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Employing the Alactic Hill Sprint: Aerobic recovery protocol to improve middle distance and distance running performance

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Abstract
Determinants of successful middle distance and distance running include: 1) alactic power, 2) event specific endurance and 3) well executed tactics. The purpose of this article is to: 1) describe the Alactic Hill Sprint – Aerobic Recovery Protocol, a workout that addresses the three aforementioned points, 2) elucidate the importance of this training stimulus from the tactical and injury prevention perspectives, 3) provide recommendations for the frequency and volume of these weekly sessions, and 4) present a sample competitive season training cycle that features the Alactic Hill Sprint – Aerobic Recovery Protocol training stimulus.

Keywords: Alactic power, event specific endurance, finishing kick, sprinting

1. Introduction
When identifying the physiological components for success in collegiate and post-collegiate middle distance (800m & 1500m) and distance running (5000m & 10,000 m), neuromuscular power and aerobic capacity are mission critical. These qualities, manifested as: 1) alactic power, and 2) event specific endurance, are hallmarks of all champion middle distance and distance runners.
In the upper echelons of middle distance and distance running, every runner becomes a sprinter on the last lap of the race. In the parlance of track & field this last lap dash is known as "the kick". Success in sprinting is built on the athlete putting force into the ground; the more force, the higher the velocity and the better the kick [6].
The purpose of this article is to: 1) discuss the importance of alactic hill sprints for middle distance and distance runners, 2) outline an alactic-aerobic training session built around repeat hill sprints, and 3) present a sample in-season training block that utilizes alactic-aerobic hill sprints.

2. Alactic Hill Sprints and Their Importance
The alactic system provides energy to working muscles during the first 10 seconds of activity [4]. This metabolic pathway is best developed using high power activities that require the athlete overcome an external resistance. For track & field athletes, sled pushes and hill sprints are two excellent modalities for this type of training stimulus. Within the context of the specificity training principle, hill sprints are ideal for middle distance and distance runners [5]. They challenge the body to generate high levels of power and speed during the running gait with biomechanics that closely resemble those seen in a finishing kick.
Approximately 50% of all runners will get injured within a one-year span [1]. The majority of these injuries occur at or below the knee joint. Consequently, it is essential to build strong legs in order to reduce the risk of injury. From a performance standpoint, as leg strength increases, so too does the athlete's ability to put force into the ground, which in turn increases running velocity [6].
Alactic hill sprints evoke neuromuscular adaptations that provide the following benefits: 1) a decreased risk of injury and 2) enhanced biomechanics [5]. Injury risk is lessened because hill sprints sequentially strengthen all muscles involved in the running gait.

A long-term training effect of regular alactic hill sprints is improved running mechanics. This, in turn allows the runner to: 1) generate more force and power, 2) properly apply the force they produce by improving economy of motion [7].

The physics equation Power = Force x Velocity forms the theoretical underpinning of alactic hill sprints. Neuromuscularly, the uphill sprints have a high-power output which increases motor unit recruitment [7]. When the motor units involved in the running gait fire rapidly, the associated muscles to contract with great force and high efficiency. Examined within the lens of motor learning, regular doses of alactic hill sprints lead to improvements in the motor programs associated with the running gait. Repeated exposure to this training stimulus can contribute to improvements in an athlete's endurance, operationally defined as the resistance to fatigue.

3. The Theoretical Underpinnings of Alactic Hill Sprints

Specific endurance is the confluence of the physiological and psychological abilities to run the full race distance at goal pace. It is a combination of: 1) neuromuscular training, and 2) aerobic support [5]. These characteristics are built from opposite ends of the training spectrum. Aerobic support is developed by continuous runs and aerobic intervals. As previously discussed, neuromuscular training is predicated on high power, short duration repeats will full recovery between efforts. One way to simultaneously build these qualities is to pair low intensity aerobic running with alactic sprints [4].

Bioenergetically, the alactic pathway operates during the first 10 seconds of activity, producing exceptionally high-power values and recruiting large numbers of muscle fibers [4]. Alactic sprinting is the bedrock of neuromuscular training. Within the context of this article, these efforts are done on a 6% to 8% grade with the intent of giving maximal effort [5]. The duration is very short, approximately 10 seconds with proper form being paramount [4].

Since function follows form, effective neuromuscular training begins with proper technique. To develop proper running form during alactic hill sprints, the following cues may be helpful when coaching athletes during this workout: 1) keep the hips and shoulders square to the target; the top of the hill during this workout or the finish line during a race, 2) have minimal tension in the jaw and hands; "lose jaw, lose hands", 3) "knee up, toe up" as the athlete ascends the hill; have them focus on lifting the knee up and pulling the big toe up toward the top of their shoe as they "march up the hill", 4) keep the elbows at a 90° angle, and 5) pull the back hand behind the hip.

Tactically, training is physical and mental preparation for competition. This psychological component of the workout is addressed by having the athletes visualize that they are coming down the finishing straightaway, closing in on their long-term training goal as they ascend each hill. It is on the home straight that the runner's form begins to falter and dreams of glory turn to dust. The athlete begins to succumb to the byproducts of the lactate pathway and rigor mortis sets in. Successfully fighting through this end of race scenario begins with the athlete shortening their stride in deference to the law of inertia; a body in motion stays in motion and a body at rest stays at rest. This is where the cue "march" comes into play. As the athlete marches up the hill their stride becomes shorter and faster. In competition, as momentum builds, the athlete overcomes the inertia of fatigue which causes the unprepared runner to slow their pace as ground contact time increases. Alactic hill sprints create an opportunity to regularly practice marching down the final straightaway of a championship race.

4. The Alactic Hill Sprint – Aerobic Recovery Protocol

First and foremost, this is a repeat workout, not an interval workout. Training sessions using repeats mandate full recovery between efforts. Incomplete recovery is the hallmark of interval workouts.

The main priority of this session is to provide a deep neuromuscular stimulus to the muscles of the running gait. This is not an anaerobic conditioning stimulus. Consequently, generous, low intensity recovery needs to be provided between hill sprints. The key to maximizing the benefits of this workout is to completely recover between alactic efforts. A secondary benefit is providing a low-level aerobic stimulus; thereby contributing to the development of aerobic support.

One set of this workout begins with a maximal power, 10 second sprint up a 6% to 8% grade. Once at the top, the athlete walks backwards down the hill then jogs at a very easy pace for 400m on level ground [4, 5]. Athletes should keep their heart rates within their aerobic range during the entire set. For this session, 100 beats per minute represents the lower limit of the aerobic zone while "180 – the athlete's age" is the upper limit [3].

The rationale for having athletes walk backwards down the hill is to: 1) minimize the eccentric contractions of the running muscles elicited by downhill running, and 2) provide a dynamic stretch of the Achilles tendon and calf muscle group [2, 5].

5. Programming the Alactic Hill Sprint – Aerobic Recovery Protocol

The training principle of progressive overload governs the design and implementation of alactic hill sprint training sessions. The initial session will evoke physiological adaptations which, in turn, protect the muscles and tendons of the legs from damage in subsequent training sessions. Once the legs adapt to this workout, frequent programming will serve to protect the runner against the myriad of lower leg injuries which routinely plague these athletes [1, 5].

The time course for adaptation is relatively short. If the first alactic hill sprint training session is programmed on a Monday, the next session can be programmed on Thursday. Following Thursday's session, the athlete will experience less muscular soreness than they did on Monday [5]. During the Off-Season and Pre-Season training cycles, twice weekly sessions of the Alactic Hill Sprint – Aerobic Recovery Protocol can be programmed to develop alactic power.

In order to express alactic power during the competitive season, this workout should be programmed on the the day before a hard workout or race. During the week of competition, the number of repetitions is reduced precipitously, however the intensity remains high. One measure of readiness for the next day's hard training session is how the athlete feels after completing a session of hill sprints. The high power alactic component of this workout promotes Central Nervous System (CNS) activation. A poor workout may indicate CNS fatigue that may otherwise go unnoticed [5].

Table 1 shows a sample weekly volume progression for the Alactic Hill Sprint – Aerobic Recovery Protocol during the Off-Season and Pre-Season training cycles.

Table 1: A Sample 15 Week Volume Progression for the Alactic Hill Sprint – Aerobic Recovery Protocol During the Off-Season and Pre-Season Training Cycles

Week	Sets of 10s Hill Sprint w/ 400m Easy Jog
1	2
2	3
3	4
4	5
5	4
6	5
7	6
8	7
9	6
10	7
11	8
12	9
13	8
14	9
15	10

Table 2 shows a sample in-season training cycle incorporating the Alactic Hill Sprint – Aerobic Recovery Protocol for an 800m runner. The number of Alactic Hill Sprints performed during this in-season training cycle assumes that the entire Off-Season/Pre-Season protocol outlined in Table 1 has been completed so as to prepare the athlete for the subsequent stressors of the competitive season.

Please note the following: 1) the workouts discussed in this article are in bold type, 2) examination of the other workouts included in this training cycle are beyond the scope of this article and 3) all workouts should be preceded by a thorough warm up that increases core temperature, activates the sympathetic nervous system, mobilizes sport specific joints and potentates sport specific musculature.

Table 2: Sample 14 Day In-Season Training Cycle for a Collegiate 800 m Runner Incorporating the Alactic Hill Sprint – Aerobic Recovery Protocol

Week 1						
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
AM: 30 to 45 min easy run effort/pace: 70% of Maximum Heart Rate then 6-8 x 100m strides with 100m jog recovery PM: resistance training	AM: 30 to 45 min easy run or cross training (swim, bike, elliptical machine) at 70% Maximum Heart Rate PM: 10 x Alactic Hill Sprint – Aerobic Recovery Protocol	Intervals at 1500m Race Pace with 1:3 work to rest recovery 3-4 x 800 with 400m easy jog between intervals at current 1500m race pace	AM: 30 to 45 min easy run or cross training (swim, bike, elliptical machine) at 70% Maximum Heart Rate PM: resistance training	AM: 30 to 45 min easy run or cross training (swim, bike, elliptical machine) at 70% Maximum Heart Rate PM: 10 x Alactic Hill Sprint – Aerobic Recovery Protocol	AM: 3 x 300m Cutdowns: progressing from current race pace to goal pace with 100m easy jog recovery between intervals PM: resistance training	10 mile easy run effort/pace: 70% of Maximum Heart Rate

Week 1						
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
A. 30 min easy run effort/pace: 70% of Maximum Heart Rate then 6-8 x 100m strides with 100m jog recovery PM: resistance training	AM: 30 to 45 min easy run or cross training (swim, bike, elliptical machine) at 70% Maximum Heart Rate PM: 6-8 x Alactic Hill Sprint – Aerobic Recovery Protocol	4 x 150m (accelerate, maintain, accelerate) with 150m walk recovery PM: resistance training	10 to 15 min easy jogging	4-5 x Alactic Hill Sprint – Aerobic Recovery Protocol	800 m Race	10 mile easy run effort/pace: 70% of Maximum Heart Rate

6. Conclusion

In the business of middle distance and distance running, every racer becomes a sprinter on the last lap. It is imperative to train the skill of sprinting regularly due to its complex neuromuscular, physiological and psychological nature. Coaches of successful athletes will begin developing the ability to sprint during the first week of the training year and continue this practice up to an including the championship training cycle. Alactic hill sprints provide an ideal modality for meeting this need.

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