

# Therapeutic Hosiery: An Essential Component of Footwear for the Pathologic Foot

Socks are an important element in the treatment armamentarium.

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## Objectives

1) To review research relevant to clinical benefits of therapeutic hosiery.

2) To review the role of pressure and shear reduction provided by specialized hosiery products.

3) To review sock fiber technologies with specific recommendations for use in therapeutic hosiery.

4) To present newer sock technologies which have anti-microbial benefits, skin hydration benefits and improved cutaneous circulation benefits.

5) To designate specific patient populations who would benefit from regular use of therapeutic hosiery.

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**Introduction**

Thirty years ago, socks had the same role as underwear in terms of function and user benefit: they were universally worn, yet ranked lowest on the scale of importance in terms of quality of life benefits.[1] Today, specialized socks (now known as therapeutic hosiery) have evolved to become an important comfort item with potential for significant medical benefits.[2] The therapeutic hosiery category of footwear is now a $200 million industry which is still in its infancy in terms of product development and patient utilization.

This article will review the history of development of improved hosiery products for use in specific foot pathologies. A review of published research will be provided as well as a critical analysis of the current state of the art of therapeutic hosiery. It is clear that both consumers and clinicians should be aware of the potential benefits of therapeutic hosiery. At the same time, the buyers and prescribers of these products should be aware that many of the benefits claimed by

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manufacturers of therapeutic hosiery are not substantiated by valid research. Since these footwear products are not under FDA control, misleading marketing promotion of health benefits of therapeutic hosiery products has led to confusion and misunderstanding.

A review of research of benefits of specialized socks or hosiery will reveal three primary areas of interest: plantar foot pressure reduction, reduction of friction skin-shear injuries, and use of antimicrobial fibers in sock construction.

**Plantar Pressure Studies**

The landmark studies documenting the pressure-relieving capability of specialized hosiery products were supported by an athletic sock company (ThorLo®, Statesville, NC) who had patented a unique padded hosiery design for sport application. These studies on substantially padded athletic socks revealed the potential therapeutic effects of hosiery products for specialized patient populations with diabetes, arthritis, and peripheral vascular disease. For the first time, peer-reviewed research was published in prestigious medical journals documenting potential benefits of hosiery for foot pathologies.

The first study of pressure relief of specialized padded hosiery was conducted at the Manchester Royal Infirmary in the United Kingdom.[3] Veves, et al. measured plantar pressures in 27 neuropathic diabetic patients while walking in a barefoot condition, while wearing their own traditional socks, and while wearing padded ThorLo hosiery. Compared to the barefoot condition, the use of conventional socks provided no significant relief of plantar pressure. When wearing padded hosiery, a significant 26% reduction of peak plantar pressure was recorded. The researchers concluded that specialized padded hosiery could be a useful, acceptable, and inexpensive addition to existing methods for protecting the insensitive foot from abnormal pressures and loads.

In a subsequent study, Veves, et al. compared the pressure reduction of experimental extra-padded hosiery with padded sport socks in the reduction of plantar pressures in patients with diabetic neuropathy.[4] Both styles of socks reduced plantar pressures significantly, although the extra padded socks reduced pressures by 31% compared to values of 17% and 10% pressure reduction by ThorLo sport socks. Of significance, the experimental padded therapeutic socks continued to provide significant plantar pressure reduction of 17% after six months of continuous use.

In another study by Veves, et al., the use of experimental extra-padded hosiery was studied in patients with rheumatoid arthritis.[5] Often overlooked is the fact that the rheumatoid foot can develop extreme plantar pressures due to restricted joint range of motion, atrophy of the fat pad, and digital deformity. In this study, padded experimental hosiery was tested in 18 patients with rheumatoid arthritis compared to the barefoot condition. Significant reduction of plantar pressure (32%) was achieved when wearing the padded socks compared to barefoot walking. In addition, pain relief after wearing the padded socks for three months demonstrated a 51% reduction. This was the first study published in the literature documenting that padded hosiery could relieve plantar pressures and pain in the rheumatoid foot.

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Murray, et al. studied the patient acceptability of extra-padded ThorLo hosiery when worn with extra-depth shoes.[6] A group of 86 neuropathic diabetic patients were followed for six months and completed satisfaction questionnaires at three and six months. Evaluation scores were good to very good in 85% of the patients. The researchers concluded that the comfort of padded hosiery could encourage improved compliance with appropriate footwear for prevention of ulceration in patients with diabetes.

The previous cited studies of specialized ThorLo hosiery were conducted on patients walking without shoes, and using the optical pedobarograph to measure plantar foot pressures. Thus, these studies were direct comparisons of barefoot vs. socks without the influence of shoes. Flot, et al. were the first to measure in-shoe plantar pressure reduction of padded socks in the shoes of eight healthy subjects.[7] Significant reduction of forefoot plantar pressures were noted when wearing the padded socks compared to the control socks, although the pressure reductions were not uniform across the entire forefoot.

Donaghue, et al. used in-shoe pressure measurements to determine the durability of padded ThorLo socks

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and extra depth shoes when worn by 50 patients with diabetes and high risk feet.[8] Significant pressure relief (10.7%) was found with new shoes and padded socks, compared to current footwear. After six months of continuous use, no loss of pressure reduction was determined with use of extra-depth shoes and padded socks. The researchers concluded that there was significant initial reduction of plantar foot pressures when padded socks were worn with proper shoes, and this protective benefit was not lost after six months of continuous use.

In addition to elevated plantar pressures, step shock has been associated with tissue damage, which can cause ulceration on the weight bearing surfaces of the foot.[9] Howarth and Rome studied the shock attenuating properties of five different sock types on a single subject while walking over a treadmill.[10] Acrylic cushion and wool cushion socks provided significantly increased shock attenuation compared to cotton socks, cotton terry and cotton double layer socks. This verified previous observations that cotton fiber socks compress and lose shape during continuous wear compared to synthetic acrylic fiber socks.

After this study, nearly ten years passed before any credible research was published in the medical literature regarding protective benefits of specialized hosiery products. In the meantime, the therapeutic hosiery segment of the footwear industry underwent exponential growth as many manufacturers introduced products with proposed benefits for pathologic feet, particularly the diabetic foot. None of these companies conducted pressure studies or other research to validate their marketing claims, yet usage of these products grew at an astronomical rate.

In 2005, Garrow, et al. studied 19 patients with diabetes and peripheral neuropathy and compared a new double layer sock to ordinary socks to determine pressure relief in various areas of the foot.[11] A specialized double-layer hosiery product provided a significant 9% reduction of in-shoe total foot pressure compared to ordinary "supermarket socks." In addition, a 14% reduction of peak forefoot pressure and 8% increased surface area contact was achieved when wearing specialized socks compared to ordinary socks.

These pressure studies of specialized hosiery products offer promise, but also provide results which require careful interpretation. While statistically significant, the reduction of between 10% and 32% peak plantar pressure may not have any influence on the rate of ulceration in the diabetic patient.

Previous studies showing 25-32% reduction of plantar pressure with padded hosiery were performed without shoes, while in-shoe studies showed much lower overall pressure reduction. While socks alone have capacity to reduce damaging forces on the soft tissue of the foot, their influence is less significant than with a shoe alone or a shoe in combination with a custom-molded foot orthosis.

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For example, Kastenbauer. et al. found that a 50% reduction of plantar pressure occurred when diabetic patients wore running shoes with custom-molded foot orthoses.[12] However, a follow-up study showed that this pressure of an orthosis/shoe combination will deteriorate over time, with only a 13% reduction of pressure provided at the end of one year.[13] Blackwell, et al. have shown that hosiery will show less noticeable pressure reduction when worn in shoes compared to when worn in slippers.[14]

On the other hand, one could argue that any pressure reduction in the shoe of a diabetic patient with a high risk foot is better than no protection at all. Since hosiery is an almost mandatory requirement of all people wearing closed shoes, the upgrade to specialized hosiery represents an acceptable, potentially cost-effective modification of lifestyle which can protect the diabetic, at-risk foot. Studies have shown that specialized hosiery products can maintain their pressure relief over a period of six months or more, which is more favorable than that seen with shoes and orthoses alone.

**Shear Studies**

Friction and shear are two other major forces which are recognized to contribute to the formation of ulcers in patients with diabetes.[15]

In gait, the human foot strikes the ground from a tangential attitude, rather than a purely vertical orientation. Friction is the active or static force that acts on the skin which resists sliding. During walking, tangential foot strike with the ground causes the superficial skin to be subjected to frictional force which then results in skin exfoliation and generation of heat. A secondary shear force is the static situation where the fixed foot exerts a horizontal (backwards) motion against the deeper tissues during push-off, which results in blistering and subsequent ulceration of the integument.[16]

Only recently have devices been developed to measure foot shear in-vivo. Lord and Hosien were able to detect a 15% reduction in shear beneath the first metatarsal head when thin nylon hosiery was compared with a barefoot condition.[17] Other researchers have relied on a clinical endpoint such as the formation of friction blisters to determine the effectiveness of hosiery products to reduce

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shearing forces acting on the foot during walking and running.

Herring and Richie were among the first to study the effects of hosiery fiber composition and construction on the incidence of friction blisters in long-distance runners. The first study compared the incidence of blisters in runners wearing special padded (Thor Lo) socks either composed of 100% cotton fibers or 100% acrylic fibers.[18] This was a longitudinal double-blind study of 35 long-distance runners. Cotton fiber socks were associated with twice as many blisters as acrylic fiber socks, and blister size was three-fold larger with the cotton socks. The runners observed that the acrylic fiber socks kept their feet drier in a blinded analysis.

The follow-up study repeated the original design, but utilized generic sock construction, rather than padded ThorLo construction.[19] The superiority of acrylic fiber socks over cotton fiber socks could not be demonstrated when the socks were not padded. The authors concluded that the friction reduction and wicking characteristics of socks were dependent on both fiber composition and construction technique.

Friction blisters are among the most common foot injuries affecting the athlete and are a serious threat of disability in the military.[20] A study performed on 357 military recruits at Parris Island, South Carolina revealed a 69% prevalence of blisters during a four-month period of training.[20] Blisters serious enough to warrant medical evaluation at sick-call occurred in 24% of all trainees. An estimated 5,000 basic trainees at Lackland Airforce Base were treated for friction blisters during one calendar year in 1990.[21]

Three studies have been published by the United States military involving the testing of sock systems to reduce friction/shear injuries in the feet. In the study of 357 military recruits, the use of a Cool Max® liner with a heavily padded wool/polypropylene outer sock significantly reduced blisters compared to a single-layer sock (40% vs. 69% frequency).[20] When the Cool Max® liner was added to the single layer sock, sick call visits were reduced from 24% to 9%. In 1993, another study of 1,079 soldiers tested five sock systems and blister frequency.[22] Synthetic fiber socks significantly outperformed the standard wool sock. Adding a Cool Max® liner significantly reduced blisters. When comparing single, extra-thick padded acrylic socks to double layer sock systems, the double-layer systems were superior presumably due to shielding of the terry loop construction away from the skin and the movement interface which is available in the double-layer construction. Jagoda also affirmed the superiority of wearing a liner sock and padded sock, compared to a single sock system in Marine recruits.[23]

Studies of socks and friction blisters on the feet suggest that the establishment of a movement interface either within the sock itself or between the layers of a sock system will prevent skin injury. Furthermore, reducing the friction force on the skin surface itself may be dependent upon the fiber composition of the sock, where synthetic fibers appear to work best.[24]

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The superiority of certain fibers for therapeutic hosiery are based upon certain factors which relate to protection from pressure and shear, reduction of moisture on the skin surface, resistance to compaction, and maintenance of shape when subjected to moisture and shear.

With regard to moisture management on the surface of the foot, the terms "hydrophobic" (repel moisture) and "hydrophilic" (retain moisture) are utilized in describing sock fiber performance. In general, cotton fibers and most wool fibers are considered hydrophilic, while synthetic fibers are hydrophobic. The response of socks to exposure to moisture is important from both a comfort and clinical standpoint.

Moisture can accumulate in the shoe of active people from three different sources: the foot itself, the legs and trunk of the athlete, and the outside environment. The foot contains eccrine sweat glands which are innervated by cholinergic fibers activated by the sympathetic nervous system. The palms and soles are unique in having the highest density of eccrine sweat glands in the body: 2000 glands per square centimeter, compared to a density of only 100 glands per square centimeter in the rest of the body.[25]

The production of moisture from the sweat glands of the feet during vigorous physical activity is estimated to be as much as 200 c.c per hour.[26] The production of moisture from the remainder of the body during exercise can exceed one liter per hour.[26] The sum total of moisture potentially collecting in the shoe of an athlete during exercise will quickly exceed the absorptive capacity of any sock. Therefore, in order to keep moisture content at a minimal level on the surface of the foot during exercise, a sock must "move" moisture away to the shoe upper for evaporation. This process is known as wicking.[27]

Cotton fibers are hydrophilic and absorb three times the moisture as synthetic acrylic fibers which are commonly used in athletic hosiery.[28] Once wet, cotton socks retain moisture and have a ten-fold greater drying time compared to synthetic fiber socks.[29] In sedentary activity, cotton socks may be preferable to acrylic socks, given the low moisture output of the feet, and the fact that cotton

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socks can absorb this moisture without becoming saturated.

However, during vigorous activity, the absorptive capacity of any sock will be exceeded, and only a wicking gradient will allow movement of moisture from the foot surface to the shoe for evaporation to the outside environment. Hydrophilic fibers such as cotton have a 2.4 times greater resistance to moisture transport.[30] This may be related to absorption of fluid and swelling within the fibers themselves. When wet, acrylic fibers swell 5% while wool fibers swell 35% and cotton fibers swell 45%.[31] Swelling of fibers is related also to a loss of shape and conformability to the foot. Cotton socks tend to bunch and elongate when wet, while synthetic fiber socks are more likely to retain shape, cushion, and resiliency in these conditions.[32]

Moisture management is an important function for therapeutic hosiery. The coefficient of friction on the skin surface is significantly increased by moisture.[33] Increased friction coefficient will result in greater risk of shear injury to the skin or deeper tissues.[34] This becomes important for patient populations with conditions of the feet which are accompanied by fat pad atrophy, bone prominences, and structural deformity. Increased moisture on the skin surface of feet is associated with greater risk of bacterial, fungal and viral infections.[35]

However, the primary patient population at risk for skin injury is the patient with diabetes and peripheral neuropathy. Autonomic neuropathy causes a loss of innervation of the eccrine sweat glands of the feet, and sweating becomes absent. Thus, concerns about wicking and moisture management by hosiery worn by the diabetic patient are irrelevant. On the other hand, the resilience, cushion properties, and shear reducing properties of synthetic fibers compared to cotton fibers should still be important factors in selection of socks for neuropathic patients.

**Fiber Recommendations for Therapeutic Hosiery**

A review of the medical literature shows a clear superiority of synthetic fibers over cotton fibers in providing health benefits for people with foot pathology. These studies have documented that acrylic fibers and polypropylene fibers can provide better protection from impact, pressure, shear, and moisture accumulation compared to cotton fibers. Yet, the medical marketplace continues to feature "diabetic socks" composed of cotton fibers. Many authorities and professional organizations continue to provide consumer information to the general public which includes the choice of white cotton socks as being preferred for healthy feet.

This underscores a significant problem for patients with at-risk feet who seek information and products to protect their feet. There is no regulation of claims made by manufacturers of footwear and foot products sold to the general public. These products are sold in retail pharmacies, department stores, home/health stores and, most importantly, over the Internet. A visit to any of these vendor outlets will reveal a plethora of products and remedies for foot conditions which promise therapeutic benefits without any scientific verification. Consumers continue to purchase products which have no established benefit, and which may pose significant threat to their foot health. The new exploding category of therapeutic hosiery has more products with misleading advertising than any other type of footwear marketed to patients with at-risk feet.

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**Other Potential Benefits of Therapeutic Hosiery**

There has been recent attention to the potential clinical benefit of compression in the upper of a sock worn by active people. In particular, some over-the-calf sport socks have enough elastic compression to aid in venous return of blood flow from the feet and lower legs. Brown and Brown were the first to show the benefits of Thor Lo basketball socks in improving objective and subjective measures in patients with venous insufficiency.[36] Ali et al. showed that over-the-calf sport socks with specially designed uppers for graduated compression would reduce the symptoms of delayed muscle soreness in men after a 10 km road run.[37] Graduated compression over-the-calf socks are now used in professional hockey and by some world class distance runners. For many people, especially males, the option to wear athletic-style socks to prevent edema of the feet and ankles is preferred over conventional compression hosiery.

There are now several therapeutic hosiery companies providing over-the-calf knitted socks which offer substantial compression and potential therapeutic benefit. Peripheral edema is found in many patient populations with lower extremity pathology. Edema causes fatigue, nerve entrap-

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ment, stasis dermatitis and limited joint range of motion. Reduction of peripheral edema has potential benefit for significant numbers of people over the age of 60. Yet, there continues to be unsubstantiated concern about the use of compression stockings for at-risk patient populations. At most, therapeutic socks will provide 20 mmHg of pressure, which would not occlude blood flow in any patient other than one with severe arterial obstruction.

**Indications for Therapeutic Hosiery**

Most research published on the clinical benefits of therapeutic hosiery has focused on pressure relief in the diabetic foot. Yet, many other patient populations would benefit from specialized hosiery. Plantar pressure, skin shear, and pressure over bone prominences occur in many healthy people who subsequently develop hyperkeratosis, bursitis and friction blisters of the skin. Moisture accumulation on the surface of the skin of the foot is associated with increased risk of bacterial and viral infection. Moisture will increase the coefficient of friction on the skin surface, rendering the foot more vulnerable to blistering and infection.

High plantar pressures are seen in patients with rheumatoid arthritis as well as healthy patients with cavus deformity of the feet. Bone pressure, causing risk of skin injury, is seen in severe cases of hallux abductovalgus deformity as well as severe claw toe deformity.

Patients with peripheral vascular disease are at risk for skin injury of the feet and would be prime candidates for intervention with therapeutic hosiery. Venous insufficiency also increases the risk of ulceration in the lower extremity, and specially designed therapeutic hosiery can protect the skin of the lower legs and feet while providing significant compression for relief of peripheral edema.

Finally, patients with generalized foot pain due to arthritis, fat pad atrophy and bone prominences can obtain relief with padded hosiery. Elderly patients with these symptoms should be prescribed specialized hosiery to supplement footwear designed to protect the feet and provide pain relief.

**Fitting Considerations**

While most podiatric physicians are aware of the importance of shoe fit in preventing foot pathology, few appreciate the problems in finding hosiery which properly fit the foot of the patient. David Higgins*, a noted authority in the design of therapeutic hosiery, has recommended that "the most fundamental and important elements of a proper therapeutic sock include optimal moisture management materials, antibacterial fibers or treatments, and proper fit and design. As is true of any footwear designed for at-risk feet, proper fit should be considered above all else."

Most health professionals are not aware that hosiery products are not sized specific to foot size: they are designed to span from three to four sizes. This leads to inappropriate stretching and thinning of the sock padding when the larger end of the size range is worn, and leads to bunching and wrinkling when the shorter end of the size range is worn.

Currently, most therapeutic hosiery manufacturers use a sizing standard based upon the National Association of Hosiery Manufacturers (NAHM) with sizing boards to verify sock size. These standards are outdated by today's standards and these sizing boards do not take into account the variations in circumference which occur in edematous, pathologic feet. Furthermore, most socks do not increase in width or circumference as the size increases. Thus, larger feet automatically have more stretching and compression of the sock around the foot.

The best therapeutic hosiery products are sized to a maximum range of two shoe sizes. "Low end" hosiery products will offer two uni-sex sizes from Women's size 6 to Men's size 13. This provides significant potential for improper fit, stretching, and bunching of sock material inside the shoe. Premium therapeutic hosiery offers at least four size ranges for men and women, with five ranges being optimal for both groups.

A fear of skin injury to the leg has propagated a host of "non-binding" socks which actually may cause more risk to the foot than properly fitted socks which have adequate elastic fibers to maintain shape and support. Newer technologies are now available in sock manufacturing which have virtually eliminated toe seams and constricting "bands" at the upper portion of the sock. Therapeutic hosiery should conform to the foot with adequate composition of Lycra® or Spandex®. These socks will not leave a seam or ridge line at the top of the sock, yet will maintain shape and resist migration into the shoe. Instead of "non-binding" socks, the physician should recommend "non-bunching" socks which are elastic, conforming and supportive.

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**New Technologies for Therapeutic Hosiery**

The most significant advance in therapeutic hosiery design over the past ten years has been the introduction of antimicrobial ingredients. So-called "hygienic fibers" have become popular in apparel, bedding, carpeting and hosiery. The appeal of this technology is a perception of protection from infection and odor when these products are used or exposed to humans. This provides far-reaching ben-

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efits for the populations who utilize therapeutic hosiery.

Silver is the first element to be utilized in hosiery products. Currently available under the brand name X-Static®, silver treated fibers have been shown to be bacteriocidal and fungicidal against most common strains of microrganisms found on the feet of humans.[38] Silver has long been recognized for its benefit in treating wounds and continues to be a favorite ingredient of newer high tech wound dressings. Today, many companies offer socks composed of a small percentage of X-Static® treated fibers with proposed "anti-microbial" benefits for the user.

Another element with known anti-microbial activity is copper.[39,40] Copper sole socks utilizing a technology known as Cupron® have recently become popular in the therapeutic hosiery marketplace.[41] The main medical claim made by copper sole distributors is the anti-odor effects of these products.

Other anti-microbial chemicals have been added to sock fibers which are now being utilized in therapeutic hosiery. One long standing compound used in sock fibers is Microban®.[42] As with silver and copper fiber socks, claims have been made in the marketing of socks containing these anti-microbial ingredients, but few of the benefits have been substantiated with clinical studies. While there may be consumer appeal about the ability of these socks to keep the skin of the feet free of bacteria and fungus, no studies have been published showing this positive clinical outcome. At best, today's anti-microbial socks will have less tendency for odor. The development of socks which can prevent infection in the feet remains a goal for future research.

New fiber technologies have shown, in preliminary studies, the ability to increase the oxygen content at the skin surface of the feet and lower extremities. Holofiber® is a new proprietary product which alters the normal wavelength of visible light and transmits this to the skin of the user in the form of energy.[43] A preliminary study conducted by Lawrence Lavery, DPM showed a significant increase in transcutaneous oxygen of patients with diabetes who wore socks composed of Holofiber®. A recently published double-blind prospective study showed that compression stockings with silver impregnated fibers caused a significant increase in transcutaneous oxygen perfusion of the skin of the lower leg compared to regular hosiery.[44]

Nanotechnology is a new manufacturing technique which imbeds microscopic particles in fibers which can be released on the surface of the skin for potential therapeutic benefit. A new patented technology known as the Difoprev system (LVM Technolgies, Bologna, Italy) consists of a sock loaded with microcapsules containing an active moisturizer. This system is designed to continuously hydrate the skin of the foot of the patient with diabetes and autonomic neuropathy, thus reducing cracking, fissuring and hyperkeratosis. A recently published prospective controlled study showed that this nanotechnology-designed, hydrating sock system caused significant improvement of skin health in patients with diabetes.[45] The authors speculated that this system could be an additional preventive measure for ulceration of the feet of patients with diabetes.

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## Summary and Recommendations

The therapeutic hosiery market has grown exponentially over the past ten years, but very little research has been published relative to these products after the initial pressure-relief studies were conducted by ThorLo in the early 1990's. As a result, most of the claims made by therapeutic hosiery companies are not substantiated by clinical studies. These claims include "non-binding" effects, anti-microbial effects, and skin protection benefits.

Based upon previous published research and current technologies available in sock construction, the following recommendations can be made for the podiatric physician who prescribes therapeutic hosiery:

1) The most credible research on clinical benefits of therapeutic hosiery has focused on plantar pressure relief. The hosiery products showing significant benefit were constructed with dense padding under the heel and forefoot areas of the foot.

2) Shearing injury to the skin of the foot has been speculated to be more important than direct pressure. Double sock systems and heavily padded socks have shown documented benefit in reducing skin shear injuries of the foot.

3) Synthetic fiber socks are preferred to natural cotton fiber socks for use by patients with pathologic feet. Synthetic fibers offer superior moisture management, better resistance to shape deformation when wet, and better resilience compared to cotton fibers.

4) Therapeutic hosiery should contain adequate elastic for conformability, fit, and resistance to wrinkling inside of the shoe. Fears of "binding" of the upper portion of the sock are unwarranted, given the new technologies to eliminate constrictive banding at the top-line.

5) Newer anti-microbial sock fiber treatments have great consumer appeal but have yet to demonstrate, in published studies, any clinical benefits to the user. Still, addition of this technology to therapeutic hosiery can only be a positive at-

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tribute to improve hygiene of the product itself.

6) Therapeutic hosiery can have benefits for patient populations with venous insufficiency, when the upper of the sock covers the lower leg and has adequate compression features.

7) Sock-fitting is critical to assure benefit of padding and avoidance of constriction around key pressure areas. Newer therapeutic hosiery products are sized to a maximum of two size ranges. **PM**

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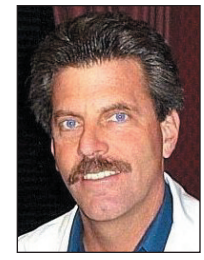

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Continuing Medical Education

SEE ANSWER SHEET ON PAGE 165.

1) Relief of plantar pressure with padded hosiery has shown a reduction as high as _____ when compared to going barefoot.
- A) 10%
- B) 20%
- C) 30%
- D) 80%

2) Relief of plantar pressure, inside of the shoe, provided by padded hosiery, can be expected on the order of:
- A) 1%
- B) 2%
- C) 3%
- D) 10%

3) Skin shear can occur during walking gait, as a result of:
- A) Plantar pressure
- B) Tangential attitude of foot strike
- C) Unequal leg length
- D) Neuropathy

4) Friction blisters of the feet can be reduced by socks with:
- A) Acrylic fibers
- B) Cotton fibers
- C) Thin padding
- D) Over-the-calf design

5) Studies on marching soldiers demonstrated significant reduction of blisters of the feet when wearing:
- A) Cotton socks
- B) Gore-Tex socks
- C) Copper sole socks
- D) Double sock systems

6) Over-the-calf athletic socks can:
- A) Reduce symptoms of venous insufficiency
- B) Heal ulcers
- C) Reduce bacteria
- D) Prevent Achilles injuries

7) Therapeutic socks may not be sized:
- A) According to exact foot size
- B) According to circumference of the foot
- C) According to modern foot measuring technique
- D) All of the above

8) Cotton fiber socks
- A) Absorb water better than acrylic
- B) Swell with water absorption
- C) Release moisture slowly compared to acrylic
- D) All of the above

9) Wicking describes the ability of a sock fiber to:
- A) Absorb moisture
- B) Repel moisture
- C) Move moisture along a gradient
- D) Attract heat

10) In terms of performance for therapeutic hosiery, synthetic fibers perform best in terms of:
- A) Moisture management
- B) Resistance to compaction
- C) Wicking
- D) All of the above

11) Reduction of shear and plantar pressure are important for patients with:
- A) Diabetes
- B) Rheumatioid arthritis
- C) Hallux valgus
- D) All of the above

12) All of the following are important characteristics of proper therapeutic hosiery EXCEPT:
- A) Padding
- B) Conforming fit
- C) Moisture management
- D) One size fits all

13) The following are used as anti-microbial additives for therapeutic hosiery EXCEPT:
- A) Copper
- B) Silver
- C) Microban
- D) Aluminum

14) Anti-microbial fibers in therapeutic socks can best be expected to:
- A) Prevent ulceration
- B) Prevent skin infection
- C) Prevent fungus toenail infection
- D) Prevent odor in the socks

15) Friction blisters of the feet represent a classic
- A) Shearing injury of the skin
- B) Ischemic injury of the skin
- C) Fungus infection
- D) Viral infection

*Continued on page 164*

Continuing Medical Education

# CME EXAMINATION

16) Increased moisture content on the skin of the feet is associated with all of the following EXCEPT:

A) Increased coefficient of friction
B) Risk of bacterial infection
C) Risk of viral infection
D) Peripheral edema

17) Diabetic neuropathy is associated with:

A) Hyperhydrosis
B) Anhydrosis
C) Spasiticy
D) Clonus

18) Padding in hosiery can be beneficial to patients with all of the following EXCEPT:

A) Cavus foot deformity
B) Rheumatioid foot deformity
C) Prominent plantar metatarsal head
D) All of the above

19) Therapeutic hosiery products:

A) Are FDA-controlled
B) Promote only scientific proven clinical benefits
C) Have potential for significant patient benefit
D) Are sized exactly to matching shoe size

20) The most important clinical benefit of therapeutic hosiery, as documented by published medical research, is

A) Relief of plantar pressures
B) Non-binding relief
C) Prevention of infection
D) Prevention of ulceration

**See answer sheet on page 165.**

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## EXAM #7/13
## Therapeutic Hosiery: An Essential Component of Footwear for the Pathologic Foot (Richie)

**Circle:**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | A | B | C | D | 11. | A | B | C | D |
| 2. | A | B | C | D | 12. | A | B | C | D |
| 3. | A | B | C | D | 13. | A | B | C | D |
| 4. | A | B | C | D | 14. | A | B | C | D |
| 5. | A | B | C | D | 15. | A | B | C | D |
| 6. | A | B | C | D | 16. | A | B | C | D |
| 7. | A | B | C | D | 17. | A | B | C | D |
| 8. | A | B | C | D | 18. | A | B | C | D |
| 9. | A | B | C | D | 19. | A | B | C | D |
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| Strongly agree [5] | Agree [4] | Neutral [3] | Disagree [2] | Strongly disagree [1] |
|---|---|---|---|---|

1) This CME lesson was helpful to my practice ____

2) The educational objectives were accomplished ____

3) I will apply the knowledge I learned from this lesson ____

4) I will makes changes in my practice behavior based on this lesson ____

5) This lesson presented quality information with adequate current references ____

How long did it take you to complete this lesson?

_____hour _____minutes

What topics would you like to see in future CME lessons ?

Please list :

_____

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