MACERATION PART 3: PREVENTING MACERATION

Posted by Mike

Preventing soggy macerated feet is all about keeping your feet dry. Dry from water coming into the shoe from the outside (environmental water – puddles, rain, sea, river crossings), water liquid over the head which runs down the legs and into the shoes, but dry from intrinsic sources of moisture, like sweat. To be sure, preventing macerated feet means "Keep Dry".

Trail runners crossing a river – Image: Flickr

First of all, apologise for the length of this article (5,300 words). To help get your bearings, here's an outline of the plan:

PREVENTION OVERVIEW

Moisture management in the athletic and wilderness arena: A quick look at current opinion on methods to protect maceration.

What's worse? Moisture from perspiration or environmental water? We'll look at the relative harm these two sources of moisture, from perspiration and environmental water (an, With the help of an experiment, at the foot-ankle joint.

What shoes and socks to wear to keep your skin dry (if barrier): We'll look at moisture wicking materials, waterproof and breathable membranes, waterproof and breathable footwear, hydro-repellent linings, waterproof shoes, breathable shoes, Keep drying shoes and a couple of basic precautions.

What topical products to put on your skin to keep it dry: We'll take a look at topical applications including powders, ointments, petroleum based products, Vaseline, Lanolin, Zinc oxide, Talcum powder, Corn starch and barrier products and topical that can help keep the skin dry and free from virulent or how effective are the organic topical products so far?

What does the perfect maceration prevention strategy looks like? A summary of your options for preventing trench foot depends on the environmental conditions, the specifics of your activity and the gear you have available to you.

MACERATION AND MOISTURE-MANAGEMENT IN THE ATHLETIC AND WILDERNESS ARENA

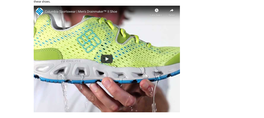
Most of many camers and volunteers from Exeter Valley Services, Lucas Tilley provides insight based on his experience as technical adviser in an outdoor/adventure retail chain over many years. He gave testing and advice to customers on footwear, socks, and gaiters.

Sailors will help with the hard. But on the most water-logging situation of a bare-knee crossing, it's safe to say it's almost impossible to keep the inside of your shoe completely dry, even with a seam-sealed footwear.

Neoprene socks - Image credit

4. Freely-draining shoes versus waterproof shoes

Some shoes are chosen for their ability to be water-ready or out of them, as opposed to being waterproof and alternating to brack water out. Philip Warner elaborates on the advantages of water-friendly footwear. Waterproof footwear is a bit like a bath tub. Once it's full, it's full. Water-friendly footwear can take 10 days or so after the end of the flood to dry out completely. The only viable alternative is to wear a pair of hot shoes that are fast drying, and we find well a breathable membrane like Gore-tex. Terrain Gear highlights the Gore-tex membrane for this quality. The video review here notes how readily water drains out of its pockets in the shoe.



Gravitation Sandals

5. Breathable uppers

Shoes with a breathable upper allow moisture to readily evaporate through to the outside. This enables the footwear to dry out quickly and prevent the build-up of moisture inside the shoe. Shoes with a mesh upper with mesh uppers are particularly open and breathable. But the breathable shoes that are so ideal in hot dry conditions provide water access for environmental water into the shoe. Jack on Adventure Ready Warrior recommends the Merrell Tetrex Crossbow for its breathability and how they also maintain the use of waterproof Rocky Gore-Tex socks (which I didn't miss, unfortunately).

Gravitation Sandals

6. Don't do this!

Tapping water or squeezing sponges onto your head is the more presentable yet overloaded source of hydration. Cindy Wolf, U.S. Bat-E-Pat-Ioner is, do something to stop this stem from running down your neck and into your shoes.

Hydration Pack Hacks: Stop Water Running Down Your Neck and Into Your Shoes - Image credit BRADY WOODFIELD

7. Change to dry shoes and socks

Change out of wet shoes and socks into dry ones when you can. That is, assuming you can carry that extra bulk in your pack, or you can have them delivered to you or strategically placed on the course. The only time I've been able to do this was on the Ultra Marathon Cow Bell Ultra Marathon, where I had a pair of shoes, clear instructions – the minutes later you finished may be in the same evaluation marathon situation.

Long-haul carrying shoes and socks, among other things - Image credit Hajdanski/Strange

8. Let your feet air

A good amount of moisture of your feet to the air is an opportunity not to be missed. It lessens the concussive impact and effect of wave exposure. It also degrees the is possible self-lor determined by your team.

Lady Lucie Sale also takes advantage of everyday by opening shoes to dry out her as long as possible - Image credit CHARLIE/MACLEAN - VIA JENNIFER BOWDEN

WHAT TOPICAL PRODUCTS TO PUT ON YOUR SKIN TO KEEP IT DRY

Athletes use topical barrier preparations (ointments, creams, lotions, powders, sprays, lasers) in an attempt to keep their skin dry. Some of the products are used to treat a medical condition, others are used for a perceived associated skin damage? In a total of Hennes-Fox parents dealing with soapy cold and scurvy-stiff dealing with urinary incontinence and heavily escalating ulcers (weepy wounds). Products like Zemitz Nappy Rash Ointment and Sudocrem are used for the management of Incontinence. Other products have found increasingly popular use in sport and comes for the management of hyperhidrosis.

Topical preparations come in many forms. Each type has different ingredients blended and different effects. Below is an overview with examples from Drugs.com Medicines. As you read through the different formulations and ingredients, think about the ultimate aim in preventing maceration – to keep the skin dry or to make it wet? Some of the ingredients are designed to make the skin wet, some are designed to make it exclusive mechanisms. Voice seem from getting into the skin while allowing it to get out of the skin. Not only that, as an athlete, you need to stay on the skin during your vigorous activity. That's a big ask! But let's look at the options.

Topical solutions

Topical solutions are of low viscosity and often use water or alcohol in the base. The solution can cause drying of the skin if alcohol is used in the base. They are usually a greater dissolution in water, alcohol, and propylene glycol than other topical preparations. They are used to treat a medical condition, but are usually an extract of plant or animal material extracted by soaking in alcohol. They are often rarely used as an athlete intervention.

- **Alcohol Solution**: Dimethicone, cyclomethicone, dimethicone, benzyl benzoate, vitamin E, aloe vera.
- **Allume Sprinkle(and roll-on solution)**: Dimethicone, aloe vera extract, tocopherol (vitamin E).
- **Triclabe (spray)**: Dimethicone, cyclopentasiloxane, propane and isobutane.
- **Dermoplast (spray)**: Benzocaine, ethyl chloride, isopropyl alcohol, acetic acid, propylene, menthol.
- **Brayd Solution**: Aluminum chloride 15% or 20%.
- **Sweat Block**: 19% aluminum chloride, 0.1% benzoic acid, botanical extracts, eugenol, polyethylene glycol, propylene glycol, polysorbate 20, polysorbate 80, water.
- **Compound Tincture of Benzoin**: Alcohol, benzoin, aloe extract, tolu balsam.
- **Tull Root**: Isopropyl alcohol, balsam pery, tincture of benzoin, 10% acetone.
- **Maximum**: Sun cream, thyme liquid, methyl salicylate, 50 alcohol 95%.

Lotions and shake lotions

Lotions are similar to solutions and are a thicker and tend to be more emollient in nature than solutions. They are usually oil-in-water emulsions and have other ones that have less alcohol than solutions. Lotions can be drying if they contain a high amount of alcohol. A shake lotion is a mixture that separates into two or three layers when it is left to stand. When the lotion is shaken, they need to be shaken into suspension before use, hence the instruction "shake well before use".

- **Brown Lotion**: Aluminum hydroxychloride in a soothing lotion base.

Creams

A cream is thicker than lotions and materials to shape when removed from its container. It tends to be more emollient than solutions and lotions. Creams are usually made of approximately equal proportions. It penetrates the stratum corneum more layer of skin and.

- **Sgb 10% 10 Cream**: Water, dimethicone, alcohol, glycerol, glycerol 95, pyrolifeen liquidum, glycerine, methylparaben, propylparaben.
- **Vesnim** (discontinued being) is Vaseline and Lanolin base 10% into oilds.

Ointments

An ointment is a homogeneous, viscous, semi-solid preparation, most commonly a greasy, thick oil/oil 80% water 20% salt in high viscosity. They are used as emollients or where a degree of occlusion is desired. Ointments are usually anti-moisturising, and good for dry skin, but they can interfere with adhesion of tapes and bandages.

- **Vaseline**: White petroleum jelly.
- **Bag Balm**: 9 hydroxyquinoline sulfate 0.3% in petrolatum, lanolin base.
- **Aquaphor Healing Ointment**: Petrolatum 41%, mineral oil, ceresin, lanolin alcohol, glycerine, castor oil, sodium benzoate.
- **Aquaphor Healing Ointment**: Petrolatum 41%, mineral oil, ceresin, lanolin alcohol, panthenol, bisabolol, allantoin.
- **Trail Toes**: Petrolatum, beeswax, aluminum starch octenylsuccinate, dimethicone, dimethiconol(base) 1%, ultraviolet-protective.
- **Sgb 10% 10 Ointment**: Hydrophilic base (10% PG, petrolatum jelly (protect no longer available).
- **Udder Balm**: Water, mineral oil, cetearyl alcohol, glycol stearate, stearic acid, glycerol, propylene glycol, lanolin, lanolin, aloe barbadensis (aloe vera), menyl palmitate (vitamin A), neopentyl acetate (vitamin E), tocopherol acetate (vitamin E), cocoyl hydrolyzed wheat protein, cocoyl hydrolyzed soy protein, fragrance.
- **Kendall Friction Block**: Hydrogenated vegetable oil, vitaj alcohol fragrance.
- **Gurney Balm**: Silicon, other goodies, tea tree oil (10%).
- **Gold Bond**: Cetyl alcohol, glycerol, glycol stearate, isopropyl palm, capryl/capric triglyceride, cetearyl alcohol, glycol, methacrylate, glycol methacrylate, sodium lauryl, sorbitol, alcohol, tolerance, tocopherol.
- **Gold Bond**: Capryl/ triglyceride, triethanol, cetearyl alcohol, cetyl esters, polyethylene, zinc oxide, silica, sorbitol, glycerol, glycol stearate, methacrylate, glycol methacrylate, lauryl myristate, lavalence, origin, phenoxyethanol, fragrance, tocopherol, propylene glycol.
- **Desitin Nappy Rash Ointment**: Zinc oxide 40%, petrolatum methyl hydroxybenzoate, hydrolyzed lactoprotein.

Lady Lucie Sale also takes advantage of everyday by opening shoes to dry out her as long as possible - Image credit

More on ointments

Wiss et al (2006) discuss three different types of ointments: petroleum-based, dimethicone-based, and zinc-based.

- Petroleum-based products are similar to the zinc-based products except that they have a greater fluid loss and are more occlusive.
- Petroleum-based products tend to melt and wash off easily.
- The newer silicone-based ointments (ie. dimethicone) have lower frictional resistance, and are more resistant to wash off.

More on zinc oxide

Just an extensive a little. Zinc oxide is in both Desitin Nappy Rash Ointment and the "zinc" sunblock you wave to the beach and sports sunheads as a kid. I still use it daily, much like Mike Hosey here. Like the sunblock version, Desitin Nappy Rash Ointment is a "barrier" ointment. It creates a barrier to the skin against the noxious vapor of quite nasty. I want get zinc dimethicone in it to prevent from from the phenomenal to see how it compared to the others. It looks and feel like an oil, but when you wipe it off, it still looks like slipping. Mix it with the more without being able to see it. That's similar to the zinc oxide – it's really difficult to wipe it off your skin.

Desitin 40% zinc oxide ointment - Image credit

The great zinc debate: Mike Hosey applying zinc sunblock - Image credit

Gels

Gels are thicker than a solution. They are often a semisolid emulsion or an aqueous colloid. Some will melt at body temperature. Gels tends to be cohesive (ie with alcohol or acetone and tend to be drying. They tend to have greasy sensation ingredients between bottels. Gels carry a significant risk of increasing hyperemia(they due to fragrance and preservatives. A gel is useful for the scalp and body fluids. Its applying gel one should avoid the eyes and mucous membranes due to the drying and stinging effect of the alcohol base.

- No examples.

Powders

Powder is either the pure drug by itself (solvent pinkeled), or is made of the drug mixed in a carrier such as starch, talc, or other inert substance. Powders are usually used for the management of Incontinence. Powders quite different ingredients compared to the others and seems to be more advantaged in its water repelling ability (watch the video for a demonstration).

- **Talcum powder**: Pure talc.
- **Desenex powder**: Talc, mechagrosa calcium, acrylamidoacrylate-acrylate copolymer, chlorophenol, tetrasodium EDTA, fragrance, 2% sulfur.
- **Brown Lotion**: Lanolin, glycerol, alum, bentonite.
- **Odor Gone/ Foot powder**: Zea Mays (corn) starch, sodium bicarbonate, sodium polacrylate
- **Fungi Foot powder**: Tolnaftate, sodium bicarbonate, sodium polacrylate.
- **Prontol powder**: Dipyrithione1 Methylcellulose (5 mg) (no longer available).
- **Zfone Wear/Anti Perspirant Powder**: 75% PE wax.

Fungi Foot powder - Image credit

Pastes

A paste is a combination of three agents – (s): water and powder. It is an ointment in which a powder is suspended.

- No examples, although Desitin is also sold as a paste with 40% zinc oxide.

Film forming liquids

Telesand in polymer science had led to the development of a new generation of product, which allow a thin semi-permeable protective silicone based, polymer coating to be applied to the skin (eg. Cavilon). Service, Kelly et al (2006) discuss the use of Cavilon in the management of skin tears. Film forming liquids provide more wash off, provide visualisation of the underlying skin and do not interfere with adhesive hypersensitivity. They come in a variety of application forms such as pads, sticks, and spray (Wiss et al, 2006).

- **Cavilon Skin Protectant**: Non-sterile silicone polymer.
- **Cavilon No Sting Barrier Film**: Non-sterile silicone polymer.

Cavilon No Sting Barrier Film - Image credit

Cavilon in action (and video) - Image credit

Waterproof tapes and adhesive dressings

Some adhesive dressings provide a breathable protective skin barrier. Opsite, for example, is clear and allows visualisation of the underlying skin. Bio is soft very tapes and dressings, a crosslink hydrolysis is that of dressing edge lift and lifting in high friction areas.

- **Opsite Flexifix (or Flexifoil)**: Transparent waterproof semi-permeable film with acrylic adhesive. See video to see how it works.

Smith & Nephew
Opsite Flexifix
Opsite Flexifix
Opsite Flexifix

One thing's for sure, though: Although this article is exclusively about *prevention*, I would not use anything occlusive in the *treatment* of maceration, for reasons that should now be clear.

b) Hydrophilic

Some ingredients are hydrophilic (water-attracting). That means they bring water into the skin and hold it there. This includes *Propylene glycol, Glycerine (Glycerol), Allantoin, Potassium alum, Tribehenin* and *Aluminium chloride (Aluminium chlorohydrate).* The first two are especially water-attracting. Called humectants, these hygroscopic liquids work by:

- Attracting water from the dermis into the epidermis, increasing the water content in the epidermis.
- When humidity is higher than 70 percent, humectants can also attract water from the atmosphere into the epidermis, increasing the pliability and flexibility of the skin, preventing it from cracking.
- Promoting consistent desquamation (shedding of the outer layer of skin) by degrading the corneodesmosomes that hold skin cells together.

These are benefits to dry skin. They're not beneficial if your aim is to keep the skin dry. Again, although this article is exclusively about *prevention*, I would not use anything hydrophilic in the *treatment* of maceration, for reasons that should now be clear.

c) Durability and longevity

Let's assume all of these products provide the perfect mechanical and/or pharmacological effect required to prevent maceration on the feet. Now consider their durability during prolonged athletic situations. It seems self-evident that anything on the skin will be gradually massaged into the sock with walking and running. And will become diluted by the very moisture they're attempting to combat, particularly those that are water-soluable.

Step by step, less product will be left on the skin, where it's needed. How long do you expect your topical product to last? How often will you need to reapply it for the effect to remain? With some ingredients more durable than others, which products are more worthy of your consideration?

d) Antiperspirants

Antiperspirants plug the sweat gland, preventing sweat from escaping from the skin. They don't prevent the production of sweat – it stays trapped within the skin. While this might not be such a big deal for your underarm area, the shear forces your feet deal with are significant. Weakening of the skin renders it less able to remain intact under these shear forces.

"Aluminium chlorohydrate and aluminium zirconium tetrachlorohydrate gly are the most frequent active ingredients in commercial antiperspirants. Aluminium-based complexes react with the electrolytes in the sweat to form a gel plug in the duct of the sweat gland. The plugs prevent the gland from excreting liquid and are removed over time by the natural sloughing of the skin. The metal salts work in another way to prevent sweat from reaching the surface of the skin: the aluminium salts interact with the keratin fibrils in the sweat ducts and form a physical plug that prevents sweat from reaching the skin's surface. Aluminium salts also have a slight astringent effect on the pores; causing them to contract, further preventing sweat from reaching the surface of the skin." https://en.wikipedia.org/wiki/Deodorant

e) Tinctures and their tackiness

Tinctures are used for their ability to form a film over the skin as they dry. But they tend to be sticky, which is why they're used as adhesive enhancers. While the advantage of the film barrier is evident when completely dry, the feet are truly dry for a very short time only. Moisture from perspiration will make the film tacky – a problem as it may lead to either grit and debris sticking to the skin and/or blisters.

One of the most widely-known tinctures is Compound Benzoin Tincture (TBCo or Friar's Balsam). There is a little confusion around this product that I can shed some light on, in case it helps:

"Benzoin is unrelated to benzoin resin or TBCo. Benzoin resin is commonly called benzoin (but is not the chemical compound of benzoin) and is also called gum benzoin or gum Benjamin. Tincture of benzoin is a pungent solution of benzoin resin in alcohol. A similar preparation called Friar's Balsam or Compound Benzoin Tincture (USP) contains, in addition, Cape aloes and storax (liquidambar resin)."

f) Powders and moisture

At first glance, there are two reasons why this base ingredient is a good thing. Firstly, talcum powder acts as a dry lubricant and while everything stays dry, it forms a low friction layer on the skin. Secondly, it soaks up moisture. The problem is, it doesn't take much moisture, only 13-17% for the two to combine and form a paste (Comaish and Bottoms, 1971). A paste will neither keep things dry nor soak up any more moisture. In fact, it becomes abrasive and damaging to the skin. However, there is one powder I looked at that contains a different type of powder of PTFE and PE wax. That was 2Toms BlisterShield Powder – here's the video if you didn't see it earlier: https://youtu.be/68lD4Qda3_I

g) Lubricants and traction

Many of the topical products listed are lubricants. Lubricants reduce friction markedly, in the short term. During this time, they result in a lack of traction for your foot in your shoe. This is not good because it reduces the functional efficiencies of gait and can predisposes to injury. If your foot is sliding around in your shoe, you are less stable on your feet. Ankle sprains, black toenails and proximal muscle strains are all more likely, not to mention reduced propulsive force.

WHAT DOES THE PERFECT MACERATION PREVENTION STRATEGY LOOK LIKE?

It depends.

Is it hot, cold or somewhere in between? If it's hot and your feet perspire a lot, you may prioritise a thin moisture-wicking socks and breathable shoe uppers. If it's cold, thermal insulation may dictate a thicker sock to be most important and breathable uppers less important.

Is it dry, wet or are you going to get saturated? If it's dry, it could be as easy as a breathable shoe and moisture-wicking socks. Or if it's a little wet, you may need to add in an occasional shoe/sock change to prevent skin maceration and making sure to air your feet for a time. If your feet are going to get saturated, you might need to rethink the ability of your shoes to drain and/or wear a pair of waterproof socks.

Is your event a few hours, a few days or a week long? Do you have lengthy rest breaks, is it non-stop or something in between? Do you have access to a lot of extra gear, have you got crew or drop bags, or are you carrying everything on your back? This has implications for your ability to air your feet out and in changing into dry footwear.

Conclusion

Keeping your feet dry is a tough gig. In pursuit of this goal of preventing skin maceration, you need to decide on one of the following objectives:

- Somehow keep all water out of your shoe and/or sock
- Concede that water will get into your shoe and/or sock (and more or less stay in), but somehow keep it off your skin
- Let the water come into your shoe and/or sock, but let it escape just as quickly

by Rebecca Rushton BSc(Pod)

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The Blister Prevention website is maintained by Australian podiatrist Rebecca Rushton as part of the BlisterPod company.

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