AMAA JOURNAL

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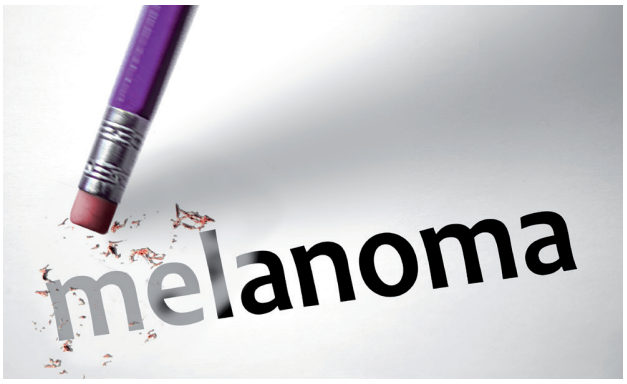
My Journey

Over the past 15 years I have been privileged to lead a group of some of best leaders in running and sports medicine where our annual meeting takes place at the Boston Marathon. We were known as the "Medical Joggers" back in the 70s and our members helped bring medical care and oversight to the greatest marathon in the world. We had over 700 bandit runners one year back when "Bandit Runners" were as welcome to Boylston Street as Boston's Billy Rodgers crossing the finish line first. Today's "Medical Joggers" are known as the medical runners and professionals of AMAA. In conjunction with our parent organization, the American Running Association (ARA) who were the "National Joggers" back in running boom #1, we have a budding cause in youth fitness—the National RUN A MILE DAYs campaign (www.runamile.org).

I will be leaving AMAA the end of June. I'm going to stay active in the RUN A MILE effort and hopefully create a documentary on some great stories from across America. I also want to speak publicly on ways we can beat cancer and live a second life. In the January/February issue of *Running & FitNews*, I shared my story of what it has been like to be diagnosed with melanoma (three times) and the journey I have taken over the past few years. I now share this you in my final writing of "Front of the Pack."

Cancer was not new to me. I first confronted it when I was 26—it was melanoma. In February 1983 I had no idea what the word melanoma meant other than anything ending with "oma" was not good. I managed to survive that encounter, but it led to leaving the Navy and starting a second career. Speed ahead to 2010 and a second melanoma is found. Was I a bit complacent after 26 years? Sure, but I had charged ahead and thought that my surgeon had gotten ahead of things. Well, this time, cancer decided to take a different path, just like going on a run. And once again, like in 1984, I had to find a way to get ahead and defeat the melanoma cancer cells.



It was just prior to the 2014 Boston Marathon when I felt a hard marble-like ball in my left upper shoulder. It was just above the surgical site of my 2010 melanoma excision. My mind raced. Could the cancer have spread to an unknown or unforeseen lymph node? In 2010, I had surgery to excise the area around the site of the melanoma lesion. It was not pretty. In fact later that summer, my then 5-year-old nephew saw me and asked what happened to my arm? I said, "Shark bite." It made him step back in awe.

I knew that surgery was going to be the best step at the time to get ahead. One aspect of that surgery was to inject nuclear dye at the original cancer site and see where it would go inside my lymphatic system. This procedure is called the "sentinel node." In my case, the melanoma cells followed a less traveled path. On that day, I was both anxious and pissed. I had not been vigilant checking all areas around my left shoulder, yet I was told that I was "free and clear." I had no scheduled visits to see the surgical oncologist or an oncologist. That was a medical mistake that angered me that day in 2014. I kept thinking, "Could we stay ahead?" (Just like running a race, you want to stay ahead of your competitors to win; in

continued on page 7

AMAA JOURNAL

The American Medical Athletic Association (AMAA), professional division of the American Running Association, was founded in 1969 by Ronald M. Lawrence, MD, PhD, to educate and motivate fellow physicians to disseminate information about exercise and nutrition to their patients, thereby enhancing their quality of life.

The *AMAA Journal* is a peer-reviewed publication. Opinions expressed in the *AMAA Journal* are not necessarily endorsed by AMAA.

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AMAA PREMIER MEMBERS

The American Medical Athletic Association wishes to thank those members who have contributed to the organization beyond their annual dues. This list reflects membership upgrades received from June 1, 2016 to June 1, 2017.

OLYMPIAN ($250)
Mary C. Boyce
Julius S. Brecht
Charles (Scott) Clark
Harry Daniell
Ronald Dubin
Edmond G. Feuille, Jr.
Cathy Fieseler *±
Wade Gaasch
Scott Glickman
Fawwaz Hamati
Jeffrey Hawkins
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John McAuliffe
Steve Morrow *±
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Peter Oroszlan
Daniel Pereles
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Robert Sanders
Charles L. Schulman
Robert Sholl
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Andrew King
J. Mark Lawson
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Ronald H. Miller
Robert P. Nirschl
Floyd Okada ±
Mark Rubenstein
Bill Snyder
Ralph Sulser
Greg Thorgaard
J. Michael Ward
Clay Whiting
Valerie Zughaib
Bruce R. Worley

* Contributions surpass Olympian level
± Life Member making contribution at the level of Premier Member

Funds from this program have helped to support NATIONAL RUN A MILE DAYS, an annual campaign promoted by the AMAA and the American Running Association (ARA) to encourage elementary and middle school age children to become more active.

AMAA JOURNAL

CONTENTS

Message from the President

To All of our Faithful AMAA Members,

It has been a rollercoaster ride for the American Medical Athletic Association (AMAA) since early fall 2016. As you know, we did not receive charity entries for the 2017 Boston Marathon and the likelihood that we could be awarded entries in the future was bleak due to a change in policies by the Boston Athletic Association. We submitted a solid proposal last summer; however, it appears selection is now based on location and the ability of the charity to positively impact the Greater Boston area. These criteria make it very difficult for AMAA to compete.

Because the Boston charity entries provided the main source of funding for the American Running Association and its professional arm AMAA, we started to experience a downward spiral. Our pursuits of alternate funding sources were unsuccessful and, as a result, the board decided to entertain other opportunities to continue the mission of the organization.

The International Institute for Race Medicine (IIRM), formerly the American Road Race Medical Society (ARRMS), stepped in and offered to assimilate AMAA. Over a span of six months, the two executive boards engaged in lengthy discussions to not only work out details of an assimilation but also to ensure that the AMAA membership stayed intact with worthwhile member benefits and familiar faces/voices in management. We were successful in meeting these goals by having Barbara Baldwin, MPH, continue as the membership director (I will be joining the IIRM executive board) and offering a slew of educational opportunities for members.

As of July 1, all AMAA members will become IIRM members and will have access to the password-protected area of the website (www.racemedicine.org). Access allows you the ability to view:

- Multiple educational videos—with more on the way—covering topics relevant to race/running medicine (17 sports medicine lectures, plus 10 short videos on medical race care logistics)
- Comprehensive 92-page medical manual developed by experts from the IIRM and Loughborough University
- Electronic version of the *AMAA Journal,* to be expanded in content delivered by sports medicine experts

The IIRM will also continue to offer sports medicine symposiums, including the Marine Corps Marathon meeting to be held on October 20 and 21 in conjunction with MedStar Sports Medicine. Also, IIRM Executive Director Chris Troyanos, ATC, has been working toward offering continuing education credit through the IIRM online videos. We'll keep you posted as this exciting opportunity evolves!

The IIRM and AMAA have a lot in common—ensuring the safety of participants in races, promoting health and wellness through exercise, and improving athletic performance with state-of-the-art information. In reality, the two organizations have run parallel courses for several years, so a merger to save AMAA makes sense.

To give you a brief history of the IIRM, it was originally founded under the American Running Association (2003) as the American Road Race Medical Society by Twin Cities Marathon Medical Director and AMAA Life Member Bill Roberts, MD (profiled in this issue of the *AMAA Journal*). Its purpose was to serve the road racing community in North America as an educational resource and medical leader for road races from the 5K up through ultra distances. Dr. Roberts had envisioned that ARRMS would serve all medical professionals who work and/or volunteer at any size road race with a mission to educate the running industry, race organizers, and the public about medical issues that impact the sport of running and road racing.

The organization then took on an international focus and was renamed the International Institute for Race Medicine. This occurred following the development of a partnership with the United Kingdom-based Matthew Good Foundation (MFG) to provide education worldwide to the medical communities who serve runners. The foundation, based in East Yorkshire, England, was created in July 2011 with its initial project aimed at education and research into the issues surrounding the death of its namesake, Matthew Good. He passed away in June of the same year while running a half marathon for charity. Matthew collapsed of heat-related illness only 1K from the race finish; he was 32.

The IIRM has various membership categories, including multiple event, single event, individual and even one offered through an MGF grant. You, of course, will become an "individual member."

There is so much wonderful history with AMAA, especially at the Boston Marathon, and we will strive to maintain the integrity of its mission. Although, at this time, there is no definite plan to hold a meeting at the 2018 Boston Marathon, this may be subject to change. We will certainly keep you posted as we get closer to the fall months.

Fear not as we enter this "brave new world"…I view this merger as an opportunity to open new and exciting doors, and to encourage growth of the organization. It has been my privilege to serve as your president for the past four years and I look forward to continuing our relationship through my involvement on the IIRM executive board for years to come.

If you have any questions or would like to learn about participation in IIRM committees, please contact Barbara Baldwin at bbaldwin@racemedicine.org or call 240-271-1657.

Sincerely,

Cathy Fieseler, MD
AMAA President/IIRM Executive Board Member

IIRM International Institute for Race Medicine

Dear AMAA Members,

The last few months have brought several changes to the American Medical Athletic Association—some have been disappointing such as the loss of Boston Marathon charity entries, but many have brought great promise for the future with opportunity for growth. As the executive director of the International Institute for Race Medicine (IIRM), I am delighted to welcome all current AMAA members as IIRM individual members; together we will expand our learning experiences and work to promote running medicine.

Since its inception in 2004, originally as the American Road Race Medical Society (ARRMS), the IIRM has had a similar focus and mission as AMAA with one of its goals including the provision of quality education to those interested in the field of endurance medicine. As we combine the AMAA and IIRM memberships, we will continue to pursue this goal and strive to provide more educational opportunities for those interested in this niche of sports medicine.

Over the years, we have found that the road race industry lacks a central source for its medical guidelines or standards of care. When it comes to providing medical care to millions of runners, proven medical protocols and coordination are in high demand. It is the goal of the IIRM to become that source of information. We do not want to dictate the types and levels of care provided at endurance events, we just want to be a reputable resource for medically-proven options and a forum for informed discussion. This will allow for additional growth in our area of expertise.

As you review our website (www.racemedicine.org), you will see that we have built the educational section on a comprehensive distance learning platform; additional video presentations, medical protocols, and other website programs will be added over time. You will also notice that we have taken impressive steps to widen our reach within the international medical community, including awarding grants for complimentary one-year IIRM memberships to qualifying events worldwide.

The IIRM Executive Board is working hard to ensure a smooth transition as we begin to take responsibility of the AMAA membership and your needs over the next few months. We hope to earn your trust and support with our commitment to provide you expanded member benefits and continuing education opportunities.

We will also make sure that our efforts and interactions with all members are supportive and collaborative. To help with this transition and to give you some continuity, we will be adding AMAA President Cathy Fieseler, MD, to the IIRM Executive Board and AMAA Programs Director and Membership Coordinator Barbara Baldwin, MPH, will become the IIRM Executive Assistant and Membership Director. Both of these outstanding professionals will not only add to the IIRM mission and brand, they will also ensure that AMAA members have a voice—a voice that we hope you will use in the coming months to provide input. We also welcome you to take part in any activities or groups created to facilitate our mission.

In closing, I also want to say a few words about AMAA Executive Director Dave Watt whom I have known and worked with since he took the position in 2002. With his support, the AMAA allowed our organization (then ARRMS) to grow and flourish under the AMAA banner. That support is something I will never forget. I told Dave that IIRM will continue supporting his mission; I cannot think of a better way to honor Dave's efforts and achievements.

I hope you will take the time to review the outline on page 6 of this journal showing IIRM developments and future plans, as well as our website (www.racemedicine.org). Comments or suggestions can be sent to Barbara Baldwin at bbaldwin@racemedicine.org. Growth of the organization depends on collaboration between the IIRM board and members and mutual support of all those involved.

We look forward to an exciting and productive future!

Sincerely,

Chris Troyanos, ATC
Medical Coordinator, Boston Marathon
Executive Director, IIRM
troyanos@racemedicine.org

As the executive director of the International Institute for Race Medicine (IIRM), I am delighted to welcome all current AMAA members as IIRM individual members; together we will expand our learning experiences and work to promote running medicine.

continued on page 6

continued from page 5

Recent IIRM Developments

- On January 1, we hired Barbara Baldwin, MPH, as the part-time executive assistant and membership director. This will move to full-time as of July 1.
- We developed partnerships with road race organizations such as AIMS (Association of International Marathons and Distance Races), Running USA, and the Road Runners Club of America.
- The Matthew Good Foundation provided a grant to allow 100 endurance events to join the IIRM for one year.
- We added a comprehensive medical manual to the IIRM website.
- A post-race reporting tool was added to the site. Information collected with this tool will support future research within our industry.

Coming Soon

- We are working with the Marine Corps Marathon and MedStar Sports Medicine to hold a comprehensive medical symposium in October 2017 and 2018 (this is a continuation of the AMAA symposium held in conjunction with the marathon).
- The *AMAA Journal* will become an IIRM publication and will be shared electronically with all members.
- Five to 10 educational videos will be added to the IIRM video library on the website (password-protected) by the end of 2017.
- We will add a blog to the website to help promote dialog within our industry as we examine some of the challenges we face.

What our Future Holds

- The IIRM plans to host four medical seminars per year. We believe that such a "traveling road show" not only helps us promote the IIRM brand, but also ensures our mission is moving forward. For each seminar, we plan to develop a strong partnership with the local marathon to ensure all volunteers and public safety support systems have access to state-of-the-art knowledge for road race medicine. Plans to hold seminars in Europe and Asia will be added over time as we strive to also meet goals for our international mission.
- We will continue to develop a strong continuing education program through our online medical content and live medical seminars, with a future goal to offer online continuing education opportunities. We believe this will greatly enhance the IIRM member experience as a valuable added benefit.

Dear AMAA Members,

On behalf of the International Institute for Race Medicine's Board of Directors, I am excited to welcome you as new individual members of the organization. Through the hard work of the current AMAA leadership, IIRM Executive Director Chris Troyanos, and the IIRM Board of Directors, we have forged a path forward bringing the best parts of both organizations together to form a stronger, larger organization that will serve our membership and endurance sports for many years to come. As Chris has laid out in his letter to you in this issue, there are many exciting projects in the works. I invite you to become active members of IIRM. We always welcome our members' feedback and suggestions—your input is vital to help guide the organization in the best direction.

As the chairman of your board, I would enjoy hearing from you. Send me your comments, suggestions or just a note to say hello. I can be reached at sweiss@racemedicine.org.

Welcome to the IIRM!

Warmest regards,

Stuart Weiss, MD, FACEP, FAAP
Chairman, IIRM Board of Directors

MCM 26.2
MARINE CORPS MARATHON

YOU CAN STILL RUN THE 2017 SOLD-OUT MARINE CORPS MARATHON

Register for only $25 and then fundraise for a total of $425 (or donate the fee yourself) to receive the following benefits:

- Guaranteed race entry (will be required to pay the $160 entry fee to the Marine Corps Marathon)
- Customized online fundraising page through CrowdRise
- Complimentary registration for one individual to the IIRM's Sports Medicine Symposium at the Marine Corps Marathon ($200 value)*
- Complimentary one-year individual membership in the International Institute for Race Medicine ($75 value)*

**transferable to another individual*

If you are interested in running the Marine Corps Marathon or know someone else who would like to run, contact Barbara Baldwin, MPH, at bbaldwin@racemedicine.org.

continued from page 2

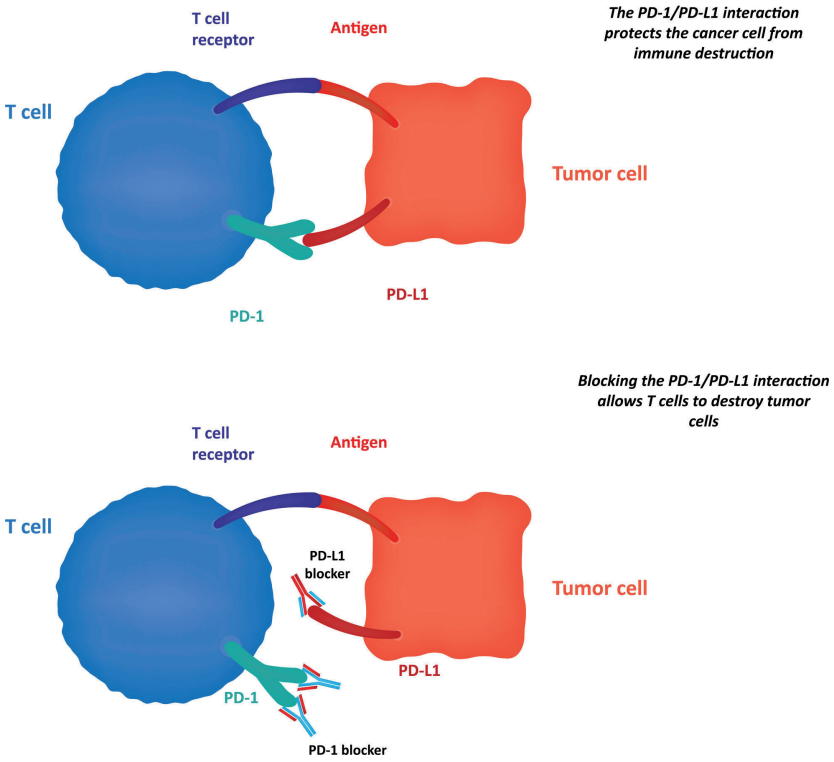
cancer's case, the race to win is critical to beating cancer). I went in for surgery and had my entire left armpit lymph nodes removed. All the nodes were negative, good news. The one piece of news that jarred me, though, came from the radiology oncologist. He said that while the other nodes were negative, the primary node that was positive (cancer) had broken through its wall lining. Now I was fighting the odds of staying ahead of the cancer cells' moves.

I was on the way to the Penn Relays in late April 2015, one week after the Boston Marathon weekend. I got a call from the radiology lab where I had gone for a CT. Something was small yet visible on my liver. Now my heart was racing. I called my oncologist and we talked about possibilities. It could be a non-lesion or it could be a metastasized melanoma lesion. It was the latter. My path ahead was not full of roses. I did not hear many great outcomes. This is when I called out for help. My friend Bill and wife Debbie went to work and started researching the advancements that were occurring in fighting advanced melanoma (I did not like using the term "stage" for where I was clinically with cancer). All I was hearing from my then-oncologist was that we could see if I was genetically pre-disposed for a type of mutated gene—the BRAF gene. It turns out that about half of melanoma patients are BRAF positive, meaning they have the mutated BRAF gene. A new immunotherapy drug was available for those patients who were BRAF positive. In my case, I was in the other half——BRAF negative, or what I would later hear as being BRAF WILD.

Quick layman's talk on immunotherapy drugs and their remarkable effect: these drugs can halt a T-cell inhibitor and unleash the ability of your immune system to go beyond the T-1 inhibitor and find the melanoma cells and lesions. (Pardon me if I have screwed up the medical terminology and description.)

It is now early May and I feel directionless. Yet my team—let me emphasize the point of "team"— yes, my team had come up with options that sounded futuristic and potentially a miracle cure. No oncologist likes to use that "C" word when it comes to defeating cancer. Bill, however, had uncovered through his research on Pubmed.org that there were highly successful clinical trials involving other immunotherapy drugs. The good news was that these drugs were working on patients

The PD-1/PD-L1 Blockade



who were "BRAF WILD" (remember I talked about a test for a mutated BRAF gene). We all met, Debbie my wife and Bill. Looking over things, it appeared there were options that my oncologist was not offering nor even mentioned to me in our meetings. Time was ripe for a summit meeting. In fact the doctors had their own meeting ahead of meeting with us. It was their "tumor board." They told us that it was their opinion that I should start taking the immunotherapy drug Prembrolimab, although it was not a great match for me. The three of us were a bit perplexed. Fortunately another "new to the team" oncologist agreed to talk to us privately. He had come to this team from Georgetown University Hospital's Lombardi Cancer Clinic. In the discussion, Bill brought up the clinical trial that involved two immunotherapy drugs, Nivolumab and Ipilumumab. This oncologist had just come from the melanoma team at Georgetown. I asked him the one question that few others would answer, "What would you do if in my position?"

Three days later I had an appointment at the Lombardi Clinic at Georgetown University Hospital. The three of us went to the appointment with the clinical trial team. The very first thing I felt was a sense of calm. These people were here to help me. They were upbeat and talked about how the trial would work. Downsides were discussed along with side effects. What remained was the upbeat and positive nature of this team. I know it may sound whoey, but I felt like I belonged. That day the #2 oncologist for the melanoma team told me I was accepted into the trial. In just a week, after some blood tests were performed and a follow-up scan, I could start treatment.

Onto the phase of infusion….and no chemo! I came up with my own suspense imagery for what the dual immunotherapy drugs were hoped to do. The drugs were the magic potion that allowed the "wild wolves," (aka, the "super cancer fighters") to go bounding throughout my body and seek, encompass, and destroy all melanoma lesions and cells. Sounds like a video game, right? That is what I hoped would happen. Based on the initial results in the first two phases of the clinical trial, the duo of Nivo and Ipilu were out there unlocking the wild wolves in over 60% of cases, and that percentage was rising. Now it was my time. Infusion is done in similar way to chemo. The main difference is immunotherapy is not poison. Also,

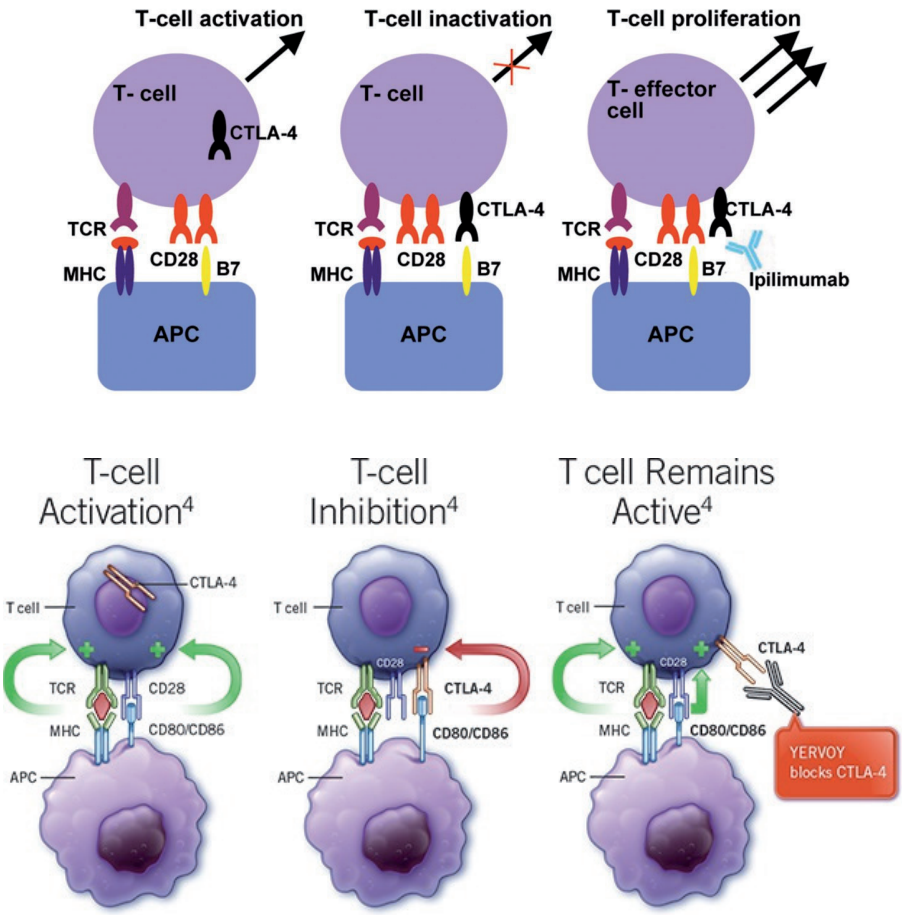
continued on page 8

continued from page 7

I did not get a "port." My first infusion was in mid-June. The plan was to have four infusion dates of the dual immunotherapy drugs. The protocol involved coming in every week for blood work. Everything went fine. A week later, all was normal. I was still running and felt good.

It was now August and I had had my third infusion. One thing had happened on my neck. An obvious lymph node that had been enlarged and was considered cancerous had disappeared—"gonzo." I was a couple weeks out from my fourth and final infusion. We had planned a vacation to Cape Cod with a rental home. On the way to the house I started feeling exhausted, a plain case of no energy. On day two of vacation it became worse. I felt like a big sloth just sitting there. We call the on-call oncologist fellow and I was advised to go to the local ER. It turns out that in Falmouth, Massachusetts, they were holding their biggest event of the year, the Falmouth Road Race. The hospital was semi-deserted when I arrived. Most of the ER staff had worked the event and only the basic crew was there. Next thing I know, after having a chest x-ray and CT, I am being admitted. It was a Sunday night and I am miserable. It turns out I had had the first major side effect of the dual immunotherapy drugs. My endocrine system had been overwhelmed. The wild wolves can attack things at-will that are not cancerous. So it went with my pituitary, thyroid, and adrenal glands. Now came the powerful steroids to right my system.

It's September and I had started the dual infusion treatments in early to mid-June. It was time for scans. I also found out that the oncology team felt the fourth dual infusion would be overkill. In addition, the clinical trial director at Bristol-Myers-Squibb removed me from the trial due to my side effects. I wanted "back in." Through this period of misery in the hospital and good results visually of my neck lymph node, my lead oncologist and the team felt that they'd see a stable or shrinking scene on my liver.



The CT scans confirmed it: my cancer was stagnated and the lesions appeared to be shrinking or surrounded. (Previous biopsies on similar patients earlier in the trial showed dead tissue surrounded by immune cells and material.) Good—actually, really great—news! It appeared that the immune system had found the cancer lesions and cells and was attacking or had attacked and defeated the cancer. Could this be a cure?

I am now at the two-year mark. This is the time that a couple of melanoma oncologists initially felt was a good marker for survival. Nothing is guaranteed. Yet the most experienced of the oncologists who have worked on defeating melanoma for decades are now smiling. Dr. Atkins, the lead oncologist on melanoma at Lombardi, sent out invitations in March 2016 to come attend a "Melanoma Survivors Luncheon." Anytime a cancer patient receives an invitation that says you are a "survivor," please do attend. Since that day, I keep battling side effects that have been tough yet somewhat tolerable. I am not back to running….yet. I may never be able to play golf again due to shoulder deterioration caused by the wild wolves. Still, it's a miracle. I am convinced that the success in beating cancers like melanoma with immunotherapy drugs will have success in other cancers. You are seeing transferable use in treatment against lung cancer. I knew it as Nivolumab or Nivo. On TV it is Opdivo.

This story does not define me. It has opened a door to a second chance at life. For all of you who have endured cancer and continue to battle it today, I offer you hope.

I feel blessed to have a VERY supportive wife and family—my wife Debbie and our kids Alex and "creative rocker" Jeffrey.

Thanks to all my AMAA friends and supporters. We all have 26.2 journeys in us.

Best Regards,

Dave Watt
ARA/AMAA Executive Director

How Can Endurance Athletes Perform Well with a Very Low Carbohydrate Diet? (Part 2)

Laura Christoph, PhD and Emily Miele, MS, ACSM HFS

Introduction

Traditionally, dietary recommendations for endurance athletes are founded on the notion that muscle glycogen content and blood glucose levels are the most crucial factors in evading fatigue and performing at one's highest potential (1). These recommendations are based on evidence that carbohydrate sources, specifically muscle glycogen, are of critical importance in providing energy during exercise (2). Therefore, the rationale behind most sport nutrition guidelines is to prevent muscle glycogen from getting too low, which would essentially exhaust a predominant energy source. In order to maintain optimal glycogen content, endurance athletes are traditionally advised to consume high levels of carbohydrate in their diet in addition to carbohydrate supplementation before, during, and after athletic events (3).

More recently, research studies investigating the effect of carbohydrate restriction on endurance performance have increased in number, and a subset of elite endurance athletes are eating low carbohydrate diets (4). To many, it may appear counterintuitive to restrict carbohydrate consumption when large amounts of energy are needed for the repetitive muscular contractions involved in endurance athletics. However, the key to carbohydrate restriction for athletes is to reduce the body's reliance on carbohydrate for energy and increase the capacity to metabolize fat—an energy source that is both more available and more efficient (5). This can be accomplished by consuming a diet high in fat and very low in carbohydrate (4,6). The human body stores at least 20 times more energy as fat than it does as carbohydrate (7); thus, avoiding a reliance on carbohydrate for energy is intuitively logical. By utilizing fat as one's predominant energy source during endurance exercise, athletes have been able to maintain a higher level of performance for a longer duration, without the need for exogenous carbohydrate supplementation, by "sparing" glycogen for later use (8). An overview of evidence supporting low carbohydrate intake in endurance athletes has previously been presented in Part I to this paper (9).

There are multiple terms used to describe dietary carbohydrate restriction that vary with respect to the extent of restriction required. These terms include "reduced carbohydrate," "low carbohydrate," and "very low carbohydrate" or "ketogenic." Though definitions for these terms can vary between sources, Richard Wood, PhD, has previously compiled the respective ranges of kilocalorie percentages from carbohydrate as well as grams of carbohydrate per day for each diet (9). Among these diets, a reduced carbohydrate diet typically involves the least amount of restriction, while a low carbohydrate diet calls for a greater reduction in carbohydrate intake, and a ketogenic diet is the most restrictive; requiring a reduction in carbohydrate to less than 50g per day. A ketogenic diet involves a significant amount of knowledge, commitment, and planning for an individual to successfully adhere to the requirements. Like any dietary practice, a ketogenic diet will produce different results for each individual and may not be optimal for some endurance athletes. In this paper, we present strategies to implement the ketogenic diet on an individual basis including how to determine whether or not the ketogenic diet is a good fit for an athlete, macro- and micronutrient guidelines and considerations, as well as strategies for transitioning to the ketogenic diet. The intent of this paper is to provide guidance on how to implement a ketogenic diet for endurance athletes with the intent to better inform those professionals who advise them.

Ketoadaptation

It is important to note that becoming more efficient at fat utilization does not occur immediately upon beginning a ketogenic diet. Within 2-4 days of the diet, ketones will usually be detectable in urine as a marker of increased fatty acid oxidation and reduced carbohydrate metabolism (10). Reagent strips for urinalysis are available over the counter and allow for easy tracking of one's status in ketogenesis by indicating the ketone level in the urine. During ketogenesis, in the presence of low liver glycogen; Acetyl CoA, the product of fatty acid oxidation, is used to form ketone bodies, or ketones. Ketones can then be used for energy production by skeletal muscle as well as the brain (11). However, it takes at least one week and possibly up to four weeks for an individual to be able to utilize ketones efficiently for the metabolic production of energy (12). This transition period is termed "ketoadaptation" and has been covered in detail in Part I (9). When

continued on page 10

The human body stores at least 20 times more energy as fat than it does as carbohydrate; thus, avoiding a reliance on carbohydrate for energy is intuitively logical.

The ketogenic diet can be a great fit for a variety of athletes, specifically those in weight monitoring sports where a weigh in or lean physique is encouraged, and endurance sports where efficient metabolism is an advantage.

an individual is in the ketoadaptation phase, performance decrements often occur while the body adjusts to using fat and ketones for energy. Timing, which is discussed in a subsequent section of this paper, is therefore a crucial consideration for athletes seeking to begin a ketogenic diet.

Athletic Performance Benefits

The ketogenic diet can be a great fit for a variety of athletes, specifically those in weight monitoring sports where a weigh in or lean physique is encouraged, and endurance sports where efficient metabolism is an advantage. The decrease in water retention resulting from low carbohydrate diets can be helpful for athletes who participate in weight class sports (13), especially females of childbearing age, whose monthly hormonal fluctuations often result in water weight gain (14). Furthermore, athletes who participate in sports in which leanness and lightness are advantageous such as distance running, cycling and triathlon, may find that the appetite suppressing effects (15-17) of lower carbohydrate, moderate protein and high fat diets are advantageous to maintaining optimal body composition.

The fat adaptation that results from a ketogenic diet protocol may also be helpful to endurance athletes for a more practical reason: because athletes on the ketogenic diet experience increased metabolic efficiency, it may be less important to consume as much exogenous fuel during training and racing (8). Furthermore, if the exogenous fuel consumed is composed of fat rather than carbohydrate, athletes can take in over twice as many kilocalories for the same amount of weight carried, as fat contains nine kilocalories per gram while carbohydrates contain only four kilocalories per gram. This can be highly beneficial in an extreme endurance event in which an athlete needs to carry all of his or her own fuel.

On the other hand, some athletes might choose to train on a ketogenic diet but take in carbohydrate during an endurance event, using carbohydrate as a performance enhancer. Athletes on a ketogenic diet have been shown to maintain relatively normal glycogen stores even with low carbohydrate intake (4), but may benefit from additional exogenous carbohydrate sources during high intensity activity (18). By consuming carbohydrate during a competitive endurance event, ketogenic athletes can rely on their fat oxidation efficiency and supplement with glucose to fuel the TCA cycle as they work at intensities close to VO2max for optimal performance.

Health Benefits for the Athlete

The ketogenic diet protocol also removes a number of major digestive tract irritants such as grains, legumes, and high fructose foods due to its restrictive nature, which may be beneficial for runners who experience the water retaining effect of 6-carbon molecules in the gut, often leading to exercise-induced irritable bowel syndrome (IBS). IBS is a common issue in those participating in endurance sports, especially running, which can impede performance by leading to nutrient malabsorption, dehydration and physical discomfort (19). Research shows that IBS symptoms may be alleviated by eliminating short chain carbohydrates through the FODMAP (fermentable oligosaccharides, disaccharides, monosaccharides, and polyols) diet (20), and preliminary studies show promise for athletes with GI distress (21). Therefore, the ketogenic diet, which is naturally low in most FODMAPs, may be helpful for athletes with IBS.

There are additional health benefits to becoming fat adapted that reach above and beyond sports performance. For instance, the American College of Sports Medicine (22) recommends that athletes consume 30-60g of sugar per hour for 1.5-2 hour events and up to 90g per hour for events lasting longer than 2 hours. If athletes are consuming sports gels and drinks at this volume, their overall added sugar intake may be of health concern due to tooth decay (23). Products that have alternative fuel sources, such as Generation UCAN, have been developed for fat adapted athletes, and can provide an exogenous fuel for endurance sport that holds blood glucose levels steady (24) without having the negative impact on dental health.

Nutrients of Concern

Athletes must learn how to moderate macronutrient intake and address potential micronutrient deficiencies when they begin a ketogenic diet. First off, in order to stay in ketosis, athletes must be careful of excessive protein intake. High protein intake leads to glucose production through gluconeogenesis, which raises blood sugar and stimulates insulin production, knocking the athlete out of ketosis (10). Consuming a reduced carbohydrate, moderate protein, and high fat diet is important in order to maintain ketosis (9).

Weight loss diets that focus on carbohydrate reduction and encourage increased protein and fat intake have been shown to be higher in micronutrient content than other dietary approaches (25). However, there are some vitamins and minerals of concern to note with a ketogenic diet including magnesium, sodium, zinc, and copper.

Magnesium is likely to be suboptimal in a typical American diet and is also depleted through sweat during exercise (26). Supplements have not been shown to improve athletic performance, but may be helpful for those at risk of deficiency (27). Ensuring the diet is high in magnesium rich foods such as leafy greens, fish, nuts, and avocados (28), as well as considering a magnesium supplement if the RDA is not achieved (27), may be helpful for athletes beginning a ketogenic diet. This is especially a concern in those who experience magnesium deficiency symptoms such as muscle twitching and muscle spasms.

Americans typically consume plenty of sodium (28); however, ketogenic athletes may be at risk for sodium deficiency. Carbohydrate restriction causes water weight loss and sodium depletion (29), leading to decreased plasma volume, and consequently, a decrease in blood pressure (28) which increases the need for sodium intake. Furthermore, major sources of sodium in the typical American diet are highly processed food and packaged high carbohydrate foods (28), so elimination of these contribute to decreased intake. Athletes might consider adding chicken broth, table salt, eggs, cheese, and salted nuts and seeds to their daily intake in order to meet sodium needs (see **Figure 1** on page 12).

Zinc is another nutrient of concern for low carbohydrate athletes, but adequate intake can be achieved through careful diet planning (30). Zinc is important for immune function, cell division, growth and development; however, supplementation is discouraged due to possible deregulation of copper (31), another nutrient of concern for ketogenic athletes. Foods such as

Preliminary studies and work with individual athletes show promise that this dietary approach can be beneficial for the athletes in weight-monitoring and ultra-endurance sports.

beef, poultry, and pork are important sources of zinc (28). Zinc and copper intake can be balanced by coupling animal protein intake with nut and seed consumption.

Transitioning to a Ketogenic Diet

The approach to implementing a ketogenic diet may vary depending on the athlete. Some may transition to a low carbohydrate diet by gradually replacing high carbohydrate choices with sources of dietary fat in a methodical approach over a few weeks or months, while others may choose to go "cold turkey." One of the "cold turkey" approaches is the appetite suppressing effect of the ketogenic diet (15-17), though this approach requires a potentially dramatic change in lifestyle. Athletes may be able to achieve ketosis within days if they reduce net carbohydrate intake to 20g or less (9). However, this protocol eliminates many typical staples of an endurance athlete's diet such as grains, legumes, fruit, and starchy vegetables. This forces the athlete to shift to a diet high in saturated and monounsaturated fat, moderate in animal proteins and nutrient dense vegetables, and extremely low in starch and sugar (see **Figure 1** on page 12 for a sample ketogenic diet meal plan). This may require more money, planning, and preparation, as grains and processed polyunsaturated oils tend to be of lower cost compared to animal products (32) and convenience foods tend to be high in refined carbohydrates (33).

Athletes should be cognizant of energy intake during this phase. Low carbohydrate diets may result in a spontaneous reduction in energy intake (34). While this may be advantageous for those looking to shed weight for the season, the combination of ketoadaptation and energy restriction could potentially lead to a substantial decrease in sports performance. A eucaloric approach at first is optimal to maintain athletic performance (6). Furthermore, athletes in sports where leanness and lightness are required are at increased risk of eating disorders (35, 36) and tend towards restrictive protocols (38), so any drastic change in dietary approach should be implemented with caution. In addition, all major diet modifications are best initiated during the off-season to allow for some time to adapt prior to a major event.

There is still much research to be done in the field of the benefits of the ketogenic diet for athletes. Long-term effects are unknown, and athletes looking to transition to a ketogenic diet should do so under a doctor's supervision. Nevertheless, preliminary studies and work with individual athletes show promise that this dietary approach can be beneficial for the athletes in weight-monitoring and ultra-endurance sports. Individuals willing to experiment with a nontraditional diet approach for training and racing may find that the ketogenic diet protocol results in optimal body composition and increased sports performance.

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Sample Meal Plan, Figure 1.

Meal Description	Food Items	Amount	Calories	Protein g	Fat g	Net Carb g	Mg mg	Zn mg	Sodium mg
BREAKFAST:									
3 poached eggs,	Egg, whole, cooked, poached	3 large	214	19	14	1	18	1.94	446
1 avocado sliced, 6 oz	Avocados, raw, California	1 fruit (without							
coffee blended with	Beverages, coffee, brewed,	skin and seed)	227	3	21	3	39	0.92	11
1 Tbsp coconut oil	breakfast blend	6 ounces	4	1	0	0	7	0.04	2
	Oil, coconut	1 tbsp	121	0	14	0	0	0	0
SNACK:									
2 stalks celery with	Celery, raw	2 stalk, small (5" long) 34g	5	0	0	1	4	0.04	27
2 Tbsp peanut butter	Peanut butter, chunk style, with salt	2 tbsp	188	8	16	4	51	0.89	156
LUNCH:									
6 oz canned salmon over	Fish, salmon, pink, canned, total can contents	6 ounces	219	33	8	0	51	1.29	685
1 cup spinach tossed in	spinach, raw	2 cups	14	2	0	1	47	0.32	47
with 2 Tbsp Olive oil	Oil, olive, salad or cooking	2 tbsp	238	0	28	0	0	0	0
SNACK:									
1 cup cucumber slices and	Cucumber, with peel, raw	1 cup slices	16	1	0	3	14	0.21	2
1 oz almonds and 1 cup	Nuts, almonds, dry roasted,								
chicken broth	with salt added	1 ounce	170	6	14.9	3	79	0.94	141
	Soup, chicken broth, ready-to-serve	1 cup	15	2	1	1	2	0.17	924
DINNER:									
Beef burger topped with	Beef patty, 20% fat, broiled	6 ounces	460	44	30	0	34	10.62	128
1 oz cheddar and 1/4 cup	Cheese, cheddar	1 ounce	115	6	9	1	8	1.02	183
sliced tomatoes	Tomatoes, red, ripe, raw, year-round average	1/4 cup sliced	8	1	0	1	5	0.08	2
TOTALS			2014	126 (25% total Calories)	159.9 (70% total Calories)	19 (<5% total Calories)	359	18.48	2754
Compared to Micronutrient and Energy recommendations for 125lb female, moderately active, 35 years of age			2000	AMDR: 10-35% total Calories	AMDR: 20-35% total Calories	AMDR: 45-65% total Calories	RDA= 310mg	RDA= 8mg	UL= 2300mg

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SUPPLEMENTAL MATERIALS

For Further Information on Ketogenic Diets and Performance

An excellent resource for health professionals looking to guide an athlete to a ketogenic lifestyle is *The Art and Science of Low Carbohydrate Performance: A Revolutionary Program to Extend your Physical and Mental Performance Envelope* (38). Volek and Phinney are leaders in the ketogenic performance research field and have written a science-based practical book for ketogenic athletes. We use this book with many athletes as a reference guide for macronutrient and micronutrient concerns and meal planning as they progress through the ketoadaptation phase.

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Running with Music

By Jasmin C. Hutchinson, PhD

Take a look around you the next time you lace up at the gym, hit a local running path, or toe the line at a road race. More often than not you'll see runners tuning into a personal beat. While some running purists recoil at the idea of listening to music while running, a growing subculture of runners wouldn't dream of taking a single step without their pulsating playlists. Case in point, there was uproar in 2007 when the USATF banned the use of portable music devices in its sanctioned events* and many chose to flaunt the rules; "I dare them to find the iPod on me," said Richie Sais, 46, a police officer in Suffolk County, New York, before running the Marine Corps Marathon as he clipped his iPod Shuffle under his shirt (1).

Of course, moving to the beat isn't anything new, but recent technological advances have facilitated this marriage between music and movement. As portable listening devices have become smaller, increasingly dependable, and more affordable we have seen a veritable explosion in the use of music by runners and other exercisers. Similarly, over the last 20 years, there has been a dramatic increase in empirical research on the psychological and psychophysical effects of music in sport and exercise settings. Insights gleaned from this body of work will be outlined below, together with a brief overview of the mechanisms by which music might exert an effect during sport and exercise, and a series of evidence based applied recommendations. Future papers in this series will explore in greater detail the varied underlying mechanisms by which music influences running performance.

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Overview of Research Findings

The benefits of music listening in a sport or exercise setting are numerous, and have each received strong empirical support. Prior to a run, music can enhance emotional state and motivation, allowing runners to find their optimal arousal "zone" and priming the various bodily systems for action (2). During a run, music can function as a distractor, drawing attention away from feelings of pain and fatigue (3). Music is also known to increase the release of feel-good chemicals in the brain, such as dopamine and opioids, that may enhance feeling state, dull pain, and delay fatigue (4). Moreover, synchronizing to a beat during running, a process known as auditory-motor synchronization, helps regulate and maintain pace, and can improve running economy (5). Finally, appropriately selected post-run music can enhance recovery, facilitating the return of runners' internal systems, such as heart rate and blood pressure, to the pre-workout state (6).

Optimizing Arousal and Affective Valence

Music can be used as either a sedative or a stimulant to engender the optimal arousal state prior to and during a run. Research has broadly supported the assumption that stimulative music increases psychomotor arousal, while soft or sedative music decreases arousal and facilitates relaxation. Music may also influence arousal if it evokes an extra-musical association that either inspires physical activity or promotes relaxation (7). A classic example of a piece of music with highly arousing extra-musical associations would be Survivor's *Eye of the Tiger,* from the Rocky movie series. Many athletes harness the arousal regulatory qualities of music to help get them "in the zone" before competition. A well-known example is Olympic swimmer Michael Phelps, who listens to music until the last possible moment before competition. "It helps me to relax and get into my own little world" says Phelps (8).

Mood responses and feeling states during exercise tend to be more positive under music compared to no-music conditions (3). This effect has been found consistently and across a variety of exercise modalities (9), intensities (10), age groups (11), and fitness levels (12). Feeling states and motivation are closely related constructs; put in simple terms, how we feel about something directs our motivation toward it. Running intensities that are associated with significant cardiorespiratory gains can induce feelings of fatigue and negative affect, which can act as a deterrent to continued participation and impact negatively on motivation levels (3). Therefore, interventions that improve the running experience, such as music, are likely to have a positive impact on motivation and adherence, particularly among novice runners.

Researchers have attempted to tease out which particular aspects of music influence emotional states in listeners. Two key elements are tempo and mode (major or minor key). "Happy music" is characterized by fast tempo and major mode, whereas sad music is typically played in slow tempo and minor mode (13). Faster tempo music also leads to enhanced psycho-motor arousal. Several studies have shown increased activation of the sympathetic nervous system—the system responsible for priming the body for action—with higher tempo music. Conversely, listening to sedative music can lead to decreased heart rate, respiration rate, and blood pressure, indicating an increase in parasympathetic activity (14).

The role of music in the affective response to exercise is complex. Perhaps more than any other stimulus, music has the ability to invoke powerful images and feelings. Music is

* USATF later amended the ban and it now applies only to those vying for prizes in championships

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often associated with enjoyable activities like socializing and relaxing, and can sometimes bring back memories of a particular person or place. Think, for example, of a particular song we associate with our youth or an important life event such as a wedding. Hearing this song can often bring back a tidal wave of memories. Scientists refer to this phenomenon as "music-evoked autobiographical memories" (15). Music has also been linked to drug-like effects in the brain. When pleasurable music is heard, dopamine is released in the striatum, a critical component of the reward system which is known to respond to naturally rewarding stimuli like food and sex (16).

An alternate mechanism by which music improves the affective experience of exercise is by functioning as a distractor, which can modulate pain levels and distract runners from the tedium and monotony of long runs. This principle is known as *dissociation*, and will be explicated in the next section.

Attentional Focus and Perceived Exertion

Based upon the idea that attention is a limited capacity resource (17), it is assumed that the presence of a distracting stimulus (such as music) will occupy attentional capacity thereby preventing or delaying sensations of pain and fatigue from entering conscious awareness (3). This reduced awareness of afferent feedback appears, in turn, to lower perceptions of exertion in the order of approximately 10% (18). It is important to note that this particular effect appears to hold for low to moderate exercise intensities only. At high exercise intensities, attentional processes are dominated by afferent feedback which demands attention, thus perceptions of fatigue override the distractional capabilities of music (19). In other words, all of the *Eye of the Tiger* in the world isn't going to help you block out fatigue during a grueling set of hill sprints!

Although the vast majority of research findings support this distraction hypothesis, qualitative data indicates that there is considerable variability in the ways in which people use music during exercise. Using in-depth interviews, it was found that during low intensity runs, music was largely used to facilitate dissociation, with runners detailing strategies such as singing along and "daydreaming" in response to the music. Contrastingly, during high intensity runs, runners described ways in which they used the music in a more associative mode (e.g., "I think about my stride," "I am able to focus") (3). Thus, it seems that when exercise intensity is high, the music is coupled with the task demands to a greater degree.

Synchronization (entrainment) and Efficiency

Entrainment is the process by which two oscillating systems assume the same period (or period ratio) when they interact. In experimental paradigms, entrainment usually refers to the synchronization of endogenous rhythms in the subject with an exogenous rhythm in the environment (20). One example of this is our natural tendency to tap our fingers, hands, or feet along to a beat when listening to music (21). Likewise, runners have a natural tendency to synchronize their stride to the beat. A prime example of an elite runner harnessing the power of auditory-motor synchronization is Haile Gebrselassie's astonishing 5,000m performance in Zurich in 1995. Described by Gebrselassie as his "most memorable achievement" (22) he smashed Kiptanui's world record by nearly 11 seconds with a time of 12:44.39 seconds. He says that as he ran the beat of the hit song "Scatman" kept ringing around his head. "It's nice music, it's fast written, that's why I could break a world record, by that music," he recalls (22).

Synchronizing movements with music also enables athletes to perform more efficiently. In one study, participants who cycled in time to music required 7% less oxygen to do the same work as compared to cycling with background (asynchronous) music (23). The implication is that music provides temporal cues that have the potential to make athletes' energy use more efficient. Significant research attention has been devoted to the optimal tempo for musical accompaniment to exercise. Tempo is considered the most significant factor in determining an individual's response to a piece of music, and, from an applied standpoint, is among the easiest aspects of music to manipulate. Karageorghis and colleagues (24,25) undertook an extensive examination of the relationship between exercise heart rate and preferred music tempo. They reported that the preferred tempo band across the range of exercise intensities was relatively narrow, 125-140 bpm. This tempo range has become known anecdotally as "the sweet spot."

Evidence Based Recommendations

Prior to selecting music for use in an exercise setting, personal and contextual factors should be taken into consideration. A runner should begin with a selection of familiar tracks that reflect their musical taste and preferences. Ideally, these tracks should have strong rhythmical elements and some personal meaning which may be drawn from past experiences and accomplishments or from

It is beneficial for the rhythm of the music to approximate the motor patterns entailed where possible which may promote neuromuscular relaxation and cardiovascular efficiency.

extra-musical associations to sport and exercise. Motivational and affirming lyrics can also provide meaning, as well as a powerful source of inspiration. A good starting point for selecting songs is to consider what you want the music to do. For example, are you using the music to relax and put the stresses of a hard day behind you or to energize you during a warm up? Are you hoping the music will distract you from feelings of fatigue during a workout or do you want the music to inspire you to perform at a higher level?

Runners should also consider factors such as desired intensity and duration of the exercise bout. Typically, warm-up tracks will be slower (80-100 bpm), and the music program will gradually build in tempo with increasing workload to the ideal range of 125-140 bpm. When it comes to a prolonged exercise bout, such as distance running, it is advisable to choose songs that have a steady beat and similar tempos to help maintain a comfortable steady pace. It is also beneficial for the rhythm of the music to approximate the motor patterns entailed where possible (27) which may promote neuromuscular relaxation and cardiovascular efficiency. Faster tempo tracks lend themselves to more intense workouts, although a ceiling effect exists at around 140bpm. Tracks that greatly exceed this tempo tend not to be preferred, and may result in negative affective experiences such as boredom or irritation.

On occasion, particular tracks or segments of a musical piece can be tailored to various components of an exercise bout, for example, to distinguish work time and recovery time during interval training. Priest and Karageorghis (26) reported that exercise participants experience a strong sense of expectancy regarding segments of a musical piece that they find especially motivational, such as the introduction or the chorus. Exercisers can tap into this phenomenon, known as *segmentation*, to coordinate bursts of effort or to plan a sprint finish.

Although the benefits of music during running are numerous, it's not for everyone. Many runners use their time on the road to "get away" or become lost in thought. Others enjoy the social element of running with a friend or a group. It also goes without saying that safety is paramount. Music use while running on roads, trails, or anywhere where safety could be compromised is not advised. But for your next track session, spin or treadmill (groan) workout, maybe you'll find some extra oomph from jamming to your favorite tunes.

Dr. Jasmin Hutchinson is an Associate Professor of Exercise Science at Springfield College, where her research interests focus on psychophysiology, attentional focus, and the effects of music in sport and exercise. She received her PhD in sport and exercise psychology from Florida State University in 2004, and is a certified consultant with the Association of Applied Sport Psychology. Dr. Hutchinson is well-published in the field of sport and exercise psychology and has given over 70 presentations at national and international conferences. She conducts her applied work with recreational runners, exercisers, and people with chronic disease. In her spare time, she enjoys running and triathlon, and is a volunteer coach for Girls on the Run.

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Practical Implementations of HIIT

By Fred L. Miller III, PhD, ACSM EP-C, CSCS

High-Intensity Interval Training (HIIT) has gained popularity in recent years. It is mostly employed in endurance exercise routines as a quick way to get an abbreviated yet full work out. However, the concept of HIIT may stimulate many questions among practitioners of this training and curious athletes who have not used this intensive exercise method. Many ask, "Is it as effective as traditional continuous training?" Others want to know "How do I design a HIIT workout for my age?" or "How do I design a HIIT workout for my sport (e.g., marathon, cycling, or swimming)?" The first question was discussed in a recent *AMAA Journal* article (1). In that article, the simple answer was "yes" to it being effective, but I also provided an in-depth response. For example, some studies show greater improvements for HIIT compared to traditional continuous training. In this article, I will build on the question of effectiveness by offering guidelines for both age adjusted efforts and sport specific workouts. I will also provide more examples of designing age based HIIT workouts using three ages (i.e., 20, 40, and 60 years). These additional examples will guide you in designing a HIIT workout for your exact age. Finally, to answer the question regarding sport specific HIIT training, I provide example HIIT workouts for marathon, cycling, and swimming. For each example, I include total time for the HIIT workout, time and heart rate for the "high-intensity" and "easy effort" bouts, and total intervals. The sport specific designs can easily be modified to your liking.

If you are you sharing this type of workout with a patient or client, of course, you will want to be sure that the individual can perform such activity without incurring risk of injury or something even more serious. As you know, such risk can increase with age, return to conditioning after a long layoff, and when an individual is just starting an exercise program.

Age Based HIIT Workout

The total time (excluding warm-up and cool-down) for a HIIT workout is normally 4 to 20 minutes, making HIIT appealing to those having limited time to exercise. However, HIIT workouts include high-intensity bouts, which may not appeal to some individuals. Most HIIT programs recommend the high-intensity bout to be at least 90% of one's maximum aerobic capacity or 95% of one's maximum heart rate (HRmax). HRmax is typically used and determined using the well-known Haskell and Fox equation (2). The equation is: HRmax = 220 - age. For example, the predicted HRmax for a 20-year-old would be 200 (220 - 20 = 200), for a 40-year-old 180 (220-40) and for a 60-year-old 160 (220-60). Once you know the person's HRmax, then you can readily calculate 95% of that person's HRmax. Therefore, it's recommended the 20, 40, and 60-year-old aim for a heart rate of 190 bpm, 171 bpm, and 152 bpm, respectively during the high-intensity bout of HIIT.

In addition to the above methodology, other common HRmax formulae may better estimate your maximum heart rate. For example, Tanaka's equation is another well-known correlation based on a group of healthy men and women (3). The equation is: HRmax = 208 – (0.7 x age). Tanaka may provide a better estimate than Haskell and Fox for estimating your maximum heart rate. Whichever equation you decide to use, keep in mind it may be just a starting point. If you ever exceed your estimated HRmax during a high intensity workout of any kind, this exceeded HR will be your new maximum.

An alternative to the two HRmax equations mentioned above to estimate the high-intensity effort, you could use the Heart Rate Reserve (HRR) method, also known as the Karvonen formula (4,5). This method accounts for differences in resting heart rate (RHR). The equation is: Exercise Heart Rate = [(HRmax – HRrest) x %intensity] + HRrest. It is recommended though to use 90% instead of 95% for calculating the high-intensity bout since HRR provides an exercise intensity equivalent to aerobic capacity (4,5). For example, a 60-year-old with a RHR of 50 will have an estimated high-intensity effort of 149bpm using the HRR method versus 160bpm using the Haskell and Fox equation. Comparing the HRmax equations is a topic for another article. For now, let's use the Haskell and Fox equation to calculate high-intensity and easy effort heart rates for different ages.

The high-intensity bout typically ranges from 10 seconds to 2 minutes followed immediately by a lower intensity (75% of HRmax) easy effort ranging from 10 seconds up to 8 minutes. Calculating the easy effort is similar to the high-intensity calculation, but instead of using 95% of HRmax, one typically uses 75% of HRmax. Using the above HRmaxes, calculating the easy effort then involves just simply multiplying the HRmax by 75%. It is recommended the 20, 40, and 60-year-old aim for a heart rate of 150 bpm, 135 bpm, and 120 bpm, respectively during the easy bout. Equations 1, 2, and 3 may be used to calculate maximum, high-intensity, and easy effort heart rates for your exact age.

Equation 1.

Estimated Maximum Heart Rate

HRmax (bpm) = 220 – age

Equation 2.

High-Intensity

High (bpm) = HRmax * 0.95

Equation 3.

Easy Effort

Easy (bpm) = HRmax * 0.75

For convenience, Table 1 shows a range of heart rates, in 10-year increments, from 20 to 80 years of age.

Table 1.
Age Based Maximum, High-Intensity and Easy Effort Heart Rates

Age (yrs)	*HRmax	*High	*Easy
20	200	190	150
30	190	181	143
40	180	171	135
50	170	162	128
60	160	152	120
70	150	143	113
80	140	133	105

HRmax: maximum heart rate (220-age); High: high-intensity (95% of HRmax); Easy: easy effort (75% of HRmax); *=beats per minute.

Keep in mind, these estimated heart rates may be too high or low, so adjust them accordingly. Let's now turn our attention to HIIT workouts for specific endurance sports.

HIIT programs can be designed for any endurance sport. The key is making sure to include short bouts of high-intensity efforts, followed by longer bouts of easy efforts.

HIIT Workouts for Endurance Sports

HIIT programs can be designed for any endurance sport. The key is making sure to include short bouts of high-intensity efforts, followed by longer bouts of easy efforts. Other measures of intensity may be used such as ratings of perceived exertion (0-10 RPE scale), METs (Metabolic equivalents, where 1 MET = 3.5 mL of oxygen per kg body weight per minute), VO2 (oxygen consumption), and watts (common for cyclists). Whichever intensity measure you decide to use, just be sure there is a noticeable difference in the effort between the high-intensity and the easy intensity bout, with the high-intensity feeling like an "all-out effort."

Below are examples of three HIIT workouts. The first one is for a marathon runner, the second for a cyclist, and the third for swimmers. In each example, I use heart rate as the measure of intensity, which is the most common intensity measure for HIIT. It is important for multi-sport athletes to note that one person's maximum heart rate will vary with each sport. As such, running may have higher HRmax than swimming.

Marathon

- Warm-up: 10 minutes (light jogging and dynamic/static stretching)
- HIIT workout: 24 minutes
  - 4 minutes easy-effort jog (75% of HRmax)
  - 2 minutes high-intensity fast (95% of HRmax)
  - Repeat 4min and 2min bouts three more times
- Cool-down: 10 minutes (light jogging and static/dynamic stretching)

Cycling

- Warm-up: 10 minutes (easy cycling and dynamic/static stretching)
- HIIT workout: 14 minutes
  - 90 seconds easy effort cycling (65% of HRmax)
  - 30 seconds high-intensity fast and/or high resistance cycling (>95% of HRmax)
  - Repeat 90 and 30 second bouts 6 or more times
- Cool-down: 10 minutes (easy cycling and static/dynamic stretching)

Swimming

- Warm-up: 10 minutes (relaxed swimming and dynamic/static stretching)
- HIIT workout: 16 minutes
  - 3 minutes easy effort swim (75% of HRmax)
  - 1 minute high-intensity swim (95% of HRmax)
  - Repeat 3min and 1min bouts 4 or more times
- Cool-down: 10 minutes (relaxed swimming and static/dynamic stretching)

Even though the example workouts vary, they are similar too, in that each HIIT workout involves going hard for a short time, followed by a longer easy effort recovery bout. Although the duration for the high intensity is 2 minutes, 30 seconds, and 1 minute for each sport, respectively, the actual time spent in the high intensity bout will be less since it takes a little time to build up to the high intensity heart rate. The workout designs are easily adjustable to one's preference, so keep this in mind as you design your workout. The key is to follow the cycle with warming up, moving into easy effort, increasing effort to hard, repeating the cycle a given number of times, and then cooling down.

Now, let's discuss a little more about HIIT workouts for endurance sports. As described in the previous HIIT article (1), these programs are normally short (less than 20 minutes) and the high-intensity phase normally varies from 10 seconds up to 8 minutes, with 30 seconds to 1 minute being the norm. However, with endurance sports, total time for HIIT workouts may exceed 20 minutes, as do the examples in this article. Determining the total duration, along with the other HIIT design variables, depends on many factors. For example, the marathon HIIT workout above is longer in duration than the other two sports. This was intentional and with the assumption that the cycling and swimming workouts were designed for individuals who compete in shorter events (e.g., 20K bike race or 1 mile swim) and/or for someone just desiring health benefits. Other factors (fitness levels, time, and level of motivation) will also play a role in the exact design of a HIIT workout. As you design a HIIT workout for yourself and/or someone else it is important to consider these factors.

In conclusion, HIIT is very popular and can be a very effective way to add variety to one's training and decrease the time working out. HIIT training may also be beneficial for improving speed in any sport and exercise economy (i.e., lowering the energy cost at a given velocity). HIIT programs can easily be modified based on age and sport, as explained in this article. Many factors, other than age and sport, may also play a role in designing the best HIIT workout, as briefly mentioned in this article. A full discussion of these other factors is a topic for a future article.

A key to HIIT is personal judgement in workout design. Feel free to shorten the high-intensity durations if you sense the cardiovascular stress and risks are not worth it. I invite you to email me (fmiller@huntington.edu) with any comments or questions about this article or the previous HIIT article, as well as other topics you would like discussed in the journal.

Dr. Fred Miller III is Associate Professor of Exercise Science, Department Chair, and Head Cross Country Coach at Huntington University in Indiana. He is a long-time distance runner who has completed over 500 races ranging in distance from the 5K to the Marathon and has completed 19 marathons (18 of those under 3 hours), winning the October 2015 Indianapolis Marathon in 2:41. Dr. Miller is an American College of Sports Medicine Certified Exercise Physiologist (ACSM C-EP) and a National Strength and Conditioning Association Certified Strength and Conditioning Specialist (NSCA-CSCS). He is currently preparing for the National Council for Strength and Fitness (NCSF) Nutrition Specialist Certification (SNS) and training for his 20th marathon, with the goal of running a personal best.

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In Memoriam

Bruce R. Wilk, PT, OCS

AMAA Life Member Bruce R. Wilk, PT, OCS, of Kendall, Florida, died unexpectedly on April 25, 2017, at the age of 60. Fellow AMAA Life Member Steve Morrow, DDS, and Miami runner remembers how Bruce first became involved with the organization. "When he asked me how I was able to run the Boston Marathon with a non-qualifying entry, I told him about the American Medical Athletic Association. To his credit, not only did Bruce become a member to run Boston [he completed eight in a row], he also spoke at the organization's Boston and Marine Corps Marathon symposiums, wrote many articles for the *AMAA Journal* and became an editorial member for the publication, joined the AMAA board of directors, and developed the 'Running Shoe Database' to help members find shoes to better match their needs."

Bruce opened his practice Orthopedic Rehabilitation Specialists in 1985, which remains one of Miami's only independently owned private practice physical therapy clinics. In 2000, he opened The Runners High, a retail running specialty shop, and soon became an expert in recognizing and educating others on how to identify manufacturing flaws in running shoes. He was even featured on multiple news programs, including a segment on ABC national news focusing on "how to buy perfect running shoes." As Morrow recalls, "Bruce's expertise in his profession, coupled with his enthusiasm and energy, was exceeded only by his extensive knowledge of it."

Bruce's daughter Tracy recalls her father in a way that many of us also remember him. "He was one of a kind." She also adds, "My Dad was a legend. He lived fully, and he taught all of us—my older sister Rachel and my Mom—how to live. He gave me my work ethic, sarcasm, love of music, and love of food which led me to become a chef in NYC. He took my sister Rachel under his wing and taught her how to swim, bike and run, always making it fun and not pressuring her to compete. She is now an accomplished marathon runner and triathlete. His motivation and enthusiasm even propelled me to complete my first half marathon. My Dad was also lovingly supportive of my Mom when she was diagnosed with breast cancer and as she moved through her recovery, he encouraged her to become a marathon walker."

"My father was incredibly busy with his practice and running shoe store, but he still found time to train for marathons and triathlons, including four Ironman races. And most importantly, his family was always his first priority," says Tracy. "I am a lucky woman to have been his daughter."

Rest in peace, Bruce. Donations in his memory can be made to The Ironman Foundation, 3407 Dr. Martin Luther King Jr. Boulevard, Tampa, Florida 33607.

Member Profile

William O. Roberts, MD

Life at the intersection of family practice and sports medicine

By Jeff Venables

Bill with the late Dan Tunstall Pedoe, MD (fondly known as the "father of marathon medicine") and former AMAA President Noel Nequin, MD, at the ACSM Endurance Interest Group meeting in 2003.

William O. Roberts, MD, is a professor in the Department of Family Medicine and Community Health at the University of Minnesota Medical School. He is also a staff physician in the Department of Family Medicine at HealthEast St. John's Hospital in Maplewood, Minnesota. Roberts holds a subspecialty certificate in Sports Medicine, a field in which he has had enormous impact over the past three decades. He has practiced medicine more generally for even longer, beginning in 1978 with his residency in Family Medicine at the University of Minnesota and Fairview Downtown and St. Mary's Hospitals in Minneapolis.

Born in North Dakota but a Minnesotan for just about all of his 65 years, at age 11 Bill moved from Bemidji, Minnesota, a small town not far south of the Canadian border, to Rochester. Though an infrequent patient of the world famous Mayo Clinic, he managed to find a path toward medicine independent of that institution's looming influence in the region. He played ice hockey growing up, as well as joining football, track, and cross-country. Yet, "Even as a high school athlete I was functioning as a manager," he says, "helping tape and those types of things."

A Sports Medicine Specialty

Since 1985, the year Dr. Roberts became the medical director of the Twin Cities Marathon as well as chairman of the Division of Sports Medicine at Group Health, Inc., he has gone on to publish sports medicine research in nearly 150 publications on topics ranging from exertional heat stroke, dehydration, concussion, the effects of marathoning on coronary plaque formation, exposure extremes, and more. He is the editor of the American Academy of Pediatrics 2010 book on evaluating young athletes before sports participation, as well as *Bull's Handbook of Sports Injuries* (2004).

In addition to the innumerable book chapters ascribed to his name, Roberts is an editorial board member of *Medicine & Science in Sports & Exercise*, the publication of the American College of Sports Medicine, of which he is a past president (and present fellow). He is also the editor-in-chief of *Current Sports Medicine Reports* and an editorial board member of both the *British Journal of Sports Medicine* and the *Clinical Journal of Sport Medicine*.

Roberts teaches the university's residency program, which divides his time between supervising residents, seeing patients and an administrative role at the Department of Family Medicine, "helping colleagues publish and work on their research interests, which is a relatively new thing for me," he says.

On top of his day job as a physician and educator, Roberts has given countless sports medicine lectures and seminars nationally and internationally over the years. At the same time, his role as professor and academic advisor has facilitated shaping multiple generations of medical students and residents both in the classroom and in a clinical setting. He has also been known to mentor patients who may have an interest in medicine, an opportunity once offered to him.

As an undergrad at Rensselaer Polytechnic Institute in Troy, New York, his pediatrician perceived a certain spark in Bill and suggested a possible shift from an engineering focus to medicine. "I started shadowing him in his office," Bill recalls. "I got interested and stayed on that course from then on. I've tried to return the favor for people who've come to my office and are patients of mine who have an interest."

His dedication has earned him accolades nationwide and in Europe. He was selected for the honor of Exchange Lecturer by the European

continued on page 20

continued from page 19

College of Sport Science and the ACSM. He has been repeatedly peer-nominated one of the Best Doctors in America by Best Doctors, Inc., and selected as one of America's Top Family Doctors by the Consumers Research Council of America.

Affecting Change from the Top Down Too

A ground-up, in the trenches approach to educating and serving has worked well for Dr. Roberts. Yet he is also a thought leader helping to guide organizations trying to make a difference. He currently sits on the board of directors of UCare in Minneapolis, a nonprofit health plan that provides health coverage to residents across the state of Minnesota. He is a member of the advisory boards of *Men's Fitness, Runner's World* and *Marathon and Beyond*, the beloved ultra-long distance running publication. He is presently a member of the USA Soccer Cup Tournament Sports Medicine Advisory Committee. Additional examples abound.

Meanwhile, Roberts remains at the helm of the medical team for the Twin Cities Marathon, as well as serving since 2007 as medical director of Twin Cities in Motion, which organizes that event and many others.

During his long tenure there, Bill has witnessed changes in the population and in attitudes about marathoning. While it is clear that sedentarism is a growing public health problem, he says, "What I've seen in the marathon is broader participation over the last three or four decades. At the same time, it is a slower population. In the early 80s, the six-hour time limit wasn't too big of a deal, because almost everybody was done. And now we have a lot of people bumping up against that time limit."

He doesn't see this as a negative, given the greater participation, but it does change the job of the medical team on race day. "Our peak medical tent activity has moved from the three-and-a-half to four-hour mark to four-and-a-half to five hours," he says. "Because the volume of runners that come in later in the day has increased, the load on the medical team has as well."

Bill is joined by his wife Deb and daughter Kelly while working at the Twin Cities Marathon.

Youth Health and Fitness

Dr. Roberts's family practice and sports medicine expertise dovetail nicely within his focus on safety in youth sports (among them ice hockey) as well as in his tireless promotion of childhood fitness in general. Roberts chairs the board of directors of the National Center for Health & Safety in Youth Sports in Indianapolis, Indiana and Sioux Falls, South Dakota.

His current research looks at adults who ran marathons as juniors, a cohort made up of race entrants under the age of 17 at the time they ran. The central question, as Roberts puts it, is, "Did their participation in marathon running as an adolescent or child cause problems for them downstream? We're looking at how many times they ran a marathon as a child, how they trained for it, and what other sports they played." He is using social media to find such runners, and then asking that they answer a questionnaire. The control group is composed of former high school cross-country runners who ran marathons later in life.

Bill is not unaware of the controversy surrounding very young children participating in extremely long distance races; it is a major impetus for conducting such research. "A common criticism has been that kids [who marathon] damage their joints," he says. "But the joint damage I see occurs in other sports, where they tear their ACL." Still, the youngest finisher in the study so far was just 7 years old. Many were age 10 when they marathoned. "I always wonder what kinds of decisions 7-year-olds make, but some of them do decide to do it on their own. That's one of the questions we ask in our survey—whose idea was this?"

The study has not had enough returns yet to conclude much, but his sense so far is that for junior runners, marathoning "probably doesn't cause much harm. And a lot of the kids who are running that distance don't push as hard as some of the kids who are running cross-country or track."

To better address the "inactivity crisis in the U.S.," Roberts feels that perhaps some P.E. reform is needed. "The physical education classes that I grew up with were a recruiting and sorting tool for the varsity sports," he says, with little attention paid to activities a person could and should adopt for a lifetime. He feels it's important in these classes to make running fun. By contrast, he says, "When they throw you into gym class and want you to run a mile for time, it kind of turns you off to running."

Additionally, he points out that most athletes will find their sport anyway. Roberts feels we don't need gym class to teach them it. "We need gym class to teach good fitness habits and good form for different things. And to teach them to keep going."

He adds, "I was on a school board for 12 years and one of my projects was trying to get gym credit for kids who were involved in the varsity athletic program so they could take that gym time and play with the orchestra or the band, take art or something else that would expand their horizons, because they were already physically active. They weren't learning that much in gym class that was different from what they were doing with their sports. But that doesn't go over big with the physical education teachers, so it didn't get as far as I'd hoped. I tried. That's all you can do, I think, is try."

The Birth of ARRMS, Now IIRM

Roberts has contributed to myriad roundtables and consensus conferences as a

A lifetime member of AMAA since 1991, Bill looks forward to the reshaped future of the organization as it moves toward a merger with IIRM. "I'm hoping the merger of membership and talent will bring us all further along," he says.

speaker and writing team member, including the 2016 American Medical Society for Sports Medicine's Cardiovascular Preparticipation Screening Statement Writing Work Group, The 3rd International Consensus Conference on Exercise Associated Hyponatremia, and the 2008 Department of Defense Roundtable on Heat Injury and Return to Duty.

He is also a founding member of the American Road Race Medical Society, now the International Institute of Race Medicine, and currently sits on the board of directors. He served as conference co-chair of the organization's 2006 flagship event, hosted in Chicago and officially titled the 2006 World Congress on the Science and Medicine of the Marathon. There he oversaw the presentations of some 43 speakers addressing a sweeping array of marathon medical topics.

"I was looking to develop an organization catered to people who were interested in long distance road racing, particularly at the marathon level," he explains of the organization's genesis. "And I was trying to get beyond just medical directors, but the scientists involved in some of the research, and others in the delivery of care for marathoners at the race site."

With AMAA/ARA Executive Director Dave Watt's help, Roberts pulled the Chicago group together, including a number of experts across various subdisciplines to answer questions like: "Who's running, what's the science behind parts of it, what are the common injuries? How should we care for them?"

ARRMS became IIRM when Roberts and others decided it ought to be internationally focused. "Institute," for its part, seemed to better convey the desire for a robust and broadly scoped research arm.

An IIRM-AMAA Future?

A lifetime member of AMAA since 1991, Bill looks forward to the reshaped future of the organization as it moves toward a merger with IIRM. "I'm hoping the merger of membership and talent will bring us all further along," he says. "The agendas aren't too far apart, and to me it would be a good marriage, so to speak. Between the two groups, there should be a treasure trove of data and expertise that we should be able to tap in order to make road racing safer and better for all."

Active Family Life

Bill has three adult children with his wife Debbie; the entire family enjoys careers in the medical profession (they are also proud grandparents five times over). Family time is important to Bill, and it is perhaps an understatement to say that as a family, they stay active.

Bill bikes, inline skates, and kayaks regularly during the more temperate times of year, and Nordic skis and snowshoes in winter. There is stationary biking and indoor rowing when the weather is truly prohibitive. The family hikes and skis together; indeed, for the Roberts family, "skiing" often also means climbing and hiking the mountain in order to ski down it. In fact, much of the Roberts's vacation time seems like it occurs at altitude.

"For our 40th wedding anniversary last year my wife and I went to Peru and hiked in the Sacred Valley and then hiked the Inca Trail to Machu Picchu," he fondly recalls. And this summer, they will spend a week hiking near Boulder River, Montana, and then head north to Glacier National Park to hike for a second week.

A Lifetime of Volunteering

It's safe to say that Bill is a "joiner." Yet chairmanships, boards of directors, advisory committees, consensus panels and the rest notwithstanding, he seems in many ways most enamored with his race volunteerism. Beyond his work for Twin Cities, Bill has contributed decades of additional volunteer service to quite an agglomeration of athletic events over the years. He joined the London Marathon medical team in 2005, performing finish-line sodium analysis on runners; he served as medical director of the National Kidney Foundation Transplant Games in 2004; he's been repeatedly involved in the medical pool of the Ironman Triathlon in Kona, Hawaii; he was a member of the medical pool in 1998 when the World Figure Skating Championships were held in Minneapolis; the list goes on.

"Being involved with the running organizations and the runners, the marathons and different races, has been one of the highlights of my career," he says. "And it has helped shape my career in a way that I would have never anticipated when I decided I wanted to go into medicine. It's been one of those fun things that I'm sure I'll look back at and say, wow, I was really lucky to get involved with this group of people." Certainly the group can count itself lucky as well.

Jeff Venables has been the editor of the American Running Association's publication Running & FitNews *for 15 years. The final issue was May/June 2017.*

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