win the round (18). Quick and forceful upper body attacks are considered essential for performance and should be developed during training (4). Previously, training was centered around aerobic/anaerobic conditioning and muscular strength compared to incorporating elements of upper body power (UBP) (8,21). Power is the amount of work per unit of time and is equal to force times distance divided by time (31). Given the speed of striking, blocking, and rapid upper body movements, UBP should be considered essential to MMA athletes.

Specific to MMA populations, researchers have examined countermovement jumps, squat jumps, and medicine ball tosses as a potential training tool to improve MMA performance (19,26). However, specific to MMA, there is still limited research on UBP. Specific to the intensity of effort, physical stress, and vigorous flexion and extension of the upper limbs during striking, a training protocol on UBP could be highly advantageous for MMA athletes. A continued emphasis on developing UBP may allow for increased ability to inflict additional damage during strikes, potentially improving the chances of victory. Moreover, a program developing UBP has the potential to yield increases in sport ability and performance. Therefore, the purpose of this article is to justify the importance and advantage to properly incorporate UBP training in MMA athletes.

IMPORTANCE OF UBP IN MMA

Developing and producing UBP is present in many combat disciplines and seen in elite MMA athletes when these strikes produce results that weaken or eventually disable the opponent in a rapid manner. MMA athletes are required to inflict maximal damage during events in an attempt to end the contest by disabling or eventually stopping the opponent by submission or knockout, many of which require upper limb engagement. Thus, the importance of developing UBP is high considering that MMA striking actions can occur in timeframes of milliseconds (1). Previous literature has examined force and power outputs in a comparable combat sport of wrestling (11,14). James et al. and Garcia-Pallares et al. inferred force dominant UBP could be indicative of sporting performance (11,14). Due to similarities in striking and submission tactics between MMA and wrestling, MMA athletes may benefit from more frequent, moderately loaded UBP training (14). Overall, a high dependence on upper body movements during competition indicates that UBP is vital to performance outcomes. Thus, strength and conditioning coaches should include UBP within training protocols to improve performance of MMA athletes.

Provided that many MMA strikes are often preceded by a quick countermovement action, training a fast eccentric loading phase may also be beneficial for athletes. While not all attacks have a loading phase, many movements that exert high amounts of force are performed with a countermovement action. This action, known as the stretch-shortening cycle, permits for improvements in muscular power compared to concentric only contractions (20). The purpose of eccentric muscle action is to increase power potential during the concentric action of the movement. Effects of a countermovement activity have been previously studied in upper and lower body performance. Jimenez-Reyes et al. looked specifically at a vertical jump and the effects of a countermovement action prior to jumping (15). The researchers observed an increase in maximal power output with countermovement actions (15). The addition of a countermovement action significantly increased maximal power output during testing. Similarly, a countermovement push-up and/or ballistic push-up have been observed to produce a higher force during a smaller time frame (28,30). Thus, upper body countermovement exercises could potentially enhance the ability to increase power output via the upper body extensor musculature (27). Considerations for such exercises and outcomes should be made prior to training combat sport athletes.

While traditional training focuses of MMA have been on upper body strength movements, an absence of UBP training may exist. Understanding that power production may be aided by increases in strength, improvements in UBP could be amplified with the addition to traditional strength training methods. As seen in contrast training protocols, a heavily loaded upper body strength movement paired with a plyometric upper body movement has demonstrated an increase in power output within athletic populations (24). With a vast occurrence of upper body strength training already performed in MMA athletes, it may provide an important basis for UBP to be built on in addition to aiding in injury reduction. While UBP relies on a combination of force and velocity, upper body strength emphasizes maximal force (9). This contrast may allow for the potential to increase UBP development. An understanding that muscular strength can increase maximal force production reinforces the ability of muscular strength to enhance muscular power output (25). Although correlations might seem logical, there is limited research on the direct effects of upper body strength to increase UBP in MMA. Nevertheless, excluding upper body strength has the potential to not only decrease UBP development, but also reduce upper body force production essential to combat sport athletes (6).

UPPER BODY POWER ASSESSMENT

With varying ages and skill sets in MMA, UBP measurements could be used to determine the needs and capabilities of specific athletes. Discrepancies in strength and power outputs between amateur and professional MMA athletes may distinguish between novice and elite competitors (14). Given the explosive and forceful movements, UBP may indeed be a major fundamental factor of performance within MMA. Considerations to assess and target UBP in training might improve the athlete's ability to strike forcefully and/or increase velocity of sporting movements. While some resource-endowed institutions may have laboratory testing equipment (e.g., force plates), others will need access to lower cost equipment for UBP measurement. A more cost-effective alternative could be the use of a Tendo©, Just Jump Mat©, Plyomat©, or potentially a smartphone application to measure movement velocity. These devices can provide instant feedback on distance and speed, allowing for UBP calculations to be done.

Proper assessment of UBP provides specific feedback to strength and conditioning coaches regarding physiological abilities of an MMA athlete. As many training facilities lack laboratory equipment, the use of a field measurement may be the most viable assessment option. An easy and effective form of measurement could be performed with the use of a barbell bench press. With this assessment the use of a countermovement prior to the bench press may more accurately imitate punches and strikes in MMA competition. As conducted by Shim et al. the use of a bench press has shown to be a viable option for UBP measurement (23). Additionally, a static position field test in the medicine ball put demonstrated by Clemons, Campbell, and Jeansonne may also be utilized for UBP measurement (5). Requiring only a participant to push a medicine ball on an inclined bench, this field test provides a reasonable and effective determinant for UBP. Benefits for both measurements can be found in monitoring athletes UBP and appropriately applying UBP protocols to training programs.

PROGRAMMING CONSIDERATIONS FOR UPPER BODY POWER

MMA relies on specific skills and tasks for success; however, programming for UBP development may resemble schemes used in other disciplines. Understanding the physiological profile of the MMA athlete may give insight for strength and conditioning coaches to make appropriate exercise selections for the development of UBP training and monitoring. Guidelines and practices on power programming set out by the National Strength and Conditioning Association (NSCA) allow for strength and conditioning coaches to build appropriate training programs for UBP. Some commonly recommended volume, intensities, and rest interval protocols focused on muscular power programming are displayed in Table 1. Given that intensities of 20 – 70% of one-repetition maximums (1RM) are used, an emphasis on velocity during the movement and interset rest intervals between 2 – 5 min should be used per NSCA guidelines (22). With a wide range of suggested intensity for UBP training (20 – 70% 1RM), a lower intensity may draw on velocity/ballistic abilities, while higher intensities will contribute to higher force production or "explosive" strength characteristics. Additionally, suboptimal technique may inhibit potential benefits with training, thus an emphasis on proper technique can enhance the individual's training adaptations.

TABLE 1. PROGRAMMING CONSIDERATIONS FOR MUSCULAR POWER

INTERMEDIATE TO ADVANCED TRAINEES
Sets per exercises: 1 – 6
Repetitions per exercise: 1 – 6
Load/intensity: 20 – 70% 1RM
Rest between sets: 2 – 5 min

A lower volume of work is typically performed with muscular power training than that of muscular strength or endurance. With an increase in neuromuscular output and coordination, rest intervals are altered to match intensity while maximizing recovery. A rest interval upwards of 2 – 5 min is recommended to allow for maximal neuromuscular recovery and power output during training (22). Athletes' rest intervals may vary based on previous training history and UBP capabilities. More advanced MMA athletes may have developed nervous system abilities to a greater level than that of a novice athlete. Thus, these individuals may be able to recruit motor units more effectively and require greater rest intervals than their less efficient counterparts (7). However, the emphasis on power and strength endurance of MMA athletes may dictate that inter- and/or intra-set rest be cut down to match those intervals seen within competition. Specific to UBP development, Jones and Ledford determined wrestlers performing complex training for power were able to increase UBP intra-set rest periods more closely mimicking physiological demands of competition (16). Strength and conditioning coaches should closely consider complexity of training methods to match more appropriately that of the competition and individual capacity.

Recommendations for training frequency have a variety of contingencies. Typical frequency recommendations for muscular power training are 2 – 4 days/week (22). However, the rigorous sport and competition training schedule performed by many MMA athletes may not allow for such additional volume or intensity. While programming for UBP with MMA athletes is not significantly different than that of other combat sports, appropriate understanding of the total workload and fatigue occurring in the athlete's other physical training should be considered daily. Without proper fatigue management training, principles may be rendered ineffective and potentially decrease the impact on improving performance outcomes. Strength and conditioning coaches should understand the importance of creating a successful program to target UBP while accounting for the accumulation of physical and mental stressors already existent within the sport. Thus, strength and conditioning coaches may use traditional programming recommendations as guidelines for individual training. As training focus changes throughout the numerous microcycles, power development should be targeted during a pre-competition macrocycle, ending 8 – 14 days prior to a bout (13).

A systematic guideline for strength and conditioning coaches to develop UBP in MMA athletes is provided in Table 2. Although this template provides a warm-up and training regimen for daily use, the specifics of training and programming should be set through a needs analysis performed prior to training. There are several methods available for UBP development. Table 2 has listed programs for contrast, cluster, and velocity-based cutoff methods. The advantage of contrast training is the combination of strength and power in heavy resistance paired with high velocity of similar biomechanical movements (12). The combination of such resistances and velocities are linked to a phenomenon known as post-activation potentiation. This phenomenon has been noted for its ability to increase power output and muscle force potential (10). Another advantageous method for MMA may be cluster sets. With the ability to maintain force and power outputs during training, cluster sets can be a useful way of training UBP. Using intra-set rest intervals of 5 – 15 s, overall force and power output experience less of a decrease than traditional resistance training (17). Implementation of velocity cutoff sets will require the use of velocity-based training equipment such as a Gymaware® or Flex® system. Training on a velocity cutoff protocol requires a specified percentage of an individual's repetition maximum or load velocity profile (if applicable) and targeted velocity for UBP adaptation (0.6 – 1.3 m/s) (29). Once percentage and velocity are prescribed, a cutoff percentage of 10 – 30% and or a repetition cap can be used to end the athlete's set (29). In this instance, an athlete will have a prescribed number of repetitions per set; however, this may be outside of the traditional recommendations for training power. With a capped repetition number, an emphasis on appropriate velocities maintains the adaptation being acquired without overly fatiguing the individual. Each method can bring forth an appropriate adaptation for UBP; thus, strength and conditioning coaches should not get too engrossed in methodology, but rather seek the desired adaptation for the athlete.

With a great variety in daily performance and stress, program design should allocate for undulations within daily training modalities and desired outcomes. In the case of MMA, athletes may be prone to fatigue induced injuries with the high workloads placed on them by sport-specific training (13). An emphasis on training tasks should efficiently utilize time without impairing other elements of physiological performance (13). Thus, specific monitoring of training workloads could be performed for fatigue management and optimizing training outcomes. Understanding fatigue and workload underscores the importance of having a certified strength and conditioning coach developing and overseeing the athlete's program. Daily changes are likely to occur, necessitating prior knowledge and experience of proper handling with said changes to not disrupt the short- and long-term goals and needs.

As mentioned previously, upper body strength training could aid in development of UBP. For practical purposes, muscular strength training has also been included in Table 2 to increase potential for

TABLE 2. SAMPLE CONTRAST, CLUSTER, AND VELOCITY-BASED CUTOFF TRAINING

CONTRAST
Warm-Up: Bodyweight push-ups, TRX rows, dumbbell bench press, cable triceps extensions. All performed 2 x 10
Main:
A1) Barbell bench press
Warm-up set: 1 x 4 – 6 at 40% 1RM (rest 1 – 2 min)
Warm-up set: 1 x 4 – 6 at 60% 1RM (rest 1 – 2 min)
Sets: 1 – 5 x 2 at 80 – 90% 1RM (rest 30 s before push-up)
A2) Plyometric push-up 5 x 4 (bodyweight) (rest 2 – 5 min before repeating)
B) Medicine ball put (incline) 3 x 5 (light to moderate weight) (rest 2 min between sets)
C) Neutral grip chin-up 3 x 8 (bodyweight) (rest 1 – 2 min between sets)
CLUSTER SET
Warm-Up: Dumbbell bench press, incline bodyweight push-up, medicine ball overhead toss. All performed 2 x 10
Main:
A) Barbell bench press throw
Warm-up set: 1 x 4 with barbell only (rest 1 min)
Warm-up set: 1 x 4 at 30% 1RM (rest 1 – 2 min)
Sets: 1 – 5 x (1,1,1) at 30% 1RM (rest 10 s between each repetition, 2 – 5 min between sets)
B) Lying medicine ball throws 4 x (2,2,2) (light to moderate weight) (rest 10 s between each repetition, 2 – 3 min between sets)
C) Incline dumbbell bench press 3 x 10 (moderate weight) (rest 1 – 2 min between sets)
VELOCITY-BASED CUTOFF
Main:
A) Barbell bench press
Warm-up set: 1 x 4 – 6 at 40% (rest 1 – 2 min)
Warm-up set: 1 x 4 – 6 at 60% (rest 1 – 2 min)
Sets: 1 – 5 x 8 (maximum) at 0.65m/s* (rest 2 – 5 min between sets)
*Stop set at 10% velocity loss on a single repetition or 8 repetitions
B) Neutral closed grip incline press 3 x 8 (moderate weight) (rest 2 – 3 min between sets)
C) Dips with V-handle attachment 3 x 10 (bodyweight) (rest 1 – 2 min)

lagging muscular strength capabilities. While not necessary with all MMA athletes, the additional strength training should be based off the needs and abilities of the individual. Daily and weekly fluctuations are likely to be needed for MMA athletes training for UBP. Strength and conditioning coaches should be monitoring and considering the athlete's overall physiological stress when implementing training strategies.

PRACTICAL APPLICATION

Practicality of UBP training in MMA athletes can remain reasonably modest with a potential for positive outcomes in sport and training. Several practical methods are available including contrast, cluster sets, or velocity-based cutoff sets. Performed correctly over the specified days and weeks, increases in UBP will be present with such methods. The addition of UBP training may increase the performance capabilities of the MMA athlete. With such demand on upper body movements for competition, UBP training offers a simplistic way to potentially improve sporting outcomes. Strength and conditioning coaches working in the MMA field may see several benefits from the implementation of UBP programming. In addition to increases in sporting capabilities, UBP may offer the ability to differentiate between high- and low-level competitors giving strength and conditioning coaches insight into further training recommendations. Thus, special emphasis on UBP in MMA athletes may have far-reaching effects potentially unestablished in current literature. Strength and conditioning coaches should consider implementation of specific UBP exercises to aid in athletic development.

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ABOUT THE AUTHORS

Marc Tangeman is the Director of Strength and Conditioning at the College of Saint Mary in Omaha, NE and CEO of Tangeman Training Systems LLC in Papillion, NE. He graduated from the University of Nebraska-Lincoln with a Bachelor of Science degree in Nutrition Exercise and Health Science in 2017 and from the College of Saint Mary in 2022 with a Master of Science degree in Kinesiology and Exercise Science. Currently he is an active member of the National Strength and Conditioning Association (NSCA) Nebraska State NSCA Advisory Board Member for Personal Training. His current research is within law enforcement populations on the studies of upper body power, physical fitness, and academic performance.

Andrew Shim is the Program Director and Professor in the Department of Kinesiology and Exercise Science at College of Saint Mary in Omaha, NE. He graduated from United States International University in San Diego, CA in 2002 with a Doctorate in Education/Health Technology. He has been in higher education for the past 30 years and a reserve police officer for the past five years. He is currently serving as the National Strength and Conditioning Association (NSCA) State Director for the state of Nebraska.

Ian Bonder is a Strength and Conditioning Coach in Omaha, NE, as well as an Adjunct Instructor at the College of Saint Mary. He graduated from the University of Nebraska-Omaha with a Bachelor of Science degree in Exercise Science in 2012 and a Master of Science degree in Kinesiology and Exercise Science from the College of Saint Mary in 2022. He is an active National Strength and Conditioning Association (NSCA) Member and a Nebraska State NSCA Advisory Board Member in the area of tactical strength and conditioning. His current research is in the area of time-efficient training and microdosing with law enforcement personnel and in sport performance.

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THE FRENCH CONTRAST METHOD—THEORY AND APPLICATION

MICHAEL LONG, MS, CHRIS FEE, MS, CSCS, USAW, AND CHRISTOPHER TABER, PHD, CSCS, USAW-2

The French Contrast Method (FCM) is a training method created by Gilles Cometti, a French track and field coach (7). After its creation, its use has become widespread by many strength and conditioning coaches, despite limited research on its effectiveness and proper implementation. The method is executed by taking four exercises that exploit various areas of the force-velocity curve in order to bring out an acute physiological response. The method aims to increase post-activation performance enhancement through a combination of traditional resistance training and plyometrics exercises leading to greater rate of force development, movement velocity, and power production. This protocol structure is a combination of complex and contrast training, designed to improve anaerobic performance. The purpose of this article is to discuss the theory behind the FCM, current evidence demonstrating its effectiveness, as well as proper implementation and execution for athletic populations.

COMPLEX TRAINING

Complex training is a combination of a high-load resistance exercise, followed by a biomechanically similar plyometric exercise (1). The basis of complex training is the acute aftereffect known as post-activation performance enhancement (PAPE) (2). The exact mechanisms leading to PAPE are not fully understood, but are thought to be related to changes in muscle temperature, calcium kinetics, myosin light chain upregulation, and nervous system activation (9). In this training method, the athlete will perform a set of a heavy resistance exercise, typically 80% or more of their one-repetition maximum (1RM), before performing a set of a non-resisted or lightly-resisted plyometric exercise immediately after. In doing this, the athlete has an increase in motor unit recruitment and will acutely increase their rate of force development, power output, and movement velocity, due to previous muscle activation (2,11).

Chronically, it is speculated, that athletes will develop more power with this method than standard loading of resistance training or plyometrics alone (3). Studies have demonstrated that incorporating complex training causes a decrease in short-distance (5- and 15-m) sprint times and improvements in vertical jump height in 17 year old elite male soccer players, when compared to a control group (1). Additional studies have shown increases in squat jump and countermovement jump height, Abalakov (vertical jump containing arm swing and quarter squat landing) test performance, and medicine ball throw distance in youth male basketball players (12). There have been increases in power measures of jump height (squat, countermovement, and depth), as well as decreases in short distance sprint times for studies implementing complex training. The theorized increases in performance are likely due to greater recruitment of motor units and the acute PAPE effect, which may lead to the potential of greater force to the subsequent movements. In the cases of testing for sprints or jump height, the power output is increased, and therefore an increase in acute performance occurs. A recent meta-analysis has highlighted the positive effects of both complex and contrast training, but determined that complex training may have a slight advantage in performance development in athletes (4).

CONTRAST TRAINING

Contrast training is the use of heavy and light loads acutely within the same session (4). Similarly, to complex training, contrast training also involves the pairing of a heavy resistance exercise and an explosive exercise directly after. For example, while complex training might call for a set of box jumps directly after a set of heavy squats, contrast training would instead have the athlete perform their set of heavy squat repetitions, alternated with lighter squat repetitions of the same exercise, and all exercises being completed with maximal intent. The combination of high and low loads has demonstrated different velocities of muscle contraction, leading to increases in power development (4). The rationale is that the heavy loaded exercise leads to an increase in neuromuscular activation, which may enhance the performance of the subsequent exercise. In this case, the subsequent exercise is a light "explosive" exercise performed at maximum velocity, another variation to develop power (14). Similarly, studies have demonstrated that there is a range of loads for the most favorable power development adaptations, which may exist on a spectrum (15). Heavy loads recruit high threshold, fast-twitch motor units, but other studies suggest that training with a higher velocity and thus lighter loads, leads to maximum power output (8,10). Therefore, using a combination of the two load methods would result in a "best of both worlds" scenario. Similar to complex training, studies on contrast training have demonstrated increases in jump height and decreases in sprint times for short-distance sprints (1). It was concluded that both complex and contrast training methods were suitable methods for developing muscle power and speed in young male soccer players (1).

FRENCH CONTRAST METHOD STUDIES

From the original method created by Cometti, Cal Dietz and Ben Peterson have reworked the FCM as a combination of complex and contrast training methods that involve the following exercise protocol: heavy compound exercise, plyometric exercise, weighted plyometric exercise, and an assisted plyometric exercise (5). These exercises are sequenced with short inter-set rest periods (10 – 20 s) between exercises and longer rest between sets (3 – 5 min) in order to allow for restoration of adenosine triphosphate (ATP) levels and high-quality movement strategies with low fatigue. The structure of these exercises allows for development of force, velocity, power, and anaerobic capacity (5).

Few studies investigate the updated version of the FCM acutely or chronically. The first study to document the acute effects of the FCM was completed by Hernandez-Preciado et al. in 2018 (7). In the study, the intervention group performed three FCM sets of isometric partial squats, drop jumps, dynamic half-squats, and hurdle jumps. Jump height was measured after each round and compared against a control group. The FCM group improved acute countermovement jump height in each subsequent round

compared to baseline by 5.1, 6.8, and 8.5% after the first, second, and third set, respectively. The study demonstrated that multiple rounds of the FCM had a positive effect on countermovement jumps and it was concluded that the FCM is a valid strategy to acutely improve an athlete's jumping capacity, as well as enhance lower body force and power production within a session.

A later study by Elbadry et al. in 2019 examined the effect of the FCM chronically over eight weeks in collegiate triple jumpers (6). They investigated the training effects of the FCM on three explosive performance variables related to triple jump performance (Sargent jump test, countermovement, jump, and seated medicine ball throw) as well as kinematic triple jump variables. Over the training period, no changes were observed in arthrometric variables, while increases in all explosive strength and kinematic variables related to the triple jump increased. The explosive strength measures of the countermovement jump height increased (1.8%), seated medicine ball throw increased (2.25%), and the Sargent jump test increased (3.79%). Thirteen of the 15 kinematic variables associated with the hop, step, and jump improved from 2.4 – 16.7%. Overall, eight weeks of the FCM proved to be effective at improving explosive strength and kinematic performance variables in collegiate triple jumpers.

A training study was completed by Welch et al. where they explored the effects of the FCM on maximum strength and vertical jumping performance over six weeks (16). Subjects completed two lower-body FCM sessions per week combining back squats, countermovement jumps, trap bar jumps, and accelerated jumps. The authors reported after the six weeks of the FCM implementation, participants improved their lower body maximum strength and power (16). Absolute strength and relative strength improved in back squat (6.2%, 4.7%) and trap bar deadlift (7.7%, 5.5%) (16). Participants improved static jump height (11%), peak velocity (4.4%), and peak power (9.76%), while countermovement jumps improved in jump height (8.5%), peak velocity (3.2%), and peak power (2.3%) (16). It was concluded from this study that FCM was an effective way to increase lower body strength and power. Additionally, the authors reported that, including a warm-up, each session lasted approximately 30 min, making the FCM a time-efficient and effective method to improve performance.

These studies, while limited, demonstrate the ability of the FCM to acutely enhance lower body force and power production and chronically to improve jumping ability, maximal force production, and total body power. Because the training effects that may result from the use of the FCM beyond what could be achieved by training alone, more evidence is needed to fully elucidate both the acute and chronic mechanisms underlying this method.

PRACTICAL APPLICATION AND IMPLEMENTATION

Strength and conditioning coaches should carefully contemplate how and when to implement the FCM for their athletes. First, an athlete's training age and experience should be considered. Because this method incorporates compound movements and may cause fatigue between rounds, athletes should be competent in all compound exercises and have a baseline of maximal strength in order to handle the acute fatigue (13). The second consideration should be the time of year for using the FCM. The purpose of the FCM is to increase the power production of the upper and lower body through the exposure to resistance training and plyometrics. For this reason, the FCM should be used later in the annual plan when maximal power production is a desirable quality to pursue. Due to the higher training density, intensity, and lower volume, this method can be used in the pre-season and competitive season as a viable method for preparing athletes in the weight room. Finally, from a practical standpoint, exercise selection should reflect the demands of the sport and available equipment and space. When choosing exercises, large, multi-joint, compound exercises should be chosen for the ability to load sufficiently and contain similar muscle actions and joint angles found in sport. From the choice of the main compound movement, the remaining plyometrics exercises should reflect similar biomechanical parameters in order have the greatest acute transfer of PAPE. Once exercises have been selected, the weight room should be arranged to allow for optimal flow of athletes so they can maintain the short rest periods (10 – 20 s) between exercises. The use of small groups may provide an efficient way to organize larger teams and minimize the need for multiple pieces of additional equipment.

Table 1 provides sample exercises and training prescription during an off-season for collegiate football or rugby athletes providing workouts focusing on power production with the inclusion of heavier weights to stimulate a maximal strength adaptation in the main compound exercise. Table 2 focuses on a competitive season workout where the main focus is power production and the main compound exercise has an emphasis on velocity of movement and moving submaximal weights as quickly as possible. Tables 3 and 4 contain sample workouts for a laterally-focused athlete, such as ice hockey and baseball, where the emphasis is placed on training outside of the sagittal plane.

CONCLUSION

Overall, from the limted evidence available, the FCM is a practical method to acutely increase force, velocity, and power production in athletes. Two studies have highlighted that in the short-term (6 – 8 weeks) the FCM improved maximal strength, explosive power, and sport performance. This method serves as a time-efficient method to develop power and improve anaerobic capabilities. Strength and conditioning coaches can consider implementing this method if their athletes have a sufficient training age, proficient technique execution, and are entering the pre-season or competitive phase of the annual plan. Future studies should endevour to explore the mechamisms underlying the FCM both actuely and chronically. Additonally, this method should be compared to already established protocols for increasing power and jump height, such as plyometrics and post-activation performance enhancement.

FIGURE 1. BARBELL BENCH PRESS

FIGURE 2. PLYOMETRIC PUSH-UP

FIGURE 3. MEDICINE BALL PUSH SLAM

FIGURE 4. BAND-ASSISTED PUSH-UP

FIGURE 5. BARBELL BACK SQUAT

FIGURE 6. COUNTERMOVEMENT JUMP

FIGURE 7. LOADED TRAP BAR JUMP

FIGURE 8. BAND-ASSISTED VERTICAL JUMP

TABLE 1. PRE-SEASON SAMPLE WORKOUT

	HEAVY COMPOUND MOVEMENT	PLYOMETRIC MOVEMENT	WEIGHTED JUMP OR LIGHT COMPOUND MOVEMENT	ASSISTED PLYOMETRIC MOVEMENT
Upper Body Exercise	Bench press	Plyometric push-up	Medicine ball push slam	Band-assisted push-up
Sets x Repetitions	5 x 3	5 x 3	5 x 3	5 x 3
Intensity (%1RM)	40 – 70%	Bodyweight	10 – 30%	Bodyweight
Lower Body Exercise	Back squat	Countermovement jump	Loaded trap bar jump	Band-assisted jump
Sets x Repetitions	5 x 3	5 x 3	5 x 3	5 x 3
Intensity (%1RM)	40 – 70%	Bodyweight	10 – 30%	Bodyweight

TABLE 2. COMPETITION PERIOD SAMPLE WORKOUT

	HEAVY COMPOUND MOVEMENT	PLYOMETRIC MOVEMENT	WEIGHTED JUMP OR LIGHT COMPOUND MOVEMENT	ASSISTED PLYOMETRIC MOVEMENT
Upper Body Exercise	Bench press	Plyometric push-up	Medicine ball push slam	Band-assisted push-up
Sets x Repetitions	6 x 2	6 x 3	6 x 3	6 x 3
Intensity (%1RM)	60 – 90%	Bodyweight	10 – 30%	Bodyweight
Lower Body Exercise	Back squat	Countermovement jump	Loaded trap bar jump	Band-assisted jump
Sets x Repetitions	6 x 2	6 x 2	6 x 2	6 x 2
Intensity (%1RM)	60 – 90%	Bodyweight	10 – 30%	Bodyweight

TABLE 3. PRE-SEASON SAMPLE WORKOUT

	HEAVY COMPOUND MOVEMENT	PLYOMETRIC MOVEMENT	WEIGHTED JUMP OR LIGHT COMPOUND MOVEMENT	ASSISTED PLYOMETRIC MOVEMENT
Lower Body Exercise	Lateral lunge	Lateral hurdle hop	Weighted lateral hurdle hop	Band-assisted lateral lunge
Sets x Repetitions	5 x 3	5 x 3	5 x 3	5 x 3
Intensity (%1RM)	40 – 70%	Bodyweight	10 – 30%	Bodyweight
Lower Body Exercise	Reverse Lunge	Split squat jump	Weighted split squat jump	Band-assisted split squat jump
Sets x Repetitions	5 x 3	5 x 3	5 x 3	5 x 3
Intensity (%1RM)	40 – 70%	Bodyweight	10 – 30%	Bodyweight

TABLE 4. COMPETITION PERIOD SAMPLE WORKOUT

	HEAVY COMPOUND MOVEMENT	PLYOMETRIC MOVEMENT	WEIGHTED JUMP OR LIGHT COMPOUND MOVEMENT	ASSISTED PLYOMETRIC MOVEMENT
Lower Body Exercise	Lateral lunge	Lateral hurdle hop	Weighted lateral hurdle hop	Band-assisted lateral hurdle hop
Sets x Repetitions	6 x 2	6 x 3	6 x 3	6 x 3
Intensity (%1RM)	60 – 90%	Bodyweight	10 – 30%	Bodyweight
Lower Body Exercise	Reverse lunge	Split squat jump	Weighted split squat jump	Band-assisted split squat jump
Sets x Repetitions	6 x 2	6 x 2	6 x 2	6 x 2
Intensity (%1RM)	60 – 90%	Bodyweight	10 – 30%	Bodyweight

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ABOUT THE AUTHORS

Michael Long recently completed his Master's degree at Sacred Heart University within the Department of Physical Therapy and Human Movement Science in May 2022. He is a strength and conditioning coach, most recently accepting a position with the United States Army at Fort Drum, NY. He also trains and competes in both powerlifting and Olympic lifting as well as coaching youth and high school wrestling.

Chris Fee is the Associate Athletic Director and Head Strength and Conditioning Coach for Sacred Heart University. He oversees the strength and conditioning programing and implementation for all 33 varsity programs. He is the primary strength coach for the men's football team and oversees a staff of six strength coaches.

Christopher Taber is an Associate Professor in the Department of Physical Therapy and Human Movement Science and Director of the graduate program in Exercise and Sport Science.

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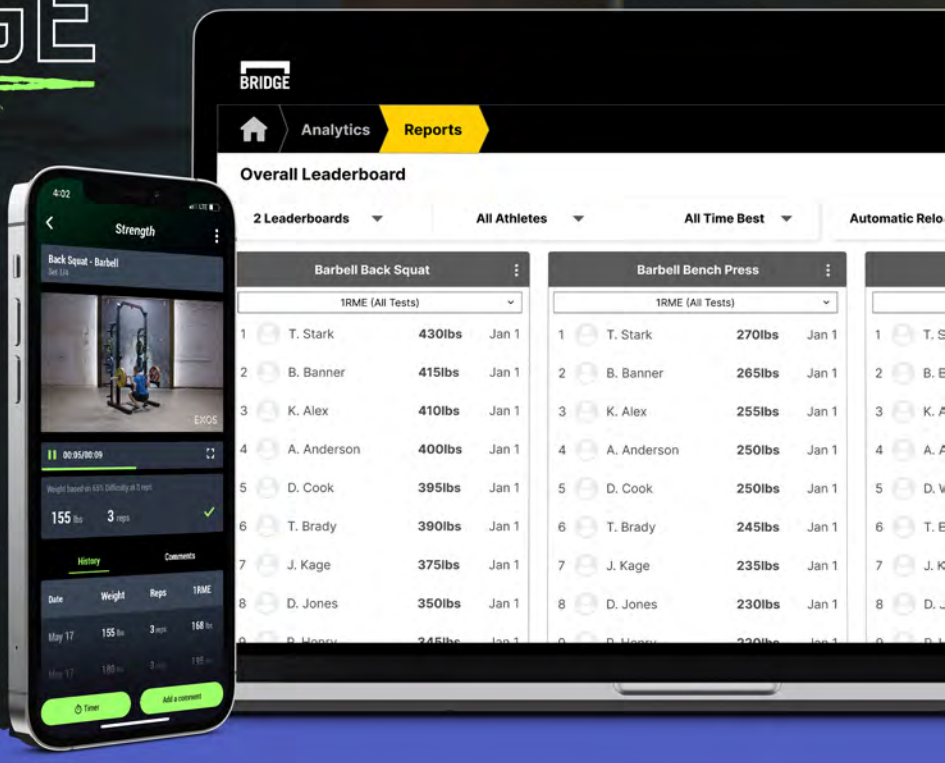

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IMPROVING THE STRENGTH AND CONDITIONING PROGRAM ON A LIMITED BUDGET

ALLEN HEDRICK, MA, CSCS,*D, FNSCA

As a strength and conditioning coach, you have a responsibility to both the coaches and athletes you work with to provide the highest quality service to them possible. However, the reality is, and especially at the high school and small university level, the available budget is often limited, sometimes severely. That does not mean you cannot still make improvements in your program, but it does mean you will have to become more creative in your approach to do so.

Having worked at both the Division I and then the Division II collegiate levels, I have experienced the difference in the financial resources available in those two settings. There is a significant financial difference and, as a result, you must take a different approach as you strive to improve the program. Discussed below are some of the approaches I took when the financial resources were limited, but the desire to be highly competitive was still the goal.

CONTINUING EDUCATION

The amount of information available to strength and conditioning coaches is literally unlimited, often at little to no cost. Belonging to professional organizations, such at the National Strength and Conditioning Association (NSCA), is a must, both from an educational and certification stand point. The amount of high-quality information available is a great way to help you provide excellent service to those you work with. Further, you owe it to your athletes to be certified, not only for their safety but to protect yourself in a liability situation and to provide you the information necessary to be as effective as possible in your role.

There is a tremendous amount of information available, online and in books and journals, related to strength and conditioning. However, unlike the NSCA, where the information presented is peer-reviewed, information presented in other formats may not have gone through a stringent review process. Therefore, you have to be more cautious when adapting any information gathered from non-peer reviewed sources.

CHOCOLATE MILK

Because of the combination of protein and carbohydrates, chocolate milk has been shown to be an effective recovery drink following a resistance training session (5,7). Realistically, most small college and high school programs do not have the funding to supply chocolate milk to their athletes. Fortunately, we were able to find a local dairy that was willing to donate chocolate milk to our football athletes. We made a few calls, and in exchange for putting up some signage in our fieldhouse and football stadium, they agreed to supply us with all the chocolate milk we needed year-round. It took a little time on our part to find a company willing to work with us, but the benefit to our athletes was significant.

REGISTERED DIETITIAN

Most high-level college football teams have a full-time sports nutritionist on staff for their athletes. Again, from a budget standpoint, this is not realistic for smaller programs. Our solution was to contact a local university that has a graduate-level sports nutrition program with students that needed as much practical experience as they could attain. It was a win-win situation; we were able to have nutritional counseling provided to our athletes, including individual nutritional programs designed for every athlete who was interested, and the students gained the practical experience they were required to attain as a part of their degree program. Again, it just took a few phone calls and signing some paperwork to finalize the agreement. If there are other areas of need (e.g., computer science student to create a spreadsheet, graduate-level student to research a specific topic, art student to enhance the visual appeal of the facility) using interns to accomplish these tasks is a sensible approach.

INTERNSHIPS

Most programs at the high school or small college level are understaffed. Typically, the head strength coach will be fortunate to have one paid assistant. This places a big load on a small coaching staff, especially when they are working with 12 – 15 teams or more. One solution to help ease the load is to seek out college students who want to perform an internship, either for personal growth or as part of a degree requirement (6). These young coaches may not be ready to take on a team by themselves, but they can certainly act in a supporting role with coaching, set up and tear down of the facility, maintenance, and other similar roles. The more help you can get, the better job you can do coaching your athletes while helping the student gain additional experience as they work towards being ready to assume a role in the profession. Interns can play an important role in achieving the desired coach-to-athlete ratios of 1:10 at the middle school level, 1:15 at the high school level, and 1:20 above the secondary school level (3).

YOGA

Yoga can play a role in flexibility and active recovery from the stress of training and competing. As noted in Fares et al., yoga resulted in lower peak muscle soreness and improved flexibility (2). The practice of yoga seems to relieve delayed onset muscle soreness (DOMS) and improve flexibility. Yoga can also help reduce the effects of mental stress (4). At my place of work, we were fortunate to have a yoga instructor on staff who was willing to donate her time and conduct yoga classes for our athletes. A simple way to add value to your training program is to find existing resources and utilize those resources for the benefit of your teams. Contact on-campus or local yoga instructors and ask who might be willing to donate their time.

VIDEO REPLAY

Video replay is a simple, but effective coaching tool. Using a tablet or phone to film your athletes training and then watching with them and providing feedback is an excellent coaching tool. Sometimes switching from telling the athlete to showing the athlete can have rapid and effective results in term of enhancing their exercise technique. When the goal is for your athletes to have very good technique, using video as a coaching tool can be a huge help in enhancing performance.

TIRES

Flipping a tire involves a similar movement pattern to performing the weightlifting movements. Although they are similar in form, the tire flip possesses some potential advantages over the power clean and clean-and-jerk that may prove beneficial during athletic competition (9). The first of these potential advantages is the completion of the initial push, during which the athlete extends the ankle, knee, and hip joints, otherwise known as triple extension (11). This action is similar to the explosive movement phase during the pulling phase of the power clean. Previous research examining seven strongman events reported that the tire flip elicited the highest muscle activation levels, through electromyogram recordings, in the lower body, core, and upper back musculature (11). Furthermore, the completion of the third phase, or the second push, potentially provides an advantage over the jerk in that it is performed in a horizontal direction and not in a vertical direction like the jerk. This horizontal movement better simulates blocking, tackling, and stiff-arming movements in American football and rugby. What is not part of flipping a tire is any sort of catch position, so the athlete can be very focused on explosive triple extension without being concerned about catching the load. I like supplementing performance of the weightlifting movements with sets of tire flips. The good news, used truck or tractor tires can generally be picked up for free at tire salvage yards. Tell them who you are associated with, what you want to use the tires for, and often they will be more than happy to let you take what you want.

KEGS

Similar to using tires to supplement the weightlifting movements, I like to use water-filled kegs to supplement exercises such as bench press, squats, and good mornings (1). The water contained in the keg results in an active resistance (the water moves back and forth in the keg) that the lifter must overcome when performing an exercise. For athletes who compete in contact sports, such as football or hockey, most of the resistance they encounter during a competition is in the form of an opponent applying active resistance against his or her body (12). The active resistance the water-filled keg provides helps mimic the active resistance they will encounter during a competition.

SOCIAL MEDIA

Many people like to be mentioned and recognized for their accomplishments. Social media provides a great opportunity to do that. The simple act of filming, posting, and mentioning an athlete(s) by name is a great way to accomplish that. The athletes learn to look forward to seeing themselves or their teammates mentioned. This is a simple, but effective way to increase motivation and reward your athletes for a job well done. They usually like it and it promotes your training program, so it really is a win-win situation for you and your athletes. It is important to post a variety of athletes performing well in the strength and conditioning program and not focus strictly on the highest performing athletes. Celebrate their successes with positive posts about their accomplishments.

RECORD BOARDS

Another way to recognize your athletes is through the use of record boards. We found a local vender who was able to put together some inexpensive record boards for us using plastic sleeves (like you see used in a grocery store to post prices) that allowed the boards to be updated quite easily. Athletes respond to being recognized and they strived to perform at a level that gets their name on the board. The importance to them of getting their name on the board is demonstrated when a mistake is made and their name is incorrectly left off the board. They were always quite prompt in letting me know a mistake had been made.

CANVAS BLOCKS

We found rectangle artists canvas at a local hobby shop that were large enough that we were able to paint the date, score, and opponent on the canvas and hang them on a wall in the weight room as a way to commemorate important victories. The canvas was painted brick red to mimic the color of a brick as a way to signify the victories as building blocks of a successful program over time.

TIMED LIFTS

Velocity-based training has become more and more of an emphasis in the programming of athletes as it has become recognized that the speed of movement at which repetitions are performed play an important role in the adaptations that occur as a result of training (8). Being strong at slow movement speeds does not transfer effectively to the needs of the athlete, especially as you get closer to the competitive schedule (10). Unfortunately, many of the methods used to measure the velocity of training can be rather expensive in a program with a small budget, although some lower cost methods to measure training velocity have been developed.

We developed a training method that allowed us to at least shift the emphasis of training from focusing solely on the amount of weight lifted to the speed of movement used during training by placing a time component on the set and repetition scheme. For example, the workout may call for four sets of six repetitions of squats to be performed, but we also included a time limit in which the athlete had to complete the six repetitions. As an example, the workout might read “4x6 at 8 seconds,” which means they have to complete six repetitions with good form in eight seconds. Athletes are instructed to always go for the entire time duration, meaning the set is completed not when six repetitions

have been completed, but when eight seconds have elapsed. The athlete is required to go as heavy as possible, but still complete six repetitions with proper form within the allotted time. If the athlete completes more than six repetitions in the eight seconds (again, just as an example) they are directed to increase the load. If they complete fewer than six repetitions in eight seconds, they are instructed to lift faster. If they are still unable to complete the required repetitions in eight seconds, then they know to reduce the load just enough to allow them to compete the required number of repetitions in the allotted time period. Using timed lifts, the emphasis shifts from how much can I lift to how fast can I move the load, so the intent becomes to lift the weight as fast as possible.

PROGRAM REVIEW

There is no such thing as writing a perfect program. With new scientifically-based information becoming available continually, you can and should be making adjustment to your program on a yearly basis, implementing that new information that fits into your training program. Further, as you have the chance to see your programming carried out over a training cycle, you can evaluate what things worked well and what things need to be adjusted based on your experience. I found the summer period a great time to go through my programming and make adjustments to the plan based both on new information and self-evaluation of what worked and what did not work as well as you would have liked. Over time, the number of adjustments in your training program will generally grow smaller and smaller, but improvements can always be made. Most of the adjustments made to my programs were based on newly published research that could be integrated into the existing program. The changes made typically were not made as a result of being unhappy with the existing program, but realizing that any program can be improved and when research-based adjustments can be integrated into the program, it made sense to do so.

In summary, the goal of improving your program should be an ongoing process. Lacking financial resources may make the process more difficult but there are things that can be done that require little to no money. You expect your athletes to give a winning effort each time they show up to train, they have a similar expectation of you as a strength and conditioning coach.

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ABOUT THE AUTHOR

Allen Hedrick retired in 2020 from the role of Head Strength and Conditioning Coach at Colorado State University-Pueblo, in Pueblo, CO. Previously, Hedrick has been the Head Strength and Conditioning Coach at the United States Air Force Academy, the National Strength and Conditioning Association (NSCA), and the United States Olympic Training Center. Prior to that, he worked as a graduate assistant while pursuing his Master’s degree at Fresno State University. Hedrick was named the NSCA’s Collegiate Strength and Conditioning Coach of the Year in 2003. Hedrick has been published over 100 times in a variety of publications on a multitude of topics related to strength and conditioning and has published a book on strength and conditioning for football along with numerous DVDs related to strength and conditioning. In addition, Hedrick has spoken at numerous conferences and clinics, both nationally and internationally.

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ICE HOCKEY SPECIAL CONSIDERATIONS—THE GOALTENDER

TAMMY KOVALUK, MS, CSCS

The ice hockey goaltender is almost in his or her own category when considering hockey athletes. As compared to their teammates, the goaltender possesses different physiological and neuropsychological needs, requiring a specialized set of skills and physical and mental characteristics that need to be trained accordingly (8). Rather than accelerating up ice to fight for the puck or breakaway to score a goal, for example, the goaltender's job is to perform saves and clear the puck away from the net. Bell et al. found that National Hockey League (NHL) goaltenders move most vertically, laterally, and into a full-butterfly position within the goal area (Figure 1). They also skate out of the goal area to move the puck (1).

As compared to forwards and defenders, goaltenders generally play the entire period as opposed to shifts with forwards and defenders, but this is at a lower intensity, reaching lower post-game blood lactate and displaying lower VO_2max values (4,8). Research in junior level goaltenders, for examples, indicates approximately 75% of the game to be at low intensity, 21% medium intensity, and 4% at high intensity (4).

The ice hockey goaltender requires exceptional skill and tactical decision making, including excellent hand-eye coordination with skilled glove work to perform saves and stick handling skills to prevent scoring and promote the play of his or her team (4,6). Goaltenders require fast reaction times, quickness, agility, mobility, explosiveness (e.g., to repeatedly drop in and out of the butterfly position), and stamina (4,6). The goaltender should have adequate stamina to enhance recovery between the short high-intensity periods, maintain alertness, and be ready throughout the game (8). To be successful, he or she needs to remain focused during every shot and situation, through intensive high-pressure situations, as this can be the potential difference in the game results (4). Their position also leads to greatly increased risk of specific muscle imbalances and injuries, particularly hip and groin injuries.

FIGURE 1. GOALTENDER BUTTERFLY POSITION

The purpose of this article is to investigate a few important considerations: common injuries faced by the ice hockey goaltender, specific physical characteristics and conditioning, and the mental game.

COMMON INJURIES FACED BY THE ICE HOCKEY GOALTENDER – HIP AND GROIN INJURIES

Hip and groin injuries are prevalent amongst hockey players (14). Some studies demonstrate the goaltender to be at higher risk (14). Seven out of 10 ice hockey goaltenders will experience hip and groin problems at some part during the season, often attributed to the movements they frequently perform (13). During a butterfly save, for example, the goaltender drops to their knees and flairs their lower legs. During this movement, injury risk is increased at the hip joint due to a combination of vertical impact from the knees through the femur, along with maximal internal hip rotation (9,12). The skating movement pattern of the goaltender, with large internal rotation, also attributes to high hip loads and risk of injury (13).

Besides groin injuries, femoroacetabular impingement (FAI) is another increasingly common injury amongst ice hockey goaltenders (7,8). FAI occurs when the bones rub against each other in the hip joint, and is associated with pain and several injuries including labral tears and early onset hip osteoarthritis (7). FAI is an increased risk, particularly in athletes requiring end-range hip movements of flexion, adduction, and internal rotation. Because hockey goaltenders are exposed to unique hip positions dynamically, especially the butterfly technique, they are at greater risk (7,9).

An imbalance of hip adductor to hip abduction strength may be an important underlying factor in the prevalence of groin and hip injuries. Tyler et al. found that ice hockey athletes who suffered groin injuries during a season had a hip adduction strength of 78% of abduction strength, whereas players who did not suffer groin injuries had adduction strength of 95% hip abduction strength (12). According to the Tyler et al. study, these muscle imbalances are common in ice hockey and also apply to the goaltender (12). For the strength and conditioning coach, it is advised to seek an adductor to abductor strength ratio of 1:1.25 or greater (12).

Ensuring an adequate combination of mobility, stability, core strength, and balancing adductor and abductor strength, could be useful tools for the strength and conditioning coach. Maintaining a combination of mobility, endurance, strength, and power at the hip complex is suggested by MacIntyre et al. for injury resilience and return to sport following injury (7). To help avoid FAI, MacIntyre et al. recomends watching for progressive decreases in hip internal rotation in young goaltenders (7). To help reduce tension and enhance mobility, rolling out work using a foam roller, lacrosse ball, trigger point release, and hip stretches are recommended by Miers (10).

SPECIAL PHYSICAL CHARACTERISTICS AND CONDITIONING OF THE ICE HOCKEY GOALTENDER

The ice hockey goaltender is a highly specialized position with specific physical characteristics. Ice hockey goaltenders require tremendous flexibility, mobility, quickness, agility, explosiveness and power, hand-eye coordination, fast reaction time, and fast decision making (8). To be able to make saves, react properly to sudden changes in play, and reduce risk of injury, ice hockey goaltenders need to move quickly in all three planes of motion at the hip joint (8). They tend to possess less upper body strength and endurance versus their teammates, which is not necessary to perform their role well (8). Goaltenders do not spend their time rallying for the puck and engaging in physical contact that would require the same upper body strength as their teammates. With this in mind, it would not make sense to emphasize upper body strength within the strength and conditioning program. For the strength and conditioning coach, focusing on mobility, core, lower body strength and stability, quickness, and power would be beneficial for the ice hockey goaltender.

GOALTENDER CORE AND LOWER BODY STRENGTH

Good core muscular strength and endurance is of great importance to withstand abrupt directional changes for making saves, passing, and clearing the puck (8). Strong core strength and endurance also enhances muscular power, strength, balance, and speed of the lower limbs, as well as reduce risk of injury (8). Ice hockey goaltenders also have a high recruitment of hip flexor, adductor, and rotator muscles, and strong lower limbs to repeatedly drop down into the butterfly position (8). For core strength and endurance, dead bug variations, glute bridges with mini band, exercise ball plank stir the pot, and standing Pallof press are a few suggested exercises (7). If adduction is comparatively weak, strength and conditioning coaches could incorporate glute bridge exercises with adduction using a exercise ball or similar exercises. Suggested hip strengthening exercises include multi-angle lunges, three-way step-ups, and single-leg squats (7). For added stability, once movement patterns and baseline strength are sufficient, a strength and conditioning coach could implement tools, such as a stability ball for the Pallof press and slide board for lunges (7).

GOALTENDER QUICKNESS AND POWER

Research reveals a need for NHL goaltenders to be explosive and agile, repeating fast lateral, vertical, and up and down actions (4). Within the strength and conditioning program, movements emphasizing quickness, lateral movements, as well as dropping or ground up actions can help the goaltender develop his or her quickness. Medicine ball skaters, goaltender rolls, knees to feet, and burpee ball toss are a few example movements, with the burpee ball toss including hand-eye coordination.

ENDURANCE

During a game, ice hockey goaltenders have fast, repetitive, and explosive actions between periods of rest or low intensity (4,8). Unlike other hockey players who perform shifts, goaltenders typically play all three periods, with the occasional overtime (8). Although they may not have or require the same VO_2max values of their teammates and have lower post game blood lactate concentrations, they do require excellent aerobic capacity (8). A high aerobic capacity will allow the goaltender to recover between intense short durations of play and action, thus being able to better maintain alertness, promote recovery from the high-intensive periods of action, and be physically in a ready position (4,8). A high aerobic capacity also matches the predominant energy system used during hockey games, with aerobic metabolism as the greatest contributor (8). Studies show approximately 75% of game time being of low-intensity, with an average heart rate of 64% of maximum heart rate (8).

THE MENTAL GAME

The ice hockey goaltender needs to be able to maintain focus throughout the game despite a heightened level of stress and fatigue, including after making a great save or alternatively, after letting in a goal. Given the high level of pressure and stress, ice hockey goaltending may be one of the most demanding positions (3,4). Mental stress also manifests in the body and vice versa. Anxiety causes muscle tension, reducing mobility and flexibility as well as hampering coordination (3).

According to Gelinas, relaxation techniques can help when a goaltender is overwhelmed with a high level of anxiety. One method to combat this is alternatively tightening and relaxing muscles of the body through a method of breathing control (2). Besides ensuring adequate conditioning, specific activation warm-up movement patterns combining mobility, stability, and breathing patterns, could be useful for the goaltender as part of the pre-practice and pre-game routine for both physical and mental readiness. A strength and conditioning coach could help to combat high levels of anxiety by prescribing some dynamic stretches paired with breath control, for example.

Opposite of hyper arousal is that some goaltenders need to be more psyched up or energized (3). According to Gelinas, some symptoms of low arousal include a heavy feeling in the limbs, wandering attention, slow locomotion, lack of enthusiasm, and feeling fatigued (3). In these incidences, a pre-competitive light workout several hours before competition can enhance activation and combat fatigue (3). Designing a light pre-competition workout, with athlete feedback during lower priority games, would be a good approach in helping the athlete overcome low arousal levels.

CONCLUSION

Ice hockey goaltenders possess unique and specialized characteristics, requiring a blend of mobility, stability, strength (especially core and lower body), quickness and reaction time, aerobic conditioning and stamina, and mental attributes to be successful. Table 1 provides a sample two-day off-season training program that aims to address many of these training needs. Getting to know the athlete and programing a specific series of exercises addressing these characteristics helps the ice hockey goaltender not only perform to their best ability, but to enjoy the sport they love with greater injury resilience.

TABLE 1. SAMPLE TWO-DAY OFF-SEASON TRAINING PROGRAM

Day 1

EXERCISE	SETS X REPETITIONS
Mobility	
Foam roller work and lacrosse ball mobilization for trigger point release to reduce tension and enhance mobility (10)	
Hip stretches (10) Example: world's greatest stretch, half-kneeling lunge hip-ankle mobilizer, 90/90 hip stretch	2 x 10
Half-kneeling reach backs or other t-spine mobilization stretches as needed	2 x 10
Dynamic inchworms	2 x 5
Main Set 1	
Rolling pattern (progress to goaltender roll into standing position, further progress with reactionary component)	3 x 6
Deadbug (contralateral movement plus exercise ball) (7)	3 x 15 or until fatigue
Bridge variations (figure 4, mini band with abduction, or exercise ball with adduction); if adduction is comparatively weak, glute bridge exercises with adduction using a exercise ball is recommended (7)	3 x 15 or until fatigue
Plank bear crawls various directions (forward, side to side, reverse)	3 x 20 – 30 steps or until fatigue
Main Set 2	
Step-up variations, including crossover step-up (7)	3 x 10
Standing Pallof press (progressing to on Bosu ball or disc) (7)	3 x 10
Standing cable row (optional with Bosu ball or disc)	3 x 10
Main Set 3	
Exercise ball plank to stir-the-pot (7)	2 x 15 s
Kettlebell swing with single-arm switch	3 x 10
Single-leg box squat (7)	3 x 10
Main Set 4	
Spiderman plyo push-up (progress only if athlete demonstrates ability)	3 x 8 – 12
Knees to feet (progressing to reactionary component)	3 x 4 – 6
Active rest with low aerobic activity 2 – 3 min	

Day 2

EXERCISE	SETS X REPETITIONS
Mobility	
Foam roller work and lacrosse ball mobilization for trigger point release to reduce tension and enhance mobility (10)	
Hip stretches (10) Example: world's greatest stretch, half-kneeling lunge hip-ankle mobilizer, 90/90 hip stretch	2 x 10
Half-kneeling reach backs or other t-spine mobilization stretches if needed	2 x 10
Dynamic inchworms	2 x 5
Main Set 1	
Deadbug (contralateral movement plus exercise ball) (7)	3 x 15 or until fatigue
Bridge variations (figure 4, mini band with abduction, or exercise ball with adduction); if adduction is comparatively weak, glute bridge exercises with adduction using a exercise ball is recommended (7)	3 x 15 or until fatigue
Slide board mountain climbers	3 x 10 or until fatigue
Multi-angle lunge (clock lunge) progressing to slide board (7)	
Main Set 2	
Multi-plane monster walks (7)	3 x 15 or until fatigue
Power curls	3 x 5
Main Set 3	
Landmine split squat to overhead press	3 x 8
Standing cable press (progressing to performing on Bosu ball or disc)	3 x 10 – 12
Single-arm dumbbell tripod dumbbell row	3 x 8 – 10
Main Set 4	
Medicine ball side facing underhand toss with stance switch	3 x 10
Burpee ball toss (goaltender performs a burpee and immediately catches the ball tossed by the strength and conditioning coach) *placed at end for purpose of enhancing resistance to fatigue	3 x 6

**Note: the exercises, repetitions and sets depend upon the athlete weaknesses and strengths, training status, injury history, program goals, and training phase. It is also recommended that the ice hockey goaltender include aerobic conditioning. Examples include incorporating jump rope, as well as running before or after sessions or between main sets.*

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ABOUT THE AUTHOR

Tammy Kovaluk has over a decade experience as a strength and conditioning coach. She has worked with both teams and individuals in most sports with a special interest in dynamic correspondence and metabolic conditioning for hockey and American football. Kovaluk was the strength, speed, and assistant wide receiver coach for Belmont High School football. She works with a variety of hockey athletes from youth to the National Hockey League (NHL) prospects, and is the current strength and conditioning consultant for Beyond the Edge International Search and Rescue. She has also worked as a clinical corrective exercise specialist alongside Dr. Rob Hasegawa, Team Canada's chiropractor. Kovaluk holds a Master of Science degree in Kinesiology and Sport Conditioning through AT Still University, where she was awarded a certificate for academic excellence. She is also a Certified Strength and Conditioning Specialist® (CSCS®) through the National Strength and Conditioning Association (NSCA), Certified Speed and Agility Specialist (CSAS) through the International Youth Conditioning Association (IYCA), and is certified as a Level 2 Function Movement Screen™ (FMS™).

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