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Polyphenol Supplements and Other Strategies for Athletes at the ACSM Annual Meeting

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Science and Performance Enhancement: a questionable model; preparing for Beijing. Acute Effects: post-activation potentiation; bupropion in the heat; computational fluid dynamics for swimming; pacing strategies; cooling vests; vibration; stretching. Biostatistics: sample size; statistical guidelines. Nutrition Pre-conference: practical advice for various sports. Nutrition: polyphenol plant extracts; antioxidants; caffeine; bicarbonate; energy supplements; other supplements; hydration. Tests and Technology: monitoring training; physiological monitoring. Training: artificial and natural altitude; interval training; PowerCranks; core-stability training; inspiratory muscle training; hydrotherapy; vision training. KEYWORDS: elite athletes, ergogenic aids, nutrition, tests, training.

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This year's annual meeting of the American College of Sports Medicine was held in Indianapolis, May 28-31. Indy is not the most interesting of cities, so I will move straight on to the conference itself, which consisted of over 2500 presentations on the relationships of physical activity with health, injury and performance. As usual, I have limited this report mainly to the studies of factors affecting athletic performance. If you have other interests in physical activity and you want to access the most up-to-date research, you should download and search the abstracts–I explain how below. And you should come to next year's meeting, in Seattle.

A criticism I level at ACSM every year is the lack of abstracts for all the special sessions. If you can't get to one of these sessions because of a clash, you miss out on all the wisdom of the experts in that session. Other conferences often provide a full transcript of the keynote addresses. The least ACSM could do is provide an abstract.

Next, my usual pleas to the authors of the abstracts… Show the magnitude of an effect and its uncertainty (confidence interval or limits), not a P-value and especially not a P-value inequality. Base your conclusion on the uncertainty in the magnitude, not on statistical significance or non-significance. In a controlled trial, don't compare the significance of the experimental and control groups: P=0.06 vs P=0.04 doesn't mean you have an effect! Finally, use as few abbreviations as possible: they make some abstracts unreadable.

As with last year's meeting, it's possible to access the abstracts on line. You have to be a member of ACSM, or you or your institution must have a subscription to ACSM's journal, *Medicine and Science in Sports and Exercise*. ACSM members, log in via this link. Enter your username (default is first 3 letters of your family name followed by your member number) and password (your member number). Click on the MEMBER SERVICES tab, then on the link for Member Journals, then the link for MSSE. Otherwise get to this point at the MSSE site via your institution and/or log in with your own subscription info. Now, click on the main Search tab (not the one in the Quick Search box). In the Title field of the search form, type the presentation number shown [in brackets] in this article, select 2008 to 2008 for the date range, then click SEARCH. You should get one hit, the abstract you want. Some of the hits have a link to a large PDF containing the abstract. There are five PDFs, one each for the featured sessions, slides, clinical case slides, thematic posters, and posters. Strangely, only the first few presentations in each PDF show a link to the PDF. So, if you want the complete PDF for each type of session, put the following word in the Title field of the search form: neuropsychological (for featured sessions–too hard to explain why "neuropsychological" works), 513 (for slides), 1042 (for clinical cases), 1215 (for thematic posters), and 1262 (for posters). If all else fails, email me.

Science and Performance Enhancement

One of the few symposia I couldn't miss was titled *The Role of Sports Science in Improving Athletic Performance*. David Bishop outlined his model of the sport-science process that he published recently (Bishop, 2008). I don't agree with the sequence of stages in his model: defining the problem, descriptive research, prediction of performance, experimental testing, determinants of key performance predictors, intervention (efficacy) studies with ideal-conditions evaluation, barriers to uptake, and implementation in a sport setting. This sequence is neither real nor ideal, in my opinion. All these stages *can* be aspects of performance-based research, but the reality is more chaotic and interesting. The next two speakers, Alejandro Lucia and Jos de Koning, stayed in their own research and did not present anything inspirational. Randy Wilber then made up for all with an outstanding account of how he has helped USA Triathlon prepare for the Beijing environment, the main considerations being air pollution, acclimatization and facilities. These guys deserve to win. The final speaker was Olympian Sheila Taormina, who gave a lively account of the ways in which sport science has contributed to her success. Surprisingly, none of the speakers touched on the issue of delaying publication of the most valuable discoveries.

Acute Effects

A couple of posters showed **post-activation potentiation** for an **explosive** movement at 4 and 5 min after the conditioning exercise [1623, 1633], and another showing enhancement of **shot-putting** that seemed clear enough (max of five shots, 3.2%) in the sample of only 4 athletes [2508]. Use it!

It was news to me, but in a recently published study acute administration of the dopamine/noradrenaline reuptake inhibitor **bupropion** produced a 9% enhancement of power output in a pre-loaded **cycling** time trial in the **heat**, possibly by allowing the cyclists to tolerate a slightly higher core temperature (Watson et al., 2005). The effect on performance was magnified by the preload, so in a straight time trial it would be more like 3-4%. Effects on performance reported here with *chronic* administration were negligible [1922], presumably because of desensitization. The author shared his belief with me that, at their peril, competitive cyclists are already using this stuff, which is not yet banned by the IOC.

Computational fluid dynamics indicated that it might be better for **swimmers** to abduct the thumb [725] in freestyle. Watch for more findings with CFD, as computing power increases.

Adding a **dolphin kick** during the **breaststroke** pullout (of the turn) seems to work [2098].

By estimating the time course of anaerobic and aerobic contributions in four 1500-m time trials with 7 **cyclists**, the authors concluded that the most successful **pacing strategy** was a short fast start [1302]. This sort of study needs a bigger sample size.

Manipulation of the **cadence** during the cycle phase of a **triathlon** had effects on oxygen cost in the subsequent run phase, but I sailed past the poster, the abstract lacks data, and the effects on overall performance weren't clear [1279].

Use of a **cooling vest** during a warm-up had a negligible effect on performance of a 10-km time trial at 24-26ºC in a crossover with 7 male **runners** [2059]. On the other hand, cooling the neck throughout exercise works [2060], but I can't see how you could use this strategy in a race.

Whole-body vibration didn't seem to have much acute effect on **strength** [1610], and there were mixed findings in a thematic poster session devoted to the topic [1228-1233].

Various kinds of **stretching** had little effect on **bench-press** 1RM [1622], but static stretching impaired **running** performance [699] and **rhythmic gymnastics** performance [2115].

Ozone alone (data not shown) "does not impair" distance-**running** performance, but it does when combined with heat and humidity [2040].

Biostatistics

Steve Marshall and I presented a conversational forum on **sample size** (chaired by Ian Shrier) and a colloquium on **statistical guidelines** for reporting research. Both talks had been organized by Allan Batterham, who was unable to attend, because the birth of his daughter coincided with the conference. The slides for our sample-size talk can be downloaded via the article on sample size at this site (Hopkins, 2006). See an In-brief item in this issue for a link to the slides we used for the stats guidelines. To our great relief, the audience reacted positively to the innovative and controversial issues in both talks.

Nutrition Preconference

A conference on sports nutrition was organized by Asker Jeukendrup for the day before the start of the ACSM meeting. Six speakers each specializing in a different kind of sport presented tutorial lectures to an audience of ~90. Here are the main points.

Middle-distance running and other endurance events lasting 2-10 min was Trent Stellingwerff's specialty. Nutrition should be periodized alongside the training program: from the general prep phase through the competition phase, carbohydrate (CHO) increases from 60% through 70% of energy while fat falls from 28% through 18%; protein stays constant at 12%. To optimize short-term (<4 h) recovery of muscle glycogen for another training bout or competition on the same day, consume CHO every 20-30 min at the rate of 1.2-1.5 g/kg/h. Adding protein won't increase the rate of resynthesis, but protein is important for longer (24 h) recovery periods to get the anabolic training response to the catabolic training stimulus. The best blend of CHO and protein and the best timing are unclear. He recommended use of bicarbonate and beta-alanine supplements to increase buffering of acid. Bicarbonate works acutely in male athletes, but not in females, in his experience, although it's hard to imagine why not. It also gives 50% of athletes serious gut problems for several hours, so it's no good for a final following soon after a semi-final. Beta-alanine works by increasing the amount of carnosine, an intracellular buffer in muscle; it needs to be taken 5-6 times a day, at a rate of 3 g/d, for at least several weeks. Trent finished by observing that more research is needed on the question of training in a glycogen-depleted state. In response to a question about control of weight, he said that it is better to be ~3% above race weight during non-competitive phases, and to increase protein intake during weight reduction so you don't lose muscle mass (if that is an issue). Athletes should be in the "red zone" of low body mass only for 3-4 wk per year. Body fat in the red zone is 10-14% of body mass, depending on the athlete.

Asker Jeukendrup focused on competing in the **Ironman triathlon**. His research shows that CHO mixtures (fructose and sucrose or maltodextrin) can be absorbed at the rate of 90+ g/h. Athletes don't normally consume such quantities, so to sustain the high intake it is important to avoid "taste fatigue". Gels are well tolerated [see Abstract 672], as are high-CHO low-fat low-fiber foods (e.g., bananas, bread rolls and jam). A single drink bottle containing concentrated CHO solution augmented with water at drink stations is another strategy. It is also important to realize that "the gut is trainable", so the athlete should get used to high-CHO intake in training sessions.

John Hawley deviated from his talk on the **marathon** to present results of his own recent research. He has found that athletes adapt to steady-state training sessions on low glycogen after several weeks, with little effect on performance (although he did not present performance data, and did that include sprint performance?). He has also found that caffeine increases the rate of glycogen resynthesis by about 50% in the first 4 h following exercise [see 669], but the dose was so high (8 mg/kg) that it could harm performance if you took it between games or heats and finals. A smaller does would probably still work on restoring glycogen and would also enhance performance directly in the following game or event.

In a panel discussion with the first three speakers, champion **Ironman Tim DeBoom** shared some of his secrets. He does "train-low" sessions (i.e., trains on low glycogen) only early in the season. His competition breakfast is French toast with syrup. He cuts out caffeine for a week before a race, has coffee on the morning of the race, but holds off on caffeine until into the run. And he eats a Power Bar as soon as he starts the cycling phase.

Adventure racing was presented by Mark Tarnopolski, himself an experienced champion in this sport. Race intensity soon levels off at 35-45% of VO_2max, but the race starts at high intensity, so CHO loading is important. Nutritional requirements are CHO ~1 g/kg/h and protein ~1.6 g/kg/24h. Extra salt intake is important, especially in hot conditions. Caffeine enhances performance and helps keep you awake. Reduce nausea and cramps with Tums or Rolaids. In tropical venues purify water with Pepto-Bismol.

In his talk on **team sports**, Stu Phillips noted that repeated sprinting has the same nutritional needs as longer endurance events, so hydration is as important as CHO during and after the game, and protein is also important for recovery after the game. The jury is still out on the issue of the glycemic index of the CHO.

Louise Burke began her talk on **swimming** by noting that there is a trend towards a positive relationship between leanness and performance, so there is a need to balance changes in energy input with output when changes occur in adolescence, tapering, racing, injury, recovery, institutional and social settings. She wondered whether LZR racing suits would have a bigger effect on swimmers with more fat by reducing drag that might arise from rippling of the skin. For key workouts she recommended CHO and protein before, CHO and fluid during, and CHO and protein after. *Adequate* CHO, especially for hard training, is the most important issue. The CHO demand of swim training is 30-60 g/h, which can be provided by sports drinks consumed at the rate of 0.5-1 L/h. Variety through use of gels and bars is also important. On the issue of supplements… Bicarbonate works, but can have side effects. Creatine can benefit interval training, but whether that translates into gains in competitive performance is unclear. Caffeine is also effective, but is problematic in a situation where it can disrupt sleep before a competition. Monitoring over a period of years allows for useful individualization of dietary strategies. Louise then led a panel discussion, in which it was noted that, on the evidence to date, milk has the best blend of amino acids.

Ron Maughan was at the conference and shared an interesting idea over lunch. Athletes who want to build muscle mass now routinely use high-protein diets. They believe in them, because whenever they come off the high protein, they lose muscle mass. But they lose muscle mass, because the high-protein diet upregulates protein catabolism, so when they reduce protein intake, their muscles break down until the protein catabolism down-regulates to a level appropriate for the lower protein intake. Chances are they could have built up the muscle mass without the massive intake of protein, which increases the risk of osteoporosis and possibly other health problems long term.

Nutrition

The title of the abstract says it all: **polyphenol supplementation** attenuates strength loss 2-3 days following eccentric **damage** [1561]. Yes, it's that usual muscle-damage model with untrained subjects, and yes, muscle damage is a necessary part of the anabolic adaptation process, but it's possible these extracts of fruit or berries (here, pomegranates) might allow you to train harder and/or recover quicker. We need some long-term studies.

Black-tea extract looks even more promising, if reducing muscle soreness, oxidative stress and cortisol following high-intensity **interval training** is a good thing [1562].

An **antioxidant** supplement made by Watkins might have had some benefit on **muscle soreness** and a marker of muscle **damage** when consumed for 3 d each side of a bout of eccentric exercise, but it's hard to say from the way the data were reported [1563].

A **resveratrol** supplement (equivalent to about 100 glasses of red wine) taken by 14 trained **runners** for 1 wk before a 1-h bout of hard running reduced markers of oxidative stress and inflammation in comparison with placebo, but another polyphenolic supplement, **catechin** (a component of green tea), had little effect in the crossover [1570]. Actually, the effect of both supplements on protein carbonyls looks worrying, even if "no treatment effects existed".

Acute supplementation with the "non-specific antioxidant" **N-acetylcysteine** reduced respiratory fatigue but if anything *reduced* time to fatigue (by 17%, equivalent to a ~1% impairment in a time trial) in 8 sedentary men [1803, 1804].

There was a clearer outcome of the effect of 5 d of unspecified **antioxidant** supplementation on time-trial performance (following a preload) of 8 trained **cyclists** in (apparently) a crossover: 1.0% more power in the *placebo* condition [1568]. It looks like some antioxidants will be harmful for athletes.

But **caffeine** still works acutely: @ 3 mg/kg it enhanced VO2max and lactate threshold in cross-country **runners** [2030]; @ 6 mg/kg it improved skill in simulated **soccer** activity [2031]; @ 5 mg/kg it increased peak power in **cyclists** [2032]; @ ~1mg/kg (as chewing gum) it surprisingly increased **shot-put** distance [2036]; and @ ~1.4 mg/kg it produced large improvements in cognitive performance of **cyclists** during steady exercise and enhanced subsequent time to exhaustion [2041]. There were no studies of the chronic effects of caffeine used in training.

The authors claimed their lack of a significant effect in a crossover with 8 runners did not support the use of **bicarbonate** to enhance middle-distance **running** speed, but the observed effect was 1.3% [1252]. Thanks, I'll take it, provided I can get used to the side effects.

Several studies in a slide session on acute effects of **energy supplements** were too badly reported in the abstract (no data, "no difference") or had too few subjects to be worth summarizing [849, 850, 854].

Not surprisingly, **glucose+fructose** in a supplement resulted in better 100-km **cycling** performance compared with isocaloric glucose [851].

A **high-fat diet** for 2 d before a **duathlon** impaired run+cycle time by 1.1% ("not altered"!) in a crossover with 11 athletes, but it's unclear whether they supplemented during the test [852].

Swimmers felt more energetic when they consumed **carbohydrate** before their morning training sessions [853].

The data aren't reported properly, so it's hard to tell exactly how much better **triathletes** did in "treadmill exhaustive exercise" when they consumed hydrolyzed **whey** protein enriched with **glutamine dipeptide** [960].

In a featured session on **carbohydrate-protein** interactions, the big message from keynote speaker Martin Gibala was that adding protein to an acute supplement doesn't enhance **endurance** performance if you have enough carbohydrate there already [no abstract]. In the first original-study presentation in the session, we learned that a small amount of protein can replace a lot of carbohydrate (0.75% protein plus 3% CHO vs 6% CHO) for endurance performance lasting ~3 h in total [350]–interesting but irrelevant, given that Asker Jeukendrup's CHO mixtures for such exercise amount to drinks containing ~10% CHO or more. The next speaker then presented data showing that, if anything, addition of protein to a supplement produced *more* damage following 90 min of shuttle running [351]. However, the last keynote speaker Luc van Loon assured us that you need protein post-exercise to get nett positive protein balance [no abstract]. In question time, muscle damage was described as a necessary evil in training, but of course you avoid it prior to competing.

A **protease supplement** taken by 4 males and 4 females 4 times a day for 4 d before a **muscle-damaging** bout of eccentric exercise more than offset the decline in strength that occurred in a matched group in the following 3 d (nett difference, 15%) [1368]. The supplement apparently reduces inflammation.

Two weeks of supplementation with **beta-glucan** (a polysaccharide derived from oat bran) had little effect on **immune function** and upper respiratory infections in a placebo-controlled trial with 36 trained cyclists [577].

Acute **arginine** supplementation resulted in *fewer* **chin-ups** [2200] and had little apparent effect on **endurance**-related physiology of **tennis** players [2199].

Chronic **coenzyme Q10** supplementation might enhance **endurance** [2203].

Cystine and **theanine** supplementation appears to have a protective effect on the suppression of **immune function** that occurs with hard training [2204].

Studies of **creatine** suffered either from lack of a control group [939] (although the effect of training with creatine combined with protein appears to have been massive), unclear reporting [941, 942], or inadequate sample size [942].

Beta-alanine consumed daily for 4 wk produced a 22% increase in the number of reps during training in a crossover study of 8 resistance-trained men [1253]. This stuff is clearly anabolic, but it's a pain to take the multiple daily doses for weeks on end.

In case you had any doubts, appropriate **hydration** does actually benefit performance [832-837]. Interestingly, **protein** in a sports drink enhanced fluid retention and performance in an 8-d **cycle** stage race in the heat [835].

In a study of **hydration**, 9 female **soccer** players sprinted 1.8% faster when they consumed 3 ml/kg of water every 15 min compared with consuming no water in a 90-min performance test in a 17ºC environment. There were "no significant effects" on passing skill (but no data shown thereof) [1348].

In a meta-analysis with everything done right (OK, I did help the authors informally), **dehydration** of >1.7% body mass starts to impair **endurance** performance, and the effect on power output is then 3.0% for each 1% loss of body mass [2177].

What is the effect of **carbohydrate** content of a drink on **rehydration** following exercise in the heat? The drinks were water, 18 mM Na+, and 18 mM Na+ with 3, 6 and 12% carbohydrate (of unspecified type). In the hour following exercise the subjects (men) consumed a volume of drink equal to the 2.6% loss of body mass. By 4 h post exercise the percent of drink retained was 66, 72, 75, 75 and 82 respectively [888]. The conclusion that electrolytes are the primary driver for fluid retention is obviously wrong. In a similar study, rehydration with a non-caloric electrolyte drink was allegedly "no different" from that with Gatorade [889], but the key data aren't shown. Come on, carbohydrate improves rehydration.

Tests and Technology

Using all the bells and whistles on a **cycling computer** for 8 wk led to greater improvements in lactate threshold in a group of 14 cyclists compared with a matched group who used the basic version, presumably by increasing the quality of training, although that's not apparent in the data as presented [1291]. Or is it an artefact of the misleading way the results are presented: significant in the study group, not significant in the control, but maybe no substantial difference between the two groups?

The correlations are probably artifactually high (0.97), because the errors of measurement of 16% for training distance and 11% for training speed are probably too large for a "commercial **accelerometer**" (which one of the many?) to be useful to monitor **swim training** [2121].

VO2max gets bad press as a predictor of performance of top endurance athletes, but it was quite good at tracking changes in peak running speed during a winter season in 34 competitive **runners**; however, there was little extra value in measuring changes in running economy, lactate threshold or body mass [2277]. These researchers are amongst the best at doing VO2s and lactates, so I conclude that there is no point in tracking physiological indices of endurance performance.

Training

The researchers called it **intermittent hypoxia**, but it was more like live-low train-high; anyway, after 6-7 days of 3 h per day, if anything the 11 men performed much worse than the placebo group of 7 in a time trial at 4300 m [1263]. So, no evidence here for any benefit of artificial hypoxia for **pre-acclimatization** to altitude, but in another study there was a benefit for acute mountain sickness and cognitive performance at altitude [1269, 1270].

Although there were only 5 experimental and 4 control highly trained **cyclists**, 3 wk of **altitude training** at 2700 m produced a likely *reduction* in exercise economy [1265], the opposite of what the artificial-altitude fraternity (myself included) would like to see.

You might not have to go that high to get extra blood from **altitude training**: two 3-wk camps at 1300 m and 1650 m separated by nearly 3 wk produced a 5.1% increase in **hemoglobin mass** and increases in markers of erythropoiesis in 8 middle-distance runners [1266]–which sounds great when the control group was "unchanged", but actually the control group increased by 3.6% (the authors somehow failed to calculate it). OK, there is probably a benefit from the low-ish altitude here, but higher is better.

Don't bother measuring ventilatory sensitivity to hypoxia if you want to identity individual **responders** to **altitude training** [1267].

Adaptation to the **brief intermittent** version of **hypoxia** (simulated altitude) for 15 d appeared to produce a ~4% increase in time-trial power output in 9 male cyclists, but the data for what appears to have been a placebo group are in the abstract only as "no [significant] improvement" [733]. Sigh…

Most of the increase in **hemoglobin mass** in 8 elite **cyclists** occurred during the first 11 d of a 4-wk **altitude-training** camp at 2760 m [738]. Wow, so you need only 2 wk up a mountain? And does this mean the gains will disappear just as quickly? Probably–red cells are more labile than people realize.

Ten weeks of **interval training** in combination with body-mass reduction did not give any extra increase in power/weight ratio compared with interval training or body-mass reduction alone in experienced **cyclists** [1290], but the sample sizes were a bit small (7-11 per group). Also, the gains were so large (8-10%) that it must have been in the base phase, so the relevance to the competitive season is unclear.

Ten **triathletes** doing 10 wk of cycle training with “independent cycle cranks” (presumably **PowerCranks**) for 3 h per week along with usual training performed no better in a (20-km?) cycling time trial and considerably worse (3.6%) in a 5-km running time trial compared with a matched group who did usual cycle training. Another matched group who did 1.5 h per week with the cranks performed *a lot* better in the cycle (5.1%) and a bit better in the run (1.3%) than the control group, although there were “no significant differences” [1293, 1294]. So, some use of PowerCranks could be worthwhile? Depends… my cycling-guru colleague Carl Paton, who has trained with PowerCranks, believes that any gain comes from the high-resistance intervals you end up doing through having to use a lower gear (and such training produces big gains with endurance cyclists). And if you use them too much, you wreck your legs. There are better ways to do high-resistance training.

Core stability training twice a week for 7 wk using a unique arrangement of slings resulted in a nett 6.2% improvement in **throwing speed** in a controlled trial of 23 female **handball** players [620]. And trunk **instability** was a risk factor for injury in **baseball** pitchers [726].

The data for the sham group weren’t presented, but it looks like **inspiratory muscle training** enhances time to exhaustion by 16% (equivalent to ~1% in a time trial) in **asthmatics** [1806]. There was a similar nett effect (1.2% in a time trial) in 14 college-level cross-country **runners** randomized to effective vs ineffective inspiratory muscle training [1807]. These gains aren’t that great, especially if, as seems likely, the study wasn’t done in the competitive season.

No data were given, but **cold-water immersion** and **contrast** (alternating hot- and cold-water immersion) forms of **hydrotherapy** produced higher power output over 5 consecutive days of hard training compared with hot-water immersion and passive recovery in a crossover study of 12 endurance **cyclists** [803].

In a case study of a **triathlete**, a Banister-style fitness-fatigue model of effects of training on performance predicted that the best **taper** would be different for the swim, cycle and run phases [1288]. Swimming, cycling and running performances were tested ~twice a week, but the tests each lasted only a couple of minutes, so one should be cautious about the relevance to competitive triathlons.

The sample size was pitiful (6 experimental, 4 control), so the claim that a sport-specific **vision-training** program enhanced ability of **softball** players to catch with the non-dominant hand should be treated as a likely Type I error, considering there were at least 5 performance tests, and maybe 10 if each was done on dominant and non-dominant hands [2114].

Elite Kenyan **marathon** runners excel by having a fractional utilization and economy that outweigh their relatively poor VO2max [805]. Hard training and spindly legs!

Travel for my attendance at ACSM was funded mainly by NordForsk (as part of a statistics workshop I ran at the Institute of Sports Medicine in Copenhagen prior to ACSM), with additional funding from Sport and Recreation NZ and the School of Sport and Recreation of AUT University. My thanks to all the people involved.

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